HORTSON Ogbomoso 2023

PROCEEDINGS OF THE 41st ANNUAL Conference

HORTICULTURAL SOCIETY OF NIGERIA (HORTSON)

Theme

Application of Science, Technology and Artificial Intelligence in Production and Practices of Horticulture

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EDITORS

Akanbi, W.B., Olaniyi, J.O., Olabiyi, T.I., Olatunji, O.O., Ipinmoriti R.R., Adesina, J.M., Ajayi, E.O. and Ojo, O.O.

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OF
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OF
HORTICULTURAL SOCIETY OF NIGERIA (HORTSON)

OGBOMOSO 2023

HOSTED BY:

LADOKE AKINTOLA UNIVERSITY OF TECHNOLOGY (LAUTECH), OGBOMOSO, OYO STATE, NIGERIA

THEME

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PROCEEDINGS OF 41ST ANNUAL CONFERENCE OF HORTICULTURAL SOCIETY OF NIGERIA (HORTSON) HELD ON NOVEMBER 12 – 16, 2023 AT THE GREAT HALL, LADOKE AKINTOLA UNIVERSITY OF TECHNOLOGY, OGBOMOSO, OYO STATE, NIGERIA

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PRESIDENTIAL ADDRESS AT THE OPENING CEREMONY OF THE 41ST ANNUAL CONFERENCE OF THE HORTICULTURAL SOCIETY OF NIGERIA (HORTSON) HELD AT THE LADOKE AKINTOLA UNIVERSITY OF TECHNOLOGY, OGBOMOSO, OYO STATE NIGERIA ON WEDNESDAY 15TH NOVEMBER, 2023

The Chairman of this occasion,
His Excellency, The Executive Governor of Oyo State,
Honourable Minister of Agriculture and Rural Development, Abuja,
Honourable Commissioners of Agriculture and Environment, Oyo State,
His Royal Highnesses here present,
The Vice Chancellor, LAUTECH, Ogbomoso,
The Chief Executives of Sponsoring Organizations,
Members of the Local Organising Committee, Ogbomoso 2023,
All Invited Guests and Fellows of HORTSON,
Distinguished Members of HORTSON,
Gentlemen of the Press,
Ladies and Gentlemen

I honourably welcome everyone to the 41st Annual Conference of this great Society, The Horticultural Society of Nigeria (HORTSON) holding here in LAUTECH, Ogbomoso, one of the ancient cities of Yoruba land, the land of valiant, and the second largest city in Oyo State (the Pacesetter State). I want to greatly appreciate our host, the Vice Chancellor **Professor Razaq Olatunde Rom Kalilu,** for his acceptance and support to host this Conference. This University is one of the top most ranked state Universities in Nigeria and unarguably, a nationally renowned Organic Agricultural practicing centre in Nigeria, As part of his support, the Vice Chancellor has provided the best of facilities on ground for a successful opening ceremony, this was in addition to other facilities for concurrent plenary sections during this conference. I want to use this opportunity to appreciate the entire University Management Staff, In-house Unions and particularly the Local Organizing Committee for working tirelessly in order to have a befitting conference.

The theme of this year's conference is **"Application of Science, Technology and Artificial Intelligence in Production and Practice of Horticulture".** This focuses on how to increase horticultural crops production in the midst of numerous challenges through the use of available research findings in Sciences, Technologies and Information Communication devices as tools. Horticultural trees and vegetable crops remain the surest solution to poverty eradication and food security and major means to improve the standard of living, income generation and foreign exchange earnings. Therefore, practicable knowledge of Science, Technology and Artificial Intelligence could be harnessed by individuals and government to enhance production under strict land tenure system. This will enhance cultivation, yield and income generation derivable from the production of horticultural crops.

Various government policies that could encourage and or mandate the adoption of Scientific and Technological recommendations as well as the use of ICT are needed in the areas of soil, crop managements, farmer security and easy access to credit facilities. It is my belief that this gathering of academia will come up with resolutions that will provide lasting solutions that will make our country not only secure for the citizenry but also to the farmers in particular with the sole aim to promote self-sufficiency in food production as well as increase in revenue generation. In order for this to become a reality, we have here today selected seasoned speakers for this year conference to do justice to the topic.

Let me state here that preparation towards the National Summit for all Horticulturists in Nigeria to review and set a draft document towards registration of the proposed Council for Regulation of Horticulture (CORHORT) in Nigeria is at its peak and necessary observation or information from members toward this could be sent to the council using info@hortson.org.ng. This will make horticulture a profession and enable production of horticultural crops that are safe for consumption by accredited bodies a reality.

In the last two years, the membership strength of the Society has increased and we appreciate the efforts of both the old and new members of the society on this, it has been a joint effort by all. However, we seek your continued support in the promoting of the society in our various institutions. The promise of the Council members is that, the HORTSON as a Society will continue to employ every available means to add value to each registered member, it is a promise that we shall keep. Therefore, we encourage everyone to share their academic research and publication challenges with the society because a problem share is a problem half solved.

As I stated in my first year speech as the PIC, the Nigerian Journal of Horticultural Science (NJHS) had enjoyed the full support from the Council. The number of issues per Volume has increased to four yearly. The Journal remains one of the most highly cited in the field of Agriculture in Nigeria today. I want to appreciate the Editorial team for this success. Some of the recent issues for the Volume 27 are here today for the purpose of launching. I am sure that many of our dignitaries will be generous towards considering the present high cost of production.

Fellow members of HORTSON, I want to appeal to every one of us that we should improve on our financial performance as registered members of the Society. The annual due is a must for all members. This is the major source of fund to run the Society. The insecurity in the country has affected attendance at our past annual conferences, and this had affected attendance and payment of annual dues. However, we appreciate the strong commitment of our Fellows, Associate and Student members, who despite the prevailing economic challenges, still find it necessary to be present at our conferences. Thank you all.

In conclusion, my appreciation goes to the entire Council members, the LOC Chairman and his team for their efforts at organising this 2023 Annual Conference. Ladies and Gentlemen, I wish to thank you all for your support and for finding time to attend this opening ceremony despite the economic challenges facing our country. My profound gratitude goes to our Host, The Vice chancellor, **Professor Razaq Olatunde Rom Kalilu**, for making this Conference a memorable one and to our distinguished Fellows of HORTSON for their present here today.

Thanks and God bless you all.

Long live the Horticultural Society of Nigeria

IPINMOROTI, R. Rotimi (PhD)
PRESIDENT-in-COUNCIL

**WELCOME ADDRESS BY THE ACTING VICE CHANCELLOR,
LADOKE AKINTOLA UNIVERSITY OF TECHNOLOGY, OGBOMOSO,
PROF R. O. ROM KALILU
AT THE 41ST ANNUAL CONFERENCE OF HORTICULTURAL SOCIETY OF NIGERIA
HELD AT LADOKE AKINTOLA UNIVERSITY OF TECHNOLOGY, OGBOMOSO, NIGERIA
ON WEDNESDAY 15 NOVEMEBR 2023**

Protocols

Your Excellency, the Executive Governor of Oyo State,
Visitor to the University and Chairman of this Occasion,
Honourable Commissioner for Agriculture,
Royal Majesties and Highnesses,
Vice Chancellors of other universities,
Principal Officers of this University,
Distinguished stake holders in Horticulture,
Distinguished ladies and gentlemen.

It is a great pleasure for me to welcome you all to the Ladoke Akintola University of Technology, Ogbomoso, a beautiful university set within the serene and peaceful land of the valiants whose other preoccupation is traditionally horticulture. It is also my privilege to welcome you to this year's conference of the Horticultural Society of Nigeria, the 41st in its series. The Horticultural Society of Nigeria, established in 1997, promotes the advancement and development of the science and art of Horticulture in Nigeria. Horticultural practices remain the surest solution to poverty eradication, food security and a major means to improve standard of living, income generation and foreign exchange earnings in Nigeria. The theme of this year's conference, "Application of Science, Technology and Artificial Intelligence in Production and Practice of Horticulture" cannot be more appropriate for a conference hosted by a university of technology, moreover by the prestigious Ladoke Akintola University of Technology, Ogbomoso. The University has been consistently rated high in world university rankings and has been consecutively adjudged to be the best state university in Nigeria for several years. It is currently the 7th overall best Nigerian university for research. This University has a lot to contribute to this theme and the studies of horticulture. The University is blessed with abundant cultivable lands and a very rich pool of remarkable scholars in diverse disciplines whose research orientations are technology based. The University is also into large scale production of horticultural crops like ginger, turmeric and lemon grass as well as cashew plants produced under organic conditions, and which placed the University on global recognition as the first certified organic horticultural crops producers in Nigeria. While wishing you fruitful deliberations, I want to assure you of this University's commitment to partner with diverse stakeholders in the horticultural sector to boost research and productions towards economic development and food security across the globe.

Thank you for your attention

KEYNOTE ADDRESS PRESENTED AT THE 41ST ANNUAL CONFERENCE OF THE HORTICULTURAL SOCIETY OF NIGERIA (HORTSON) HELD AT THE LADOKE AKINTOLA UNIVERSITY OF TECHNOLOGY, OGBOMOSO, OYO STATE NIGERIA ON WEDNESDAY 15TH NOVEMBER, 2023

TOPIC:
URBAN HORTICULTURAL TECHNOLOGY AS A VERITABLE STRATEGY IN ENHANCING FOOD SECURITY AND POVERTY ALLEVIATION

BY
Odunayo Clement ADEBOOYE,
PhD (Ibadan), Fellow UNU, Fellow DAAD, Fellow AvH
Vice-Chancellor, Osun State University, Osogbo

Preamble:
I want to express profound gratitude to the Executive Committee of the Horticultural Science Society of Nigeria (HORTSON) for inviting me to function as the Keynote Speaker at this 41st Annual Conference of the professional body. I particularly thank the Ag Vice-Chancellor of LAUTECH, Prof ROM Kalilou for allowing me entry into LAUTECH and for warmly welcoming me into this campus. I want to thank the generality of our association (HORTSON) for counting me worthy and for unanimously agreeing to my nomination to deliver this keynote to mark the commencement of our 41st Annual Conference and meeting holding here in Ogbomosho. This type of Lecture often offers policy institutions the opportunity to gain ideas for public policy formulation in order to drive regional and national development in the area of food security. My speech today will centre around the theme of this conference to catapult our nation-Nigeria to achieve food security. The Yoruba people say, "*Bi ounje ba ti kuro ninu ise, ise buse*". The same people also say, "*Oun ti a o je lagba oun ti a o se*". In their wisdom, the same people say, "*Ebi kii wo inu ki oro miran wo*". Satirically too, the Yoruba people say, "*Eni ebi n pa ko gbo yago*". The English also say, "*The three basic needs of human are Food, water and shelter*". The meaning is that food is the first unnegotiable option for human survival. Even in prison, where people are supposed to be serving some forms of punishment, food is provided to keep the inmate alive so that he can serve punishment. You can see how critical food is. This is the reason that we should start to interrogate the state of horticultural food production in Nigeria and thus place our interests correctly to develop and motivate the producer-the farmers, the food sellers-marketers and the value addition sectors-Processors. We should thank the eaters-Consumers…….. This is the reason that I will engage you in the next 30 minutes or so to chat with you on the topic, "**Urban Horticultural Technology as a Veritable Strategy in Enhancing Food Security and Poverty Alleviation"**

Introduction
Horticulture, the science and art of cultivating fruits (Pomology), vegetables (Olericulture), and ornamental plants (Floriculture), is undergoing a remarkable transformation in the face of advances in Science, Technology and Artificial Intelligence (AI). These advancements are not only shaping the future of horticulture but are also instrumental in addressing the pressing challenges of global food security, sustainability, poverty alleviation, climate change adaptation, resource use efficiency etc.

United Nations' Committee on World Food Security (2013) defined food security as when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. But we have a shocker as documented in the Holy Bible Deuteronomy 15:11, "*the poor will never cease to be in the land*" and seems to be in direct contradiction to Deuteronomy 15:4, "*there will be no poor among you, since the LORD will surely bless you in the land which the LORD your God is giving you as an inheritance to possess*." Can food security as defined by the UN be a reality? By 2050, food demand is projected to increase by 59–98% in order to feed 9.7 billion people, of which 70% will be living in urban areas (United Nations Department of Economic and Social Affairs, 2019).

Saifaddin Galal (2023) in 2023 reported that nearly 12% of the world population in extreme poverty lived in Nigeria, considering the poverty threshold at US$1.90 a day. While the number of people living in extreme poverty in Africa was estimated to reach 422 million in 2025. With a fast-growing population of nearly 240 million, Nigeria is the leading country in Africa by number of inhabitants. For this reason, among others, the burden of unemployment has been prevalent over the years, leaving the labor dependency ratio forecast at 2.6% in 2022. In that year, the total labor force was estimated to increase to over 67 million. Together with the rising active population, the number of unemployed residents was also estimated to grow to reach over 63 million in 2021.

Overall, the unemployment rate in Nigeria has increased considerably, rising to 9% in 2020. Urbanization is an irreversible global trend, with more than half of the world's population now residing in cities. This rapid urban growth poses significant challenges, including ensuring food security for urban populations and addressing poverty, particularly in vulnerable urban communities. Urban horticultural technology has emerged as a promising strategy to tackle these challenges, offering a multitude of benefits. This paper discusses the role of urban horticultural technology in enhancing food security and poverty alleviation in urban and peri-urban areas. Over the recent years, urban farming has revealed its superiority over conventional farming (Keong and Mahkeswaran 2021). Conventional farming often adopts environmentally unsustainable practices, which can lead to deforestation, land degradation, environmental pollution, excessive water usage, and high carbon footprint (Clercq *et al.*, 2018). The drawbacks of conventional farming, along with the fast reduction of arable land, give rise to the development of urban farming – a practice of cultivating, processing, and distributing crops and livestock in urban areas (Mok *et al.*, 2020).

The current Urban farming techniques are:

1. Vertical farming: The concept of vertical farming is to farm up instead of farm out. Fish and vegetable crops in vertical farming are grown in vertically stacked layers on rooftops, building facades, or inside commercial or residential buildings, restaurants, grocery stores, greenhouses, warehouses, or shipping containers (Benke and Tomkins 2017)

2. Indoor farming: The method of growing plants and crops on a large or small scale entirely indoors and with the help of hydroponics and artificial light is known as Indoor Farming or Indoor gardening. Artificial light is required for providing the plant with nutrients and it also contributes to plant growth.

3. Hydroponics: It involves plants growing in soilless media where their roots are directly submerged in nutrient-rich solution (Jai *et al.*, 2018)

4. Aeroponics: It involves spraying nutrient-rich solution onto the plant roots periodically (Rahman *et al.*, 2018)

5. Aquaculture: entails farming of fish and shellfish in all kinds of water environments (Keong and Mahkeswaran 2021).

6. Aquaponics: combines aquaculture and hydroponics in a symbiotic closed-loop ecosystem. Fish excretes wastes in the form of ammonia. The ammonia is converted into nitrite and then nitrate by nitrifying bacteria. The nitrate-enriched water is pumped to the grow beds and provides natural fertilizer for the growth of plants. In return, the plants clean the water that flows back to the fish tanks (Alyssa *et al.*, 2019)

To explore the full potential and benefits of the urban farming techniques, new technological innovations are evolving such as:

1. Internet of Things (IoT)

It refers to an internet-connected network of multiple physical devices that can collect and share data with minimal human intervention (Kumar *et al.*, 2020). The global IoT platform market size is projected to hit USD 13.310 billion by the end of 2026, with a compound annual growth rate of 28.5% in 2021–2026 (Valuates Report 2020). Instant messaging software can be activated to send early warning alerts and notifications to farm operators so that immediate intervention can be done to prevent farm conditions from worsening (Li et. al., 2019). Multiple IoT-enabled farms can exchange information and interact with one another (Kodali and Valdas, 2018). IoT enables farm operators to remotely monitor their farm conditions in real time from anywhere at any time on any smart mobile devices (Sadiku *et al.*, 2020)

2. Automation

Agriculture involves multiple and repetitive operations, making automation a viable technology to improve urban farming processes (Keong and Mahkeswaran 2021). Hydroponics systems can be automated by deploying sensors to monitor environmental factors (e.g., air temperature, humidity, and light intensity). If any of these factors exceed the ideal conditions for crop growth, their corresponding actuators (e.g., air conditioners, ventilation fans, and grow lights) will automatically rectify the situation. Automating routine processes can significantly reduce manual labour. The implementation of fully automated farms can bring about entire farms managed by just a farm operator (Charania and Li 2020).

3. Artificial Intelligence (AI)

AI is a field of computer science that enables computers and machines to make decisions like human beings (Tian *et al.*, 2020). To make smart decisions independently, computers and machines need to be taught using machine learning (ML) algorithms; these algorithms can be broadly classified into four categories: supervised, unsupervised, semi-supervised, and reinforcement (Sarker 2021). Examples of common ML algorithms are linear regression, logistic regression, support vector machines, Naïve Bayes, decision trees, random forests, k-nearest neighbours, k-means clustering, and artificial neural networks. AI can analyze soil and water, as well as identify potential pests, weeds, and diseased plants so that proper irrigation, specific pesticides and fertilizers can be timely applied to plants that need treatments (Tian *et al*., 2020), hence cut down labour load on farm operators, decreasing yield loss and increasing farm productivity. Precise utilization of resources by AI helps lessen wastes and emissions in production (Mungai *et al*., 2019).

4. Robotics

Robotics is the unity of mechanical, electrical, and computer engineering to fabricate machines that can perform complex tasks based on pre-programmed instructions (Charania and Li 2020). Routine tasks, such as crop monitoring and watering, can be carried out by pre-programmed robots or drones. Required fertiliser or pesticide can be delivered to individual plants in a precise manner by robots. Drones are capable of sustained flight; they can provide a top view of rooftop farms, as well as a deterrence to pests (Sadiku et. al., 2020). Robots allow farm operators to monitor and manage farms without needing to move from their comfort. Tasks that pose hazards, such as handling chemicals and working at heights, can be easily managed by dispensable robots (Aisyah *et al*., 2019).

5. Blockchain

With the introduction of cryptocurrencies like Bitcoin, blockchain technology has elicited substantial attention from many industries. Moving away from a traditional centralised server, blockchain adopts a decentralised, open, cryptographically managed network of blocks to store information (Sadiku *et al*., 2020). Through blockchain, food can be traced back to the production farm, making food regulation more manageable and effective. Blockchain also provides an efficient tamper-resistant avenue to track the food journey through the supply chain, while keeping the consistency of product ownership and reducing the need for inefficient crop certifications. Other product information (e.g., batch number and expiry dates) can be stored; this addresses food safety, traceability, and quality, which in turn combat food fraud, safety recalls, and other supply chain inefficiencies (Mistry *et al*., 2020).

6. Digital Twins

A digital twin is a virtual representation of a physical system which uses simulation and AI to mirror system properties and behaviours in real time, embodying all statuses and information of the physical system. With digital twins, farm operators need not be physically at agricultural site to monitor, control, coordinate, and execute farm operations (Verdouw *et al.*, 2012). Virtual models of farm operating parameters such as energy and water consumption can guide farm operators in decision making, thereby maximizing yields while minimizing energy and water usage (Benis *et al*., 2017).

7. Renewable Energy

Solar energy and wind energy are two well-known clean and renewable energies (Campana *et al*., 2015). Both solar and wind energies can be utilized to power electrical equipment in the farms, for example, air blowers, water pumps, air conditioners, ventilation fans, and grow lights. Agrivoltaics combines crop cultivation and solar energy production with solar panels on the same land area. The shade provided by the panels lowers plant surface temperature and evaporation, decreasing plant drought stress and increasing plant biomass production (Barron-Gafford, *et al.*, 2019). At the same time, the plants reciprocate by keeping the panels cool and lowering panel heat stress (Keong and Mahkeswaran 2021).

8. Nanotechnology

Nanotechnology is the manipulation of nanomaterials with dimensions of less than 100 nanometres (Zhao *et al.*, 2020). Nanoencapsulated pesticides or fertilisers ensure that the optimal amount is administered to the plants, thus enhancing growth while lessening stress on the plants. Other benefits are increased germination success, improved root size and length, and enhanced photosynthetic and nitrogen metabolism activities (Agrawal *et al.*, 2014). Controlled environmental agriculture can be improved by using nanosensors to estimate crop harvest time, detect crop health, and determine microbial or chemical contamination on crops (Keong and Mahkeswaran, 2021).

Benefits of Urban horticultural technology

Local Food Production and Year-Round Availability

Urban horticultural technologies, such as vertical farming, hydroponics, and rooftop gardens, are instrumental in facilitating local food production within cities. By reducing the need for long-distance transportation, these methods minimize food losses and the associated environmental impact. Furthermore, controlled environments enable year-round cultivation of crops, ensuring a consistent food supply even in adverse weather conditions.

Space-Efficient Farming

Urban areas are often characterized by limited space, making efficient land use a necessity. Urban horticultural technology maximizes space utilization through innovative approaches. Rooftops, walls, and small plots can be transformed into productive gardens, effectively addressing the challenge of space constraints and enabling urban areas to meet the growing demand for fresh produce.

Diversification of Crops

A diverse diet is essential for good health. Urban horticultural technology supports the cultivation of a wide variety of crops, including fruits, vegetables, herbs, and even non-traditional crops. This diversification not only contributes to food security but also promotes a balanced diet.

Community Engagement and Job Creation

Urban agriculture is not only about growing food; it also fosters community participation and social cohesion. Community gardens and urban agriculture initiatives empower local residents, including marginalized communities, by providing employment opportunities in cultivation, maintenance, and distribution of produce.

Access to Fresh Produce and Reducing Food Deserts

Urban farming enhances access to fresh, nutritious, and locally grown produce, significantly improving the dietary quality of urban residents. In areas characterized by food deserts, where access to fresh and healthy food is limited, urban horticultural initiatives become a lifeline for better nutrition.

Resource Efficiency and Climate Resilience

Controlled urban horticultural technologies are resource-efficient. For example, hydroponics and aquaponics require less water compared to traditional agriculture. Moreover, the practices employed in urban farming enhance climate resilience by diversifying food sources and reducing the carbon footprint associated with long-distance food transport.

Waste Reduction and Empowerment

Urban horticultural technology can incorporate sustainable waste management practices. By composting and recycling organic waste, these initiatives reduce the overall waste generated by urban areas. Furthermore, they have the potential to empower vulnerable and underserved populations, offering training, resources, and economic opportunities for those who need them most.

Precision Agriculture and Smart Farming

Advances in science and technology is most pronounced in precision agriculture. Modern horticulturists are harnessing the power of remote sensing, imaging, and predictive analytics to optimize their farming practices. Satellites, drones, and ground-based sensors provide real-time data on crop health, growth, and water requirements. AI algorithms then analyze this data to offer insights into resource allocation, enabling farmers to make informed decisions. Predictive analytics, driven by AI, forecasts crop yields, identifies potential diseases, and recommends optimal harvest times. This technology allows for resource-efficient and environmentally sustainable practices.

The advent of smart farming has ushered in a new era of efficiency and automation. Network of sensors and actuators that monitor and control various environmental factors, such as temperature, humidity, and irrigation have also been innovated. Data collected from these sensors is then analyzed using AI, allowing for automated adjustments to optimize growing conditions. Moreover, automated systems, including robots and machinery, are capable of performing labor-intensive tasks such as planting, weeding, and harvesting. This automation not only reduces labor costs but also ensures precision and consistency in farming practices.

Advances in Plant Breeding

Science and technology have significantly impacted the field of plant breeding. Genomics, the study of an organism's entire genetic makeup, has empowered horticulturists to develop crop varieties that are resistant to diseases and more tolerant of changing climates. The rise of CRISPR-Cas9 gene-editing technology has taken this a step further by enabling precise modifications of plant genomes to enhance desirable traits. These innovations in plant breeding hold the promise of addressing food security concerns by creating crops that are resilient and productive in challenging environmental conditions.

Sustainability and Environmental Monitoring

A critical aspect of modern horticulture is sustainability. With the aid of AI, horticulturists are adopting sustainable practices that are eco-friendly and resource-efficient. Biological pest control, for example, is facilitated by AI monitoring systems that track pest populations and release beneficial insects precisely when needed, reducing the reliance on chemical pesticides. Additionally, water management is optimized through AI, ensuring that irrigation schedules are tailored to minimize water use and prevent wastage. AI also plays a pivotal role in climate control, particularly in greenhouses and indoor farming environments. These controlled environments provide ideal conditions for plant growth. AI algorithms can efficiently manage variables like temperature, humidity, and lighting to create the perfect microclimate for crops, ensuring optimal yields and resource efficiency.

Quality Control and Food Supply Chain

Quality control in horticulture is a critical aspect of ensuring that consumers receive the best produce. Computer vision, a technology driven by AI, assesses the quality and ripeness of fruits and vegetables. Automated sorting and grading systems, ensure that only top-quality produce reaches the market. Furthermore, in the food supply chain, AI is instrumental in predictive maintenance, which forecasts equipment maintenance needs, reducing downtime and ensuring the smooth operation of storage and transportation facilities. Additionally, blockchain technology, a distributed and tamper-proof ledger, enhances traceability and transparency in the supply chain. This reduces food spoilage and mitigates the risk of fraudulent practices.

The integration of science, technology, and AI in horticulture is nothing short of a revolution in the way we grow and distribute food. These innovations are essential for addressing the complex challenges of a growing global population, resource scarcity, and climate change. The application of precision agriculture, smart farming, sustainable practices, and advances in plant breeding are not only enhancing food security but are also promoting resource efficiency and environmental sustainability. The fusion of science, technology, and AI is propelling horticulture into a new era of productivity, sustainability, and resilience that will foster food security and poverty alleviation.

Urban horticultural technology is a transformative strategy for promoting food security and alleviating poverty in urban settings. By making the most of limited urban space, diversifying food production, creating jobs, and improving access to fresh produce, urban agriculture contributes to healthier and more sustainable cities. As urbanization continues, the integration of horticultural technology in urban planning becomes not just a choice but a necessity, ensuring that our cities are not only livable but also nourishing and inclusive for all.

Conclusion:

Distinguished ladies and gentlemen, we are all partners in progress to ensure that we help our nation to escape from the present bondage of inefficient and ineffective “food security strategy and poorly implemented policy on development of horticultural business in Nigeria”. The World Bank (2022) reported that Nigeria experienced its deepest recession in two decades, but growth resumed in 2021 as pandemic restrictions were eased and oil prices recovered to counter the economic shock. Nigeria, like other countries in Africa was highly vulnerable to the global economic disruption caused by COVID-19, particularly due to lock down of businesses and farms. Oil accounts for over 80% of exports, a third of banking sector credit, and half of government revenues. In 2021, 40% of Nigerians (83 million people) lived below the poverty line, while another 25% (53 million) were vulnerable. The number of Nigerians living below the international poverty line is expected to rise by 12 million in 2019–23, no thanks to the unpredictability of economic indices on a global scale and general gloomy economic outlook.

As a nation, our economic outlook remains highly uncertain because of the volatility in the oil sector and weaknesses in the financial sector. Even in the most favorable global context, the policy response of Nigeria’s authorities will be crucial to lay the foundation for a robust economy and food security through serious promotion of horticultural business. That policy recovery should be hinged on honest investment in agriculture, particularly horticultural technology. There is nothing that can replace food. Man must eat… Food must always be available for sale to everybody, whether they like it or not. Petrol can be replaced and you may be surprised to see very soon vehicles that will use water as fuel….. The only seriousness we can demonstrate as a nation is to focus on innovative food production through the development of urban horticultural crop technology because it is the only business that cannot and will never fail, for as long as the earth lives.

Distinguished guests, officers of the HORTSON, farmers and other stakeholders, I thank you for tolerating me and for listening.

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LEAD PAPER PRESENTED AT THE 41ST ANNUAL CONFERENCE OF THE HORTICULTURAL SOCIETY OF NIGERIA (HORTSON) HELD AT THE LADOKE AKINTOLA UNIVERSITY OF TECHNOLOGY, OGBOMOSO, OYO STATE NIGERIA ON WEDNESDAY 15TH NOVEMBER, 2023

TOPIC: DEPLOYMENT OF ARTIFICIAL INTELLIGENCE IN HORTICULTURAL CROP PRODUCTION

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BACKGROUND

Horticulture holds significant importance in a country due to its economic, nutritional, and environmental contributions (Cyprian and Ndubisi, 2023). It encompasses the production of fruits, vegetables, flowers, and ornamental plants, which serve as essential components of a nation's food supply, export commodities, and beautification efforts (Jaskani and Khan, 2021). Horticulture plays a crucial role in ensuring food security and promoting healthy nutrition all over the world. The cultivation of fruits and vegetables provides a diverse range of essential vitamins, minerals, and dietary fiber, contributing to a balanced diet and improved public health. Moreover, the ornamental plants and flowers produced in horticulture contribute to aesthetic enhancement, tourism, and the cultural identity of a country. Despite its significance, horticultural crop production in many countries faces several challenges that hinder its full potential, such as limited access to modern agricultural practices and technologies, inadequate infrastructure and storage facilities, pest and disease management, climate variability, and water scarcity. Technology plays a crucial role in addressing the challenges faced in horticultural crop production.

Artificial Intelligence (AI) refers to the simulation of human intelligence in machines, enabling them to perform tasks that typically require human intelligence, such as perception, reasoning, problem-solving, learning, and language understanding. AI systems rely on algorithms, statistical models, and machine learning techniques to process and interpret information, adapt to new situations, and improve their performance through experience. By leveraging technological advancements, farmers can overcome these challenges and enhance productivity (Dinrifo *et al.,* 2022). With the advent of AI in agriculture, new technologies are being implemented to modernize and transform traditional methods of farming. This paper is aimed at identifying and highlighting how AI has been effectively deployed in horticultural production and how it can be further used.

OVERVIEW OF IMPLEMENTING AI TECHNOLOGIES IN HORTICULTURE PRODUCTION

AI technologies are revolutionizing horticulture production by enabling precision agriculture, crop monitoring, disease detection, automation, and data-driven decision-making. Integrating AI in horticulture improves resource management, enhances productivity, reduces environmental impact, and promotes sustainability. As AI continues to advance, horticulturists can leverage these technologies to optimize crop production, address challenges, and meet the increasing global demand for fresh and sustainable produce. Here are some key AI technologies and their applications in horticulture:

1. **Internet of Things (IoT) and Sensors**: IoT devices and sensors play a crucial role in collecting real-time data from the field. These sensors measure parameters such as soil moisture, temperature, humidity, light intensity, and nutrient levels. AI algorithms process this data to provide insights into optimal irrigation schedules, fertilization requirements, and environmental conditions for specific crops. By integrating IoT and AI, horticulturists can make data-driven decisions, ensure resource efficiency, and promote sustainable practices.
2. **Computer Vision and Imaging**: Computer vision technology enables the analysis of images and videos to extract valuable information about plant health, disease detection, and growth patterns. AI algorithms can identify and classify diseases, pests, and weeds based on visual cues, allowing for early intervention. Additionally, computer vision enables the assessment of crop quality, fruit ripeness, and yield estimation; facilitating informed harvesting decisions and post-harvest management.

3. **Robotics and Automation**: AI-powered robots and automated systems are transforming labor-intensive tasks in horticulture. Robots equipped with computer vision and machine learning can perform activities like planting, pruning, and harvesting with precision and efficiency. These technologies reduce the reliance on manual labor, alleviate labor shortages, and enhance productivity. Automated systems can also handle logistics, sorting, and packaging, streamlining the supply chain and reducing post-harvest losses.
4. **Machine Learning and Predictive Analytics**: Machine learning algorithms enable the analysis of large datasets to identify patterns, make predictions, and provide actionable insights. In horticulture, machine learning models can predict crop yields, optimize planting schedules, and recommend optimal nutrient management strategies. By analyzing historical data and environmental factors, AI can help horticulturists anticipate and adapt to changing conditions, mitigate risks, and optimize production processes.
5. **Decision Support Systems**: AI-powered decision support systems assist horticulturists in making informed decisions. These systems integrate data from various sources, including weather forecasts, market trends, and crop models; to provide recommendations on planting, harvesting, pest control, and resource allocation.

BENEFITS OF AI IN HORTICULTURE

1. **Field management:** Using high-definition images from airborne systems (drones or copters), real-time estimates can be made during the cultivation period by creating a field map and identifying spots where crops need water, fertilizer, or pesticides. This will sustain resource optimization to a great extent.
2. **Weather forecasting:** This is important in the horticulture industry as numerous intercultural operations depend on the weather. Machine Learning technology can be handy in using algorithms in connection with satellites to predict changing weather on a daily basis. These algorithms can also be used to predict crop health without contact with large fields. Machine learning also widens the scope of prediction and detection of pests and pathogens in the farmer’s field (Anonymous, 2019).
3. **Soil Health Analysis:** Soil health in terms of both moisture and nutrients is a basic need for horticultural crops. Nutrient and moisture-rich soils not only enhance yield but also increase fruit quality (Sennar, 2019). Both artificial intelligence and machine learning have the potential to build algorithms and sensors for detecting and quantifying moisture and nutrients in the soil. Robots may also be used to quantify soil nutrients, which may give predictive analysis for the recommended dose of fertilizer and irrigation.
4. **Agrochemical Production:** Horticultural crops require numerous synthetic chemicals, such as plant bioregulators, weedicides, pesticides, etc., for high production and quality. These chemicals have a tendency to remain in the soil and have plant-enhancing toxicity. Moreover, these chemicals enter the food chain, creating various metabolic ruptures. Machine learning with Big Data Analytics can be used to develop models that may help in the production of appropriate agrochemicals by capturing images of pathogens, weeds, and pests (Baruah, 2019).
5. **Post-Harvest Management:** Post-harvest processes such as cleaning, sorting, and grading can be done using Artificial Intelligence and Robots. Sensors can also be used in storage and warehouses to detect stored pests and pathogens. About 40% of horticultural produce is wasted as post-harvest loss. Machine learning and Digital Image Processing can be used to reduce such losses, which may enhance annual horticultural production (Kamilaris, 2018).

HORTICULTURAL PRODUCTION IN NIGERIA

Horticulture holds significant importance in Nigeria due to its economic, nutritional, and environmental contributions. It encompasses the production of fruits, vegetables, flowers, and ornamental plants, which serve as essential components of the nation's food supply, export commodities, and beautification efforts. Horticulture plays a crucial role in ensuring food security and promoting healthy nutrition in Nigeria. The ornamental plants and flowers produced in horticulture contribute to aesthetic enhancement, tourism, and the cultural identity of Nigeria. The cultivation of fruits and vegetables provides a diverse range of essential vitamins, minerals, and dietary fiber, contributing to a balanced diet and improved public health. Fruits and vegetables are among these crops that play a critical part in global horticultural production and exports.

Nigeria's export of fruits and vegetables has fluctuated substantially throughout the years (1970-2019). However, exports of fruits and vegetables from Nigeria were recently valued at 254,137.00 US dollars at the end of 2019 (Okorie and Nwachukwu, 2022). Horticultural crop production plays a vital role in

Nigeria's economy, contributing to the income improvement of rural communities and creating employment opportunities, particularly for youth and women. Despite its significance, horticultural crop production in Nigeria faces several challenges that hinder its full potential, such as; Limited access to modern agricultural practices and technologies, Inadequate infrastructure and storage facilities, Pest and disease management, Climate variability, and water scarcity. Technology plays a crucial role in addressing the challenges faced in horticultural crop production in Nigeria.

CASE STUDIES OF IMPLEMENTATION OF AI IN HORTICULTURAL CROP PRODUCTION

1. **Blue River Technology – Weed Control:** Controlling weeds is one of the top concerns for farmers, where an estimated 250 species of weeds have become resistant to herbicides. A California-based startup company developed a robot called “See & Spray” which reportedly leverages computer vision to monitor and precisely spray on weeds. Precision spraying can help prevent herbicide resistance. It precisely sprays fertilizers directly to the plant that needs it. This could save about 90% amount of herbicide that would be needed to spray in the entire field (Songthat, 2020).
2. **AI -Driver Less Tractor:** Driverless tractor has been introduced using ever-more sophisticated software coupled with off-the-shelf technology (sensors, radar, and GPS), the system which allows an operator working a combine to set the course of a driverless tractor. For the first time, Case IH and New Holland both introduced their new autonomous tractors at the 2016 Farm Progress Show (Songthat, 2020).
3. **FarmShots-Satellites for Monitoring Crop Health and Sustainability**: Based in Raleigh, North Carolina, FarmShots is another startup focused on analyzing agricultural data derived from images captured by satellites and drones. Specifically, the company aims to “detect diseases, pests, and poor plant nutrition on farms.” The company claims that its software can inform users exactly where fertilizer is needed and can reduce the amount of fertilizer used by nearly 40 percent. Hyperspectral imaging and 3D Laser scanning are capable of rapidly providing enhanced information and plant metrics across thousands of acres with the spatial resolution to delineate individual plots and/or plants and the temporal advantage of tracking changes throughout the growing cycle.
4. **Where - Satellites for Weather Prediction and Crop Sustainability**: ‘aWhere’, a Colorado-based company uses machine learning algorithms in connection with satellites to predict the weather, analyze crop sustainability, and evaluate farms for the presence of diseases and pests. The company provides its users with access to over a billion points of agronomic data on a daily basis. Data sources include temperature, precipitation, wind speed, and solar radiation, “along with comparisons to historic values for anywhere on the agricultural earth.”

Key Challenges and Limitations of AI in Horticulture

While AI offers great potential in horticulture, there are several technical challenges and limitations that need to be addressed. Here are some of the key challenges:

1. **Data Availability and Quality**: AI algorithms rely on large and diverse datasets for training and validation. However, acquiring high-quality horticultural data can be challenging due to various factors such as limited access to data, data privacy concerns, and data annotation requirements. Additionally, the availability of labeled datasets that cover a wide range of crops, diseases, and environmental conditions is often limited, making it difficult to develop accurate and robust models.
2. **Lack of Standardization**: There is a lack of standardized data formats, protocols, and platforms in horticulture, making it challenging to integrate data from different sources. Inconsistent data formats and variable data quality across different systems hinder the seamless exchange and analysis of data. Standardization efforts are necessary to facilitate data interoperability and improve the effectiveness of AI applications in horticulture.
3. **Adaptability to Diverse Crop Varieties and Growing Conditions**: Horticulture encompasses a wide range of crops, each with unique growth patterns, phenotypic characteristics, and environmental requirements. Developing AI models that can effectively adapt to different crop varieties and growing conditions is complex. Models trained on one crop may not generalize well to others, requiring significant efforts to customize and fine-tune AI algorithms for specific crops.
4. **Interpretability and Explainability**: AI models often operate as black boxes, making it challenging to interpret and explain their decisions. In horticulture, where decisions can have significant consequences on crop health and yield, it is crucial to understand the reasoning behind AI-generated recommendations. Ensuring transparency and interpretability of AI algorithms is necessary for building trust among growers and stakeholders.

5. **Limited Real-Time Decision-Making**: Some AI applications in horticulture, such as crop monitoring and disease detection, require real-time decision-making capabilities. However, the computational requirements and latency associated with training and deploying AI models can be a limitation. Real-time data processing, model deployment, and feedback loops pose technical challenges that need to be addressed to enable timely decision-making in horticultural operations.
6. **Cost and Infrastructure:** Implementing AI solutions in horticulture may require significant investments in hardware, software, and infrastructure. High-performance computing resources and storage capabilities are often necessary to handle large datasets and computationally intensive AI algorithms. The cost of acquiring and maintaining such infrastructure can be a barrier, particularly for small-scale growers or resource-constrained regions.

EMERGING TRENDS AND ADVANCEMENTS IN AI FOR HORTICULTURAL CROP PRODUCTION

1. **Advanced Sensing Technologies**: The integration of advanced sensing technologies, such as hyperspectral imaging, LiDAR, and multi-sensor fusion, holds great promise for enhancing AI applications in horticulture. These technologies can provide detailed information about plant physiology, nutrient status, and environmental conditions, enabling more accurate monitoring, diagnosis, and decision-making.
2. **Edge Computing and IoT:** The rise of edge computing and the Internet of Things (IoT) enables real-time data processing and analysis at the field level. By leveraging AI algorithms on edge devices, such as drones or field sensors, horticulturalists can gain immediate insights and make timely decisions, reducing dependence on centralized computing resources.
3. **Explainable and Transparent AI**: As AI becomes more prevalent in horticulture, the need for explainable and transparent AI models becomes crucial. Researchers are focusing on developing methods that enhance the interpretability of AI algorithms, allowing growers and stakeholders to understand the reasoning behind recommendations and decisions made by AI systems.

CONCLUSION

The deployment of Artificial Intelligence (AI) in horticulture offers significant opportunities to revolutionize crop production, resource management, and decision-making processes. Through the integration of advanced algorithms, sensing technologies, and data analysis techniques, AI can provide valuable insights and support in various aspects of horticultural crop production. The emerging trends and advancements in AI for horticulture, such as advanced sensing technologies, edge computing, and explainable AI, hold great promise for enhancing crop monitoring, disease detection, and autonomous operations. These technologies enable real-time data analysis, accurate decision-making, and improved resource allocation, leading to increased productivity and sustainability in horticultural systems. The potential benefits of AI in horticulture are vast. From enhanced crop productivity and precision management of pests and diseases to sustainable agriculture and climate resilience, AI has the potential to transform the industry and address key challenges faced by growers. However, it is important to acknowledge and address the technical challenges and limitations associated with AI deployment in horticulture. These challenges include data availability and quality, adaptability to diverse crop varieties, interpretability of AI models, real-time decision-making, and the cost of infrastructure.

LOOKING FORWARD

Further research in AI for horticulture should focus on developing comprehensive and adaptive AI models, precision management strategies, and decision support systems. Exploring the integration of AI with advanced sensing technologies, reinforcement learning, and climate modeling can unlock new possibilities for optimizing crop production, resource management, and sustainability.

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ADOPTION OF HERBICIDE TECHNOLOGY IN CASSAVA WEEDS MANAGEMENT IN FEDERRAL COLLEGE OF EDUCATION, OKENE, KOGI STATE, NIGERIA

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Abstract
Cassava (Manihot esculenta Crantz) requires adequate and effective weed management, especially during the early development and establishment phase of the crop life for optimum yield and prolific productivity. In traditional Agriculture, manual weeding and such cultural practices as time planting, planting density, the use of vigorous cultivars, intercropping, cover cropping, minimal tillage, mulching, crop rotation etc. Studies have shown that use of herbicides in addition to these practices is necessary for optimal yields. Some recommended pre-emergence herbicides are Fluometuron, Diuron and Alachlor while full use of Glyphosate is recommended for post emergence. However, a combination of Diuron and Alachlor for pre-emergence, Glyphosphate in a variety of dosages according to soil characteristics, has been used successfully. It is however recommended to put shield on the sprayer while spraying to prevent damage of cassava crop plant.

***Keywords**: Active ingredients (ai), cassava, dosage, effects, emergence, recommendations,*

INTRODUCTION

Cassava (Manihot esculenta Crantz) otherwise called Tapioca, Arrow root or Manioc is a very important arable crop and a very good source of carbohydrate in the low latitude regions of the world (The tropics), especially in Africa and to some extent in Asia, in the Pacific and in the Latin America. It is a root/ tuber crop order of Ephorbiables, family of Euphorbiaceae, tribe Manihotae, genus Manihot and hence the species Manihot esculenta, which comprises of 7200 species (CIAT, 1990; IITA, 1999). It is established that Nigeria is the best producer of Cassava and unfortunately also the most important consumer of the crop in the world. Cassava is grown in and around the campus of Federal College of Education, Okene (Latitude 7^0 36'37.34"N, Longitude $6^0$15' 45.67"67^0 E and Altitude 1236 above sea level), Kogi state , Nigeria.

The direct impacts of tropical weeds on cassava on the field, competing with the crop for sunlight, water, nutrients and even space constitute a huge production problem. The invasion of weeds limits the productivity of cassava both in quantity and quality, and also negatively affects the producers and their families' economic life (Ogunwolu, 2004). Weed species hace adverse bearing on the yields and quality of cassava output and they are the number one enemy the farmer has to contend with to sustain profitable production or salvaging yield loss. (Smith *et al.*, 2007&Abdullahi, 2023). Cassava is purposely produced for the tuberescence starchy root storage as source of food and feed for man and livestock or as raw materials industrial use. It grows well between 30^o N and30^o S in areas where annual rainfall is greater than 500mm and average temperatures more than 20^o C (IITA, 1997; Onwueme, 1996 &CIAT, (1990). Nweke, (2004) observed that the length of cuttings and the parent plant source affect their germineability and ability to establish steadily in a given ecological settings. Global production of the crop was put at 160 million tonnes of fresh tubers in 1994 (Bruinsma, 2003).

Cassava production and weeds problems

Weeds infestation is the number one problem the farmer has to contend with if he means a profitable production (Smith & Akande, 2000). Many proficient cassava producers in the zone are toiling day and night to optionally produce the crop for himself, his family and immediate market, but their efforts are almost rendered wasteful by the infestation of unwanted flora of different species (Akobundu, 1987, 1988 and 1990). Weeds are undesired plants that voluntarily emerged or developed out of yesteryear cultivation in a crop field (Smith, 2004); they are plants adapted to disturbed or undisturbed habitats (Gorsi *et al.*, 1991) affecting the agricultural crops adversely by competing with them for light, nutrients, water and space.. Weed infestation is becoming more serious in the region because its development is favoured by high humidity, high average temperature and heavy rainfall (around 1900mm) per annum (Melifonwu, 1994) and regional edaphic variables which favours the species as does the arable crops.

Cassava production in the tropics is confronted with several problems of which weed competition is one of the most important. Weed species identified in cassava fields vary from location to location. However, the most common species of weeds found in cassava fields in most locations in and ar0und the campus of FCE, Okene include those enumerated in the table below:

Table 1: Occurrence and Abundance of weed flora in cassava fields in Federal College of Education, Okene.

Name of weed	Family	Lifecycle	Dem. Farm	Bsd. clinic	Staff quarter
*Ageratum convzoides*L.	Asteraceae	ABL	+++	+++	+++
Calopogonum mucunosoides	Asteraceae	ABL	++	++	+++
Chempodium carintum	Asteraceae	ABL	+	+	+
Chromolaena odorata	Asteraceae	ABL	+++	+++	+++
Clidemia hirtus	Asteraceae	ABL	++	+	+
Desmodium intortum	Asteraceae	ABL	+	+	+
Desmodium ovalifolium	Asteraceae	ABL	+	+	+
Emilia javanica	Asteraceae	ABL	+++	+++	+++
Bidens pilosa L.	Asteraceae	ABL	++	++	++
Plantago cuminghani	Asteraceae	ABL	++	++	++
Salvia reflexa	Asteraceae	ABL	+	+	+
Spermacoca latifolia	Asteraceae	ABL	++	++	+
Sida retusa L.	Asteraceae	ABL	+	+	+
Tridax procumbens	Asteraceae	ABL	++	++	++
Amaranthus spinosus L.	Amaranthaceae		+++	+++	+++
Amaranthus viridis L.	Amaranthaceae	ABL	++	++	++

Note: ABL=Annual Broadleaf, (+++) = very abundant, (++) = abundant, (+) = present but not abundant, (-) = not present at all. Those abundant have RIV up to 5%

Weeds management in the Cassava fields

Weed management entails every effort and strategy adopted to eliminate or decimate weed population in a field. This includes manual hand pulling, cropping cultural practices such as crop rotation, mulching and burning (Cultural); hoeing, slashing, mowing (Mechanical); use of other living organisms to drill the weeds to their bases (Biological). All these are laborious and less effective; and of importance to this write up, the use of herbicides or plant killers to kill the weeds (Chemical). The success of the use of different management strategies depends largely on a combination of principles and realistic approaches in cognisance of weed control and environmental safety. The principle of weed control is not necessarily the total elimination of weeds but importantly decimating the number to the minimal population so that much yield is not loss from a crop production function. This is not only necessary to check the menace of weeds but to also accomplish excellent environment for the crop and other cohabitants in the ecosystem, as much as ensuring profitable production with minimal cost. In cassava production, weed management is the task that gives the farmer many sleepless nights. It is laborious, time consuming, and wastages of human and material resources, (taking 50 -80% of total labour budget) with gambling hope of good marginal return (Zimdhal, 2013). The root crop is usually in the field for a very long time (8-15 months), they are usually planted at wide spacing (0.5-1m apart depending on variety) and thereby giving chance for more weeds infestation. Weed management in cassava compared to other arable crops in the humid tropics-home to cassava (Alumai *et al.*, 2010) is much more demanding. Weed control is far more difficult without herbicides even with the integrated pest management principles. Continuous zero tillage is therefore almost not possible in economic Cassava production business. The use of hoe and cutlass common with peasantry, need to be done many times to achieve minimum though excellent result in the field life of the crop. This is almost impossible because of other household or farming activities requirements and demands (Akobundu, 1970 & 1980; Melifonwu *et al.*, 2000). The ultimate option to effect adequate control of weeds for optimal successful production of cassava of good quality and high yields is the use of chemical to kill the weeds (Herbicides technology).

Adoption of Herbicide technology in cassava weeds management will help to increase productivity of cassava while minimizing the drudgery of manual hoeing, cost of labour and time wastages (Alimi &

Manyong, 2000). This management strategy however demands for wide consultation, education and sensitization of farmers and all the stakeholders. This becomes a necessity because of divergent opinions on the use of chemical substances on cassava fields. There are people with the opinion that herbicides should not be used on cassava field because it may add to the acidic contents of the tubers on formation or because of residual effects of chemicals on plants. Others think chemical can be used wisely and cautiously without necessarily endearing the crop to danger. Labrada *et al* (1994), suggested that herbicides are better used on cassava fields pre-emergence, in the process of stale bed preparation. This implies that after land clearing; early emerging weeds could be checked by spraying non selective herbicides before planting the cassava stems. Otherwise, the use of chemical herbicides post-emergence on cassava fields should be selective and done with caution (Onwueme, 1999, Abdullahi *et al*, 2017) and thereby preventing the chemical from getting in contact with the cassava plant, especially the root storage system (Melifonwu *et al.*, 2000).

Research on the use of herbicides to control weeds has been used successfully in Malaysia, Thailand and Indonesia (Howeler, 2000; Abdullahi *et al.*, 2017). The use of paraquat has been limited to research stations only in some African countries especially, Nigeria. In Malaysia, a mixture of 2 litres of alachlor and 2kg of fluometuron/ha is recommended for pre-emergence while 2litres/ha of paraquat are recommended for post emergence and pre harvest respectively (Tan, 1988, Tan *et al.*, 1995) In Lampung, Indonesia, a mixture of paraquat and diuron (3.75 l/ha) at 30 days after planting (post emergence) have been used successfully (Onweme, 1999; Abdullahi *et al.* 2017). The use of herbicides is more divergent in Thailand especially in CIAT research stations in Bangkok. Pre emergence application of 1.56kg a.i./ha of metolachlor with or without post emergence spraying of paraquat (0.5 kg a. i./ha) or with fluazifob-butyl (0.38kg a.i./ha) have been used on cassava fields successfully without residual effect. Spot treatment with paraquat (0.5kg a.i./ha) was also used in compliment of manual or tractiled weeding Zimdhal *et al.*, (1988). Application of metalochlor pre-emergence (2.4 l/ha) was used in South Vietnam and as an alternative for paraquat, glyphosphate (1.5kg a.i. /ha) was used post emergence to control weeds in cassava fields (Abdullahi *et al.*, 2017). It is good to note that, it is recommended in all cases, to use shield on the sprayer while spraying to prevent damage of the cassava crop plant. Their performance is very much influenced by a number of factors ranging from edaphic, climatic to the botanical nature of the weed flora as well as the dosage or rate of application of the herbicide (Melifonwu, 1994).

An experiment was conducted at the demonstration farm of the Agricultural Education department, Federal College of education, Okene, Nigeria. The soil at the site was sandy loam, with a pH of 6.5. Cassava cuttings were obtained from a local farm and planted at a spacing of 1 m x 1 m. The experiment was laid out in a randomized complete block design, with each treatment having three replications. The treatments were Paraquat (2.0 kg a.i./ha), Diuron (1.5 kg a.i./ha), Glyphosate (2.0 kg a.i./ha), and a control (no herbicide). The herbicides were applied at 6 weeks after planting (6WAP) using a knapsack sprayer. Data were collected on weed control efficacy, plant height, stem girth, leaf area, and yield. Diuron, Glyphosate, Round up and Alachlor were also used successfully in several fields in FCE,Okene and environs. The results showed that Glyphosate was the most effective herbicide, followed by Diuron and Paraquat. Glyphosate provided 100% weed control, while Diuron and Paraquat provided 80% and 60% weed control, respectively. Glyphosate also resulted in the highest plant height, stem girth, leaf area, and yield of cassava roots. The control had the lowest yield and quality of cassava roots. It is observed that the effectiveness of these herbicides depends on climatic and edaphic factors, weed flora, rate of herbicide applied, crop variety and management practices. (Akobundu, 1983; Aldrich, 1984; Onwueme, 1999). Herbicide application can provide the most effective and time – efficient method of managing weeds. Numerous herbicides are available that provide effective weed control and are selective in that grasses are not injured. Along with herbicide use is user responsibility and compliance with all product label requirements for herbicide handling

Conclusion

Herbicide technology in Cassava fields is imperatively the ultimate means of accomplishing weed management success in Cassava production, with less labour, time saving and result reassurance.70-80% successes of weed control has been recorded. The vulnerability, toxicity and environmental friendliness should be taken to cognizance at any point of herbicides usages in cassava fields and environs as the plant, the root and shoot systems are very sensitive to chemicals. It is the surest method of weeds control in large scale cassava production. The option of herbicide technology in cassava weed management is a viable alternative to traditional manual weeding. However, it requires proper training and adherence to safety precautions to avoid negative effects on human health and the environment. The adoption of herbicide technology in cassava weed management in Federal College of Education, Okene, Kogi State, Nigeria, has the potential to improve productivity, reduce labor costs, and improve the quality of cassava produced.

Recommendations

1. When using herbicides be mindful of proximity to water, trees, shrubs and other desirable vegetation. Herbicides are applied by banding, ringing round the crop stand or the spot spraying – where single nozzle application targeting individual plants, or broadcast spraying-multiple nozzles covering an entire area.
2. The use of Glyphosate is recommended for weed control in cassava fields. However, caution should be taken in the application of Glyphosate to avoid damage to non-target plants and the environment.
3. Whatever method is used calibration of spray equipment (gallons per acre spray output) is essential for accurate delivery and mixing calculations.
4. Estimating or guessing sprayer output can lead to misapplication which either injures non-target plants or results in failure to control the target weed species.
5. Pre-emergence chemicals are better used pre-planting of the propagules for expected germination success.
6. It is also recommended to put shield on the sprayer while spraying to prevent damage of cassava crop plant.

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THE FIRST BUSINESS MODEL CANVAS IN NIGERIA BEEKEEPING: THE CASE OF SPECIALTY HONEY IN NIHORT

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ABSTRACT
In Nigeria, the practice of managing honeybee colonies for deliberate pollination of established crops is very rare, resulting in complete underutilization and poor exploration of beekeeping, consequently, limiting the potential of large-scale commercial honey business in the country. Business models are important drivers of business commercialization without which value created from business opportunity and innovation cannot be captured. Consequently, descriptive features of National Horticultural Research Institute, NIHORT, Ibadan was used to provide the business model of NIHORT to establish specialty fields with particular crops to produce genuine honey. Value will be added to the honey through a quality test to bring it to international standard. The bottled honey will be branded with logo and QR-code to trace the source and sold in grocery stores.

Keywords: *Honeybee, Specialty honey, Business model, Pollination, Quality assurance.*

INTRODUCTION
The National Horticultural Research Institute (NIHORT), Ibadan, Nigeria is the Institute with mandate to conduct research into genetic improvement, production technologies, processing and marketing of fruits – citrus, mango, vegetables - melon, spices, and ornamental plants of nutritional and economic importance. Honeybee enhance the productivity of pollinated crops such as citrus, mango and melon, as was evident in the mean 6 fruits/plant, 19.9g seed weight and 90% seed viability compare with hand pollinated field of 1 fruits/plant, 5.7g seed weight and 10% seed viability (Kuti and Rovelo, 1992). Beekeeping in Nigeria is the practice of baiting hives to attract honeybee for the purpose of honey harvesting. Meanwhile, commercial beekeeping requires appropriate and adequate knowledge of honeybee's biology, integrated management of associated pests and diseases, provision of crops for pollination, application of modern equipment and tools for bee's management, honey processing and packaging and accessing potential and profitable markets with honey and hive products. Africa consumes more than three times the amount of honey it produces (Mattheus, 2019). Aside Ethiopia, Kenya, New Guinea, Papua and Tanzania who are self- sufficient in honey production and also produce most of the continent's honey, other large markets like Nigeria and South Africa are deficient in honeybee products (Mattheus, 2019, MyFarmbase Africa). In Nigeria, honey production is related to poor and ineffective collection and processing methods which results to inferior quality. Furthermore, honeybees are kept to forage on their own in the wild. The practice of managing honeybee colonies for deliberate pollination of established crops or gardens is very uncommon, resulting in complete underutilization and poor exploration of beekeeping, consequently, limiting the potential of large-scale commercial honey business in the country.

Business models provide the architecture for a firm to create and capture value out of an innovative idea (Teece, 2010), while an innovative idea or a technology do not represent any value until they are commercialized via a business model (Chesbrough, 2003; Schneider and Spieth, 2013). Business models help new businesses determine product types, labour availability, marketing strategies, distribution, delivery sales process, price strategies and customer payment methods. It is critical for business future growth. Inadequate preparation results in the business inability to anticipate future trends and challenges. Business models are important drivers of business commercialization without which value created from business opportunity and innovation cannot be captured. The discovery of business opportunities, innovations and technological developments in NIHORT beekeeping requires a business model to be commercialized. Therefore, this paper presents for the first time the business model to produce specialty honey through the planting of specialized crops for premium honey.

MATERIALS AND METHODS

A business model for commercial beekeeping is not yet in place in Nigeria. We used descriptive features of National Horticultural Research Institute (NIHORT), Ibadan to provide the business model of NIHORT considering the elements of the business model as provided in the business model canvas (Osterwalder and Pigneur, 2010). This reveals how NIHORT in the beekeeping value chain will create and appropriate in the new business models. SWOT analysis was applied according to the examination of the production capacity for specialty honey by NIHORT.

RESULTS AND DISCUSSION

Business Model for specialty honey in NIHORT

This business model is based on establishment of specialty fields with particular crops to produce genuine honey which will be stored in barrels. Value will be added to the honey through a quality test to bring it to international standard. The honey will be bottled then branded with logo and QR-code to trace the source and sold in grocery stores (Fig. 1).

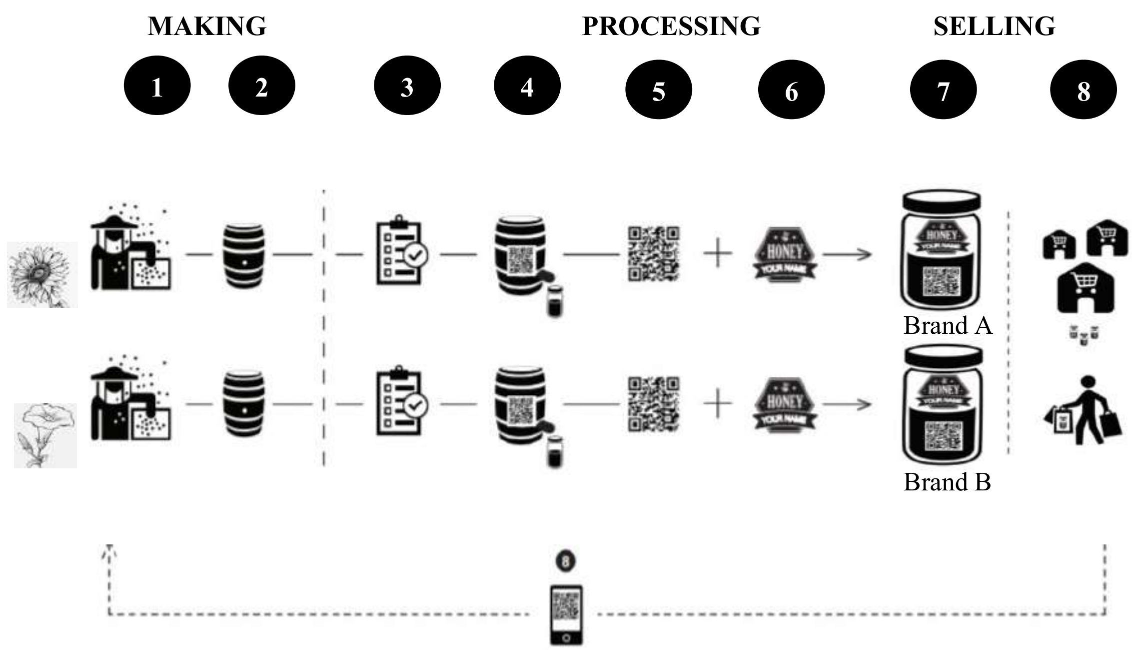


Figure 1. Business Model to produce specialty honey in NIHORT

Adapted from Single Spark 2014

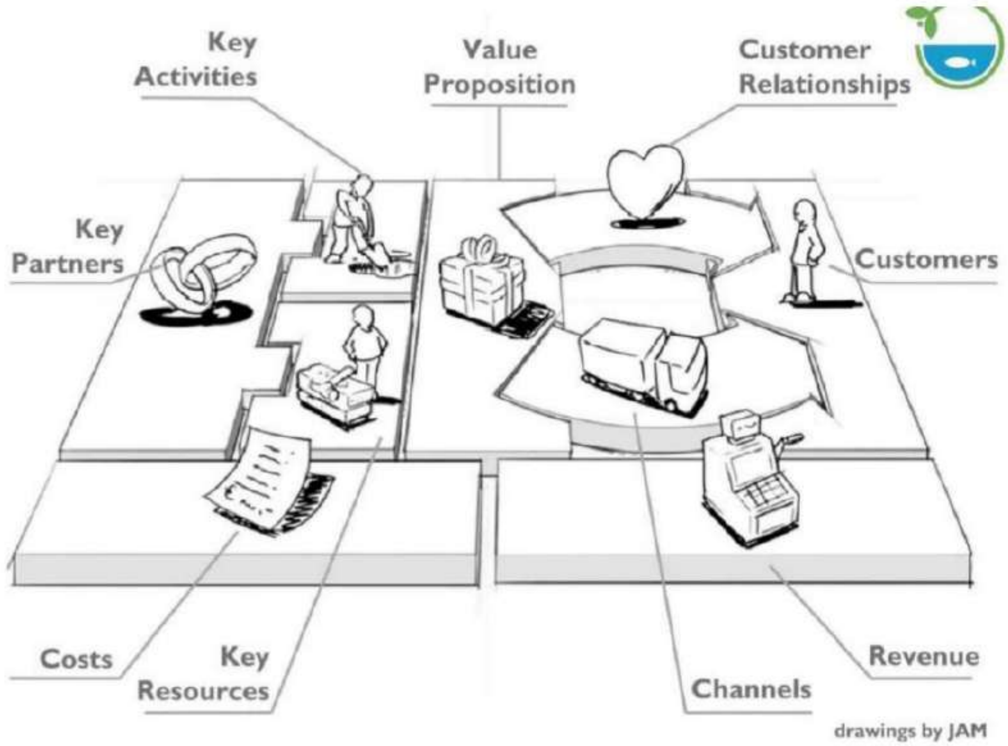
Business Model canvas for specialty honey in NIHORT

Business Model Canvas is a tool to create and analyze business models (Osterwalder and Pigneur, 2010). It consists of nine building blocks, each represented by a rectangle (Fig. 2). The nine blocks cover the three main areas of a business: desirability, viability and feasibility.

Desirability: This segment covering the value proposition, customer relationships, customers and channels exposes aspiration of customers to want the product.

Viability: This segment covering costs and revenue gives the worth of the product.

Feasibility: This segment covering key activities, key partners and key resources determines if the product can be delivered



Source: Mitja Kopina, 2015

KEY PARTNERS

These are the most important assets required to make the production of specialty honey business model work in NIHORT.

- Federal Ministry of Agriculture and Rural Development: Research is basically funded by the ministry supported by donor organizations.
- Bottles suppliers: NIHORT will develop partnership with bottle company for constant supply of different sizes of bottles.
- Grocery Stores: NIHORT will go into agreement with management of grocery stores on supply of honey to their stores.

KEY ACTIVITIES

These are the most important things NIHORT must do to make the production of specialty honey business model work

- Set up specialty fields: NIHORT will establish specialty fields with particular crops. Hives will be placed around the specialty field to pollinate the crops. This will guarantee the source of the honey.
- Set up clear track and trace system for honey: Every bottle of honey will have batch number and Quick Response (QR) code sticker. Consumer may scan the QR-code with mobile phone. The QR-code will be linked to a page on NIHORT web- site which will have information about the honey. Batch number can also be traced to a store.
- Build up a good and trustworthy brand: NIHORT will build brands that will be acceptable nationally and exportable.

- Discount at certain moments to old and new customers: NIHORT will give discounts to customers at Christmas, Easter, Ramadan and Eid Kabir.

KEY RESOURCES

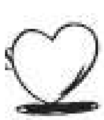
These are the most important assets required to make the production of specialty honey business model work in NIHORT

- Knowledge: NIHORT has expertise in modern commercial beekeeping, best management practice of honeybee and integrated pest management of honeybee pests and diseases.
- Quality assurance tools: Modern equipment will be available to check the moisture content and Brix Sugar Baume of honey.
- Modern honey extraction equipment: Health-conscious consumers want to be sure they buy hygienically processed honey, the modern honey extraction equipment will be available for the processing of the honey to prevent contamination assure health safety.
- Bottling machines with scale: Bottling machine will be used to fill bottles preventing contamination and scale to guarantee accurate measurement.
- Corking machine: This will be used to cork the bottles preventing spillage
- Labelling machine: This will be used to stick labels on the bottles
- Transport: This is required to distribute honey to grocery stores
- NIHORT marketing unit: customers can buy directly from NIHORT marketing unit

VALUE PROPOSITION

These are the bundle of products and services that create value for the customer of specialty honey

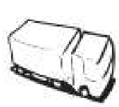
- Specialized honey: Consumers are weary of the genuineness of most available honey due to adulteration with sugar caramel or sugar cane caramel. The specialized will give an assurance of the source of the honey.
- Batch number and QR-code on the label: This will give consumers sense of trust and confidence in the honey
- Tamper proof package: This will further build the trust of consumers on the authenticity of the honey and quality assurance.
- Exclusive package for gifting/ souvenir: Customers can experience impressive and convenient package that will build high self-esteem.
- A day delivery for some areas: A convenient way of purchase without having to go to the grocery stores.



CUSTOMER RELATIONSHIPS

These are the types of relationships a NIHORT will establish with Customer of specialty honey

- Specialty honey: This will provide traceability of the honey
- Provide information about quality control of honey: This will give NIHORT trustable name.
- Provide information related to benefits of honey: This will make consumers to enjoy the honey
- Special promo for customers: This will give a sense of appreciation to customers

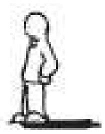


CHANNELS

This is how NIHORT will communicates with and reach its Customer to deliver specialty honey

- Web site: Information about the specialty honey and special promo will be made available on the web sites of NIHORT, and all the grocery stores to attract customers.

- Social media: Information about the specialty honey and promo will be circulated on different WhatsApp groups, Facebooks and Instagram of NIHORT and grocery stores to inform customers
- Jingles: NIHORT will create jingle to advertise the honey
- Live radio and television phone in interview: Honeybee expert will grant live radio and television phone in interview to create awareness about the honey and the promo.



CUSTOMER

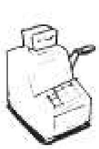
These are the different groups of people or organizations NIHORT aims to reach and serve.

- Neighbours: They will have opportunity to purchase honey at NIHORT marketing unit
- Event planners: They will have opportunity to book special branding of honey as souvenirs for different events
- Hoteliers: There will be an agreement for the production of one use pack for hoteliers
- Healthy life style enthusiast: People that do not take sugar

COST STRUCTURE

These are all costs incurred to operate a business model

- Specialty fields: This will involve the purchase and delivery of specialty seeds, cost of land preparation, planting and field maintenance all year round for continuous supply.
- Extraction machines: Cost of purchase and delivery of extraction machines.
- Bottling machines: Cost of purchase and delivery of bottling machines.
- Labelling machine: Cost of purchase and delivery of labelling machine to stick labels to bottles.
- Scales: Cost of purchase and delivery of scales for weighing the bottled honey.
- Crates: Cost of purchase and delivery of crates for packing the bottles.
- Bottles: Cost of purchase and delivery of bottles.
- Labels: Cost of production and delivery of labels.
- Transportation: cost of fueling and maintenance of vehicle used for distribution delivery of honey.
- Labor: Payment of manpower for different activities.



REVENUE STREAMS

This is the cash NIHORT will generate from each Customer (costs must be subtracted from revenues to create earnings).

Honey sale: Customers are willing to pay for hygienic packed honey in different weight and special packs for souvenirs.

SWOT analysis to evaluate the strengths, weaknesses, opportunities, and threats of specialty honey production: the case of NIHORT.

 STRENGTH	 WEAKNESS
• Expertise • Modern processing equipment • Quality assurance • Scarcity of un-contaminated honey	• Cumbersome accounting system • Non timely release of funds for expenses • Bureaucracies

• Scarcity of unadulterated honey • Easy quality track and trace system • Entrance to supermarkets	• Lack of policy on beekeeping/ documentation
 OPPORTUNITIES • Modern beekeeping training for those interested. • Collaboration with law makers for inclusion of training in constituency youth empowerment projects. • Organising Workshop for associations and organizations • Selling queens and nucleus colonies to beekeepers • Selling modern beekeeping equipment • Expanding business model to other NIHORT substations and part of the country	 THREATS • Delay in payment by supermarket • Labor strike/ unrest • Insecurity

CONCLUSION

The Business Model Canvas for the production of specialty honey by NIHORT for the first time will create value through establishment of specialty fields with particular crops to guarantee the source of the honey with precise track and trace system for consumer satisfaction, thus build up a noble and dependable honey brand in Nigeria.

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INFLUENCE OF DIFFERENT CONCETRATIONS OF TOMATOTONE ON YIELD OF RAINFED TOMATO (UC82B) (*Solanum lycopersicum* L.) IN SUDAN SAVANNA OF NIGERIA

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ABSTRACT

Tomatotone (4-Chlorophenoxy acetic acid (4-CPA)) is a plant hormone used to enhance fruit setting and yield of tomato. The aim of the research is to investigate the efficacy of 4-chlorophenoxy acetic acid at different concentrations on yield of tomato. Field trials were therefore conducted during the rainy season of 2020 at two locations. The treatments consisted of four concentrations of 4-CPA (0, 50, 75 and 100 mgL^{-1} of distilled water). The experiment was laid out in a Randomized Complete Block Design and replicated three times. The data collected on yield and yield components were subjected to analysis of variance. The result showed that 4-CPA had significant effect on fruit length, fruit weight, marketable fruit yield and total fruit yield. Based on the findings of the study, it was suggested that farmers in the areas of study can be advised to grow tomato and apply100 mgL^{-1} of distilled water of 4-CPA for higher yield of the crop during rainy season.
Keywords: *Tomato, Tomatotone, Fruit, Yield and Components*

INTRODUCTION

Tomato was reported to have originated from around Peru and Ecuador from where it spreads to as far north as Mexico in pre-Colombian times. It was introduced into Europe from Mexico by the Spanish in 1523. Then from Europe it was carried across the pacific into south East Asia before 1650 (Srinavasan *et al*., 2010). Later it was introduced into West Africa in the 16th century by the Portuguese and it has since been regarded in temperate and tropical ranking next to potato in importance. In Nigeria, the main production area of tomatoes is the Northern part of the country, (latitude 8^0 – 13^0N) under irrigation during dry season between the months of September- March, when the temperatures are mild and humidity moderate. The rain fed production (June – September) is also important due to the fact that fresh tomato demand is all year round, but generally limited by high pests and disease that are prevalent under such humid and warm conditions (Grubben and Denton, 2004). Although tomato plants can be grown under a wide range of climatic conditions, they are extremely sensitive to hot and wet conditions, the type of weather that prevails in the summer and rainy season of tropical countries (Baliyan *et al.,* 2013).

However, tomato is adapted to wide range of climatic conditions from temperate to hot and humid tropical environment, with optimum temperature for growth in the range of 20 – 27^o C (Grubben and Denton, 2004). Moreover, marked prohibition of photosynthesis happens at temperatures above average, causing remarkable decrease in yield. Therefore, improved agronomic practices with potential for reducing the effect of high temperature and humidity for high yield of tomato especially during the wet and dry seasons should be investigated in order to meet up with the all year round demand of the crop. The agronomic practices with potential for reducing wet and heat effects on tomato especially during the dry/rainy seasons are reported to include; use of determinate varieties these are known to be better moisture conservers and also withstand adverse effect of heat, increase in plant population that could afford more shade to the developing fruit, mulching that could reduce evaporation and lower soil temperature. Several reports also indicated increased fruit size and fruit setting in tomato due to application of plant growth regulators such as 4-chlorophenoxy acetic acid (Tomatotone) and 2, 4-dichlorophenoxy acetic acid (2, 4-D). However, there is dearth of information on the effect of Tomatotone (4-chlorophenoxy acetic acid) on tomato production in Nigeria, as there was little or no study of such nature in the country. It is with all that in mind that the research was conceived with the aim of determining the effect of 4-Chlorophenoxy acetic acid (4-CPA) on yield of tomato under rain-fed condition.

MATERIALS AND METHODS

The research was conducted during the 2021 rainy seasons at two locations, Research and Teaching Farm of Faculty of Agriculture, Bayero University Kano (BUK) which lies on latitude 11^0 97' 98.6'' N and longitude 8^0 42' 03.7'' E and 475 m above the sea level and demonstration Farm of Audu Bako, College of Agriculture, Dambatta (DBT) which lies on latitude 11° 83' 40.3'' N and longitude 08° 10' 33.9'' E and 418 m above the sea level all within the Sudan Savanna Zone of Northern Nigeria. The treatments consisted four concentrations of 4-Chlorophenoxy acetic acid, (0, 50, 75 and 100 mgL^{-1} of distilled water). The experiment was replicated three times and laid out on a Randomized Complete Block Design. Seedlings of UC82B tomato variety were raised using seed beds until they were ready for transplanting at 6 weeks old. The area for the experiment was prepared by clearing, harrowing and ridging using a tractor mold board ridger. The area was then demarcated in to 27 main plots of 24 ridges that were 5 m long (24 x 0.75 x 5 m = $90m^2$). One meter (1m) alley was left between replications and between main plots. The seedlings raised in the nursery were transplanted at the age of 6 weeks after sowing on spacing of 60 x 75 cm, after establishment all agronomic management practices were carried out according to recommendation. The 4-CPA was applied after it was prepared by mixing 100 mg of 4-CPA powder L^{-1} of distilled water and two drops of baby shampoo were added to enhance stickiness of the 4-CPA on the flowers as recommended by (Baliyan *et al*., 2013). The mixtures were later applied to the flowers after few flowers had opened, about 1 ml per flower cluster was applied using hand held sprayer in the morning as from 8 am as recommended by Asian Vegetable Research and Development Center (AVRDC), (2001). Harvesting was done by hand picking at the time the fruits attained physiological maturity specifically when they were observed to changed colour from green to pink or reddish spanning four pickings. Data were collected from five tagged plants in the inner rows. The data were on: number of flowers clusters $plant^{-1}$, average fruit length (mm) $plant^{-1}$, average fruit weight (g) $plant^{-1}$, marketable fruit yield (t ha^{-1}), non-marketable fruit yield (t ha^{-1}) and total fruit yield (t ha^{-1}). The data collected were subjected to analysis of variance using Genstat (17^{th} Edition) and the means were separated using Fisher's Protected Least Significant Difference Test. The weather record during the study period was presented in Table 3.

RESULTS

Number of Flower Clusters $Plant^{-1}$

Table 1 shows the 4 – CPA effects on number of flower clusters $plant^{-1}$ during 2019 rainy season at BUK and Dambatta. At both location the result showed no significant difference among the 4-CPA concentrations on number of flower clusters $plant^{-1}$.

Fruit length (mm)

Fruit length of tomato as affected by 4-CPA concentrations during the 2019 rainy season at BUK and Dambatta is also shown in Table 1; the result obtained depicts that application of 4-CPA at different concentrations significantly affected fruit length of tomato at BUK, 75 and $100mgL^{-1}$ were at par but $100mgL^{-1}$ was significantly higher in fruit length than 0, and 50 mgL^{-1} 4-CPA concentrations which were statistically similar, while at Dambatta the result showed no significant difference among the 4-CPA concentrations on fruit length of the tomato.

Average Fruit Weight (g)

Also, Table 1 shows the fruit weight of tomato as affected by 4-CPA concentrations during 2019 rainy season at BUK and Dambatta. However, at BUK the result revealed significant effect of 4-CPA concentrations on the fruit weight, were 4-CPA concentrations of 50, 75 and 100 mgL^{-1} statistically at par with one another recorded significantly heavier fruits than the control, but at Dambatta the result shows that 75 and 100 mgL^{-1} statistically at par with one another recorded significantly heavier fruits than 50 and 0 mgL^{-1} statistically at par also.

Marketable Fruit Yield (t ha^{-1})

Table 2 revealed the Marketable fruit yield t ha^{-1} of tomato as affected by application of different concentrations of 4-CPA, the result indicated that at both locations, 100 and 75 mgL^{-1} 4-CPA concentrations were at par with one another but significantly higher in marketable fruit yield than 50 mgL^{-1} 4-CPA which was in turn higher than 0 mgL^{-1} which was the control.

Non-Marketable Fruit Yield (t ha^{-1})

Non-Marketable fruit yield t ha^{-1} of tomato as affected by 4-CPA concentrations; at BUK, 4-CPA concentration of 75 mgL^{-1} was significantly higher in non-marketable fruit yield than 4-CPA concentrations of 100, 50 and 0 mgL^{-1} which were at par with one another, while at Dambatta there was no significant difference among the 4-CPA concentrations.

Total Fruit Yield (t ha^{-1}) of Tomato

Table 2 also showed the total fruit yield (t ha^{-1}) of tomato as affected by 4-CPA application; the result indicated that at both location of the trial 4-CPA at 100 mgL^{-1} concentration was significantly higher in total fruit yield than 4-CPA concentrations of 75 and 50 mgL^{-1} which were statistically at par with one another but significantly higher than 0 mgL^{-1} concentration.

Table 1: Number of Flower Clusters Plant-^{1}, Fruit Length (mm) and Fruit weight (g) of Tomato as affected by 4-CPA during 2019 Rainy Season at Bayero University Kano and Dambatta

	Flower Clusters		Fruit Length		Fruit Weight	
Treatment	BUK	DBT	BUK	DBT	BUK	DBT
4-CPA Concentration						
0	10.45	10.10	68.28^{b}	68.87	47.53^{b}	41.78^{b}
50	10.11	9.97	66.63^{b}	69.02	50.948^{a}	41.97^{b}
75	11.00	10.66	70.70^{ab}	68.99	51.34^{a}	48.06^{a}
100	11.00	10.85	72.33^{a}	69.00	51.05^{a}	49.25^{a}
P-Level	0.056	0.076	0.003	0.084	<.001	0.050
SE$\pm$	0.985	0.890	0.310	0.104	0.669	0.702

Means followed by the same letter(s) are not significantly different at 5% level of using Fisher's protected least significant difference test.

Table 2: Fruit Yield (t ha^{-1}) of Tomato as affected by 4-CPA during 2019 Rainy Season at Bayero University Kano and Dambatta.

	Marketable Yield		Non Marketable Yield		Total Yield	
Treatment	BUK	DBT	BUK	DBT	BUK	DBT
4-CPA Concentration						
0	10.81^{c}	9.31^{c}	0.21^{b}	0.11	11.02^{c}	09.42^{c}
50	13.46^{b}	11.78^{b}	0.22^{b}	0.09	13.68^{b}	11.96^{b}
75	15.36^{a}	13.18^{b}	0.18^{b}	0.08	14.54^{b}	13.26^{b}
100	17.45^{a}	15.45^{a}	0.33^{a}	0.13	17.78^{a}	15.58^{a}
P-Level	0.005	0.005	0.048	0.059	0.008	0.005
SE$\pm$	1.204	0.067	0.004	0.007	0.910	0.672

Means followed by the same letter(s) are not significantly different at 5% level of using Fisher's protected least significant difference test.

Table 3: Meteorological Data showing mean Temperature, Relative Humidity, Solar Radiation and Rainfall at BUK, during the production Period in 2021 Rainy Season.

Variable	**Temperature (^{0}C)**		**RH (%)**		**Solar Radiation**	**Rainfall**
Month	Max	Min	Max	Min	(mj/m2/day)	(Mm)
May	37.9	25.0	70.7	24.4	22.7	40.0
June	35.1	23.7	78.9	34.4	22.3	98.5
July	31.7	22.1	88.9	47.0	20.5	41.9
August	30.6	21.5	92.4	50.7	18.5	320.4
September	32.5	22.1	91.2	44.4	19.9	182.2
October	32.5	20.5	75.5	23.7	21.3	2.3
Total	200.3	134.9	497.6	224.6	125.2	685.3
Mean	33.4	22.5	82.9	37.4	20.9	114.2

Source: IITA, Weather Station Kano

DISCUSSION

Effect of 4-CPA on Yield of Rain Fed Tomato

Plant growth enhancers can help address the challenges of feeding a growing world population and increasing food demand by improving crop yields in a sustainable way. They are usually found in small amounts throughout the plant. These substances are very important as they determine many different attributes of a plant. Plant hormones can be natural or synthetic. Plant hormones are also known as phytohormones. Thimann in 1948 coined the term "Phytohormone" The five major plant hormones are auxins, gibberellins, cytokinins, abscisic acid, and ethylene. (Hazra *et al*., 2007). The result of the study showed that application of 4-CPA significantly increase the total fruit yield of tomato at both locations, higher fruit yield was obtained with application of 100 mgL^{-1} 4-CPA. This could be attributed to the ability of the 4-CPA to enhance flower retention by the plant resulting to more fertilized flowers without much abscission and high fruit retention. This result was supported by the findings of Asian, Vegetable Research and Development Center (AVRDC, 2012), Nandwani *et al*. (2014), Ozguven (2000), Baliyan *et al*. (2013) and Lathiya & Sanjeev (2017) who reported that application of plant growth regulators has been shown to improve fruit setting in tomato, they further reported that sprays of hormone especially 4-chlorophenoxy acetic acid on flower cluster effectively increase the fruit set as well as fruit production. Also Karim *et al.* (2015) had shown that application of 4-CPA induced higher number of fruit set to some extent. It was further reported that application of plant growth regulators increased fruit set of summer tomato (Rahman *et al*., 2015). 4-CPA is also used in reducing pre-harvest fruit drop and resulting in increased number of fruits and yield in tomato crop. Alam and Khan (2002) reported that other plant growth regulators were also reported to increase fruit production and retention in tomato for example it was reported that application of Naphthalene Acetic Acid (NAA) at the time of flowering prevents pre-harvest flower abscission by increasing auxin concentration at this critical phase of reproductive development hence increasing yield. Meliha, Bengu and Kit (2006) reported that a number of studies have already established that external application of synthetic growth regulators and mineral nutrients are effective in increasing both yield and quality of crops including horticultural crops. They further revealed that the growth regulating substances used increased the number and size of fruits of tomato and their fresh and dry weights with 4-CPA being most effective.

CONCLUSION

Based on the findings of this study, it can be concluded that; there was significant and positive effect of 4-Chlorophenoxy acetic acid on yield and yield components of tomato during rainy season in which the result depicts application of 100 mgL^{-1} 4-CPA concentration recoded the highest fruit yield. Therefore, it can be suggested that farmers in the areas of study can be recommended to grow tomato (UC82B) variety and apply 4-CPA at 100 mgL^{-1} of distilled water in order to increase fruit yield of the crop during rainy season.

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ASSESSMENT OF FOOD AND FOOD-LIKE CONSUMPTION AMONG ADOLESCENT STUDENTS: A CASE OF NIHORT ADOPTED SCHOOLS IN IBADAN, OYO STATE.

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ABSTRACT
Adolescence marks a critical time for the establishment of healthy eating habits, as dietary beliefs and behaviors formed in this period can be maintained into adulthood. Therefore, the study aimed to identify the consumption patterns of food among adolescent students in Oyo State, using NIHORT-adopted secondary schools as a case study. Multi-stage sampling procedure was used to select 103 respondents. Data were collected using a questionnaire and was analyzed using descriptive statistics. The results showed that 70.9% of the students were still in their adolescent age between 11- 13 years old and they preferred empty-calorie foods over healthy options like fruits and vegetables. Snacks and sweets were consumed frequently (55.3% and 41.7% respectively), while vegetables and fruits were only consumed 1-3 times per week. Most students received only ≤₦200 per day, limiting their ability to buy healthier food options. This study found that, on average, students only eat vegetables and fruits once or twice a week, whereas snacks and sweets are consumed daily. The study also found that most students have a limited budget for food purchases, limiting their access to healthier options. The study recommends promoting more nutritious packed lunches from home and healthier snacks at school through nutrition education and policies to improve healthy dietary food intake.
Keywords: *Food consumption**,** Dietary, Students, Adolescent, Fruits and Vegetables*

INTRODUCTION

The health and wellbeing of children and adolescents is critical for achieving the Sustainable Development Goals, especially those related to poverty, health, education, and inequality reduction (WHO, 2017). The World Health Organization has emphasized the importance of adequate nutrition for enabling young people to enjoy good health while contributing to sustainable development (WHO, 2020). Proper nutrition during childhood and adolescence is essential for growth, development, preventing chronic diseases, and overall wellbeing. Adolescence is a critical period for establishing dietary behaviors that support current health, growth, and development as well as reducing the risk of chronic diseases later in life. The rapid physical, cognitive, and psychosocial changes that occur during the adolescent years create increased nutritional needs at a time of growing independence over food choices (Story, 2002). Inadequate or excessive intake of key nutrients during adolescence can negatively impact growth, bone mass development, menstrual health, mental health, dental health, and risk factors for conditions like iron deficiency anemia, eating disorders, obesity, and cardiovascular disease (Das *et al.,* 2017). Adopting healthy dietary patterns in adolescence characterized by nutrient-dense foods and beverages in moderation can support healthy maturation and reduce both short- and long-term disease risks (Salvo *et al.,* 2012). Adolescence marks a critical time for the establishment of healthy eating habits, as dietary beliefs and behaviors formed in this period can be maintained into adulthood (Hu et al., 2016). Studies show that Nigerian youth have an inadequate intake of nutrients needed for growth and development, including iron, iodine, and calcium (Ene-Obong *et al.,* 2018). Food habits adopted during adolescence tend to track into adulthood (Craigie *et al.,* 2011).

The impetus for this study was based on the observation that students are more inclined towards taking empty-calorie foods with little consideration for healthy foods, especially fruits and vegetables. This tends to predispose them to obesity, dental cavities, and other non-communicable diseases in later years. Although the prevalence of obesity is increasing worldwide, it is faster in developing countries due to declining levels of physical activity as well as nutrition transition characterized by a trend towards consumption of a diet high in fat, sugar, and refined foods low in fiber (Ogden *et al.,* 2014). Current evidence revealed a clear transition of increasing proportions of overweight/obesity in school-aged children in Sub-Saharan Africa, and a similar, but less prominent trend toward increasing proportions of obesity over time (Muthuri *et al,* 2014). This transition to higher proportions of overweight/obesity is similar to observed trends in developed countries. Therefore, assessing food and food-like consumption patterns among students in NIHORT-adopted secondary schools is a major concern to know the rate at which students in these adopted schools consume food, especially horticultural products, and also if NIHORT has been able to fill any gap in improving their nutrition on food consumed regularly.

Objectives

i. Describe the socio-economic characteristics of respondents in the study area;
ii. Ascertain student's frequency of consuming the selected categories of food;
iii. Identify reasons for consuming the selected categories of food by students;
iv. Evaluate constraints faced in the consumption of selected categories of food.

METHODOLOGY

The study was conducted in Ibadan, Oyo State, located on Latitude 8 00' North and Longitude 400' East of Greenwich Meridian. Oyo State covers approximately an area of 28,454 square kilometers. The population of this study consisted of JSS 2 students in NIHORT Adopted schools in Ibadan Ido Local Government. A multi-stage sampling procedure was used to select respondents for the study. In the first stage three secondary schools were purposively selected (Oba-Abass secondary school, Anwaru-Islam secondary school, and Baptist High school) which is because they are NIHORT adopted schools. In the second stage, a purposive selection of Junior Secondary School 2 class was selected which is because they have a long time to still be in school for further research and training. At the last stage, 20% of the students from the total population of level two junior secondary students (JSS2) students were selected given a total of 103 respondents. The data were collected with the aid of a questionnaire/ structured interview and analyzed using descriptive statistical tools. The descriptive statistics include means, frequency counts, and percentages.

RESULT AND DISCUSSION

Socio-Economic Characteristics of Respondents

The results in Table 1 revealed that the majority (70.9%) of the students were still in their adolescent age between 11- 13 years old, the average number of the respondents (50.5%) were male while 74.8% of the respondents were Yoruba. Also, 27.2% were 2nd born and 25.2% were 1st born respectively. The majority (54.4%) of the students' fathers were involved in other occupations aside from civil service, artisan, and trading, and also most of their mothers (40.8%) were involved in other occupations aside from civil service, artisan, and trading. It was also discovered that most (78.6%) of the parents had other sources of income apart from their major occupation, which implies that some parents might be able to provide more for their children in terms of feeding and pocket money. Majority (49.5%) of the respondents had a family size of 6-8 with an average of 6 people per household, indicating a relatively large family size considering the economic situation of the country. This may likely affect the purchasing power in terms of consumption of healthy nutritious food

Regarding food preferences at home, the most popular choice was "other" foods not listed (35%), followed by jollof rice and chicken (23.3%), and yam and egg (13.6%). Only small percentages preferred more nutritious options like vegetables (6.8%) and fruits (10.7%). In school, snacks were the top choice (38.8%), reflecting a desire for convenient, tasty foods, while few opted for vegetables (3.9%) or fruits (1.9%). The data on purchasing habits shows a similar preference for snacks, with 60.2% of students buying snacks at school. Only 19.4% purchased grains, 10.7% protein foods, and very few bought fruits or vegetables. This indicates that students are not purchasing well-balanced meals and snacks at school. In terms of money provided, most students received only 0-200 naira per day (63.1%), which limits their ability to buy healthier options. This finding connotes Wyse *et al.,* (2017) which suggests that students need sufficient financial resources to be able to purchase healthy food. The results suggest an opportunity to promote more nutritious packed lunches from home and healthier snacks at school through nutrition education and policies to improve healthy dietary food intake.

Table 1: Socio-economic characteristics of the respondents (n=103)

Variables		Frequency	Percentage	Mean
Age	11-13	73	70.9	13
	14-16	29	28.1	
	>16	1	1.0	
Sex	Male	52	50.5	
	Female	51	49.5	
Family Size	3-5	42	40.8	
	6-8	51	49.5	6
	>8	10	9.7	
Ethnicity	Yoruba	77	74.8	
	Igbo	23	22.3	
	Hausa	3	2.9	
Father's Occupation	Civil servant	17	16.5	
	Artisan	9	8.7	
	Trader	21	20.4	
	Others	56	54.4	
Mother's Occupation	Civil servant	17	16.5	
	Artisan	15	14.6	
	Trader	29	28.2	
	Others	42	40.8	
Another source of Income	Yes	81	78.6	
	No	22	21.4	
How much does your parent give you to school? (In Naira)	0 – 200	65	63.1	
	201 – 400	28	27.2	
	401 – 600	4	3.8	243
	601 – 800	1	1	
	801 – 1000	5	4.9	
What is your best food at home?	Jollof rice and chicken	24	23.3	
	White rice and egg	5	4.9	
	Yam and egg	14	13.6	
	Beans and bread	3	2.9	
	Porridge	2	1.9	
	Spaghetti	1	1.0	
	Vegetables	7	6.8	
	Fruits	11	10.7	
	Others	36	35.0	
What is your best food in school?	Rice and beans	7	6.8	
	Sweets	3	2.9	
	Fruits	2	1.9	
	Rice and Spaghetti	9	8.7	
	Snacks	40	38.8	
	Vegetables	4	3.9	
	Others	38	36.9	
Kindly indicate all the food you normally buy while in school	Grains	20	19.4	
	Protein	11	10.7	
	Sweets	2	1.9	
	Fruits	4	3.9	
	carbonated drinks	1	1.0	
	Vegetables	3	2.9	
	Snacks	62	60.2	

Source: Fieldwork, 2023

The Consumption Frequency of Food Categories

The result in Table 2 below shows the frequency of consumption of food categories. This revealed that Snacks and sweets are being consumed very frequently, with 55.3% and 41.7% of students respectively eating these daily. In contrast, vegetables and fruits are only consumed 1-3 times per week by most students. The high daily consumption of snacks and sweets aligns with the study of Bucher *et al*., (2016) which shows that snacks make up a large proportion of adolescents' daily food intake globally. Also, 35.0% of the respondents stated that they consume Grain/Cereals (Wheat, Rice, Maize, Oat, etc.) and 29.1% 27.2% of them affirmed that they consume Protein (Beans, Fish, Egg, etc.) 2-3 times per week. Consumption of Beverages is polarized, with 33.0% drinking them daily but 25.2% once or twice per week. Dairy foods is as well polarized with 31.1% intake daily, but 16.5% only weekly. Dairy is an important source of calcium and vitamin D. This implies that the students' dietary habits are poor and may have negative health implications (Molan, 2019). Their frequent snacking and low fruit/vegetable intake is especially concerning.

Table 2: The frequency of consumption of food categories (n=103)

Food categories	Once per week	2 times per week	3 times per week	4 times per week	Every day of the week
Grain/Cereals (Wheat, Rice, maize, Oat, etc.)	7 (6.8)	23(22.3)	36(35.0)	7 (6.8)	30 (29.1)
Protein (Beans, Fish, Egg, etc.)	8 (7.8)	30(29.1)	28(27.2)	20(19.4)	17 (16.5)
Beverages (Juice, Tea, soda, coffee, etc.)	26 (25.2)	26(25.2)	11(10.7)	6 (5.8)	34 (33.0)
Sweets (cookies, candies, chocolate, etc.)	16 (15.3)	22(21.4)	13(12.6)	9 (8.7)	43 (41.7)
Pastries (Meat pie, Doughnut, Puff-puff, etc.)	15 (14.7)	17(16.5)	16(15.5)	21 (20.4)	34 (33.0)
Fruits (Name)	18 (17.5)	18(17.5)	26(25.2)	14 (13.6)	27 (26.2)
Vegetables (Name)	34 (33.0)	22(21.4)	16(15.5)	18 (17.5)	13 (12.6)
Carbonated drinks (Fanta, Pepsi, etc.)	23 (22.3)	24(23.3)	19(18.4)	13 (12.6)	24 (23.3)
Dairy food (Milk, Yoghurt, etc.)	17 (16.5)	17(16.5)	23(22.3)	14 (13.6)	32 (31.1)
Snacks (crackers, chips, etc.)	8 (7.8)	18(17.5)	13(12.6)	7 (6.8)	57 (55.3)

Source: Fieldwork, 2023 *The figures in parenthesis are the percentage

Table 3: Reasons for consuming the selected food categories (n= 103)

Variables	Yes	No
Health Benefit	99 (96.1)	4 (3.9)
Family culture	22 (21.4)	81 (78.7)
Flavor	79 (76.7)	24 (23.3)
Price	31 (30.1)	72 (69.9)
Affordability (Cheap)	73 (70.9)	30 (29.1)
Availability	83 (80.6)	20 (19.4)
Gift/free	48 (46.6)	55 (52.9)
Due to hunger	56 (54.4)	47 (45.6)
For proper growth and development	97 (94.2)	6 (5.8)
Energy	101 (98.1)	2 (1.9)
Peer pressure	23 (22.3)	80 (77.7)
Protection from diseases	87 (84.5)	16 (15.6)
To have a balanced diet	98 (95.1)	5 (4.9)
Favorite	88 (85.4)	15 (14.6)
Others	30 (29.1)	73 (70.9)

Source: Fieldwork, 2023 *The figures in parenthesis are the percentage

Reasons for Consuming the Selected Food Categories by Students

The result in Table 3 provides insight into students' reasons for the consumption of selected food categories. The most commonly cited reasons were health benefits (96.1%), having a balanced diet (95.1%), proper growth and development (94.2%), and energy (98.1%), which connote the findings of Temple (2013). This indicates students are aware of the importance of nutrition for their health and growth. However, other factors reveal room for improvement. It is an indication that the students have the knowledge of the reasons for consumption of food but lack adequate knowledge about its application and inclusion in their dietary intake. Taste was a major driver (76.7%), which may explain preferences for snacks and sweets. Affordability (70.9%) and availability (80.6%) were also key, suggesting cost and access to healthy foods are barriers. Hunger (54.4%) may lead to less nutritious choices.

Constraints Faced in the Consumption of Selected Food Categories.

The result in Table 4 reveals some key constraints that may be limiting students' ability to consume a nutritious diet. The top constraints identified were food taste (82.5%), vendor hygiene (77.7%), and the environment where food is sold (77.7%). Between 24-33% rated these factors as very severe constraints. Cost also appears to be a major issue. Inadequate money was cited by 73.8%, with 32% calling it a very severe constraint. Food inflation was identified by 69.9%. This suggests students' limited funds may be forcing them to choose cheaper, less healthy options. Furthermore, 50.5% of the students attested that peer influence was a constraint which suggests mixed social norms related to healthy eating. Parents' economic status was also seen as a constraint with 64.1%. The result is consistent with the study of Akinyele *et al.,* (2021), which suggests that students may be hampered in their efforts to eat healthily due to a number of key constraints

Table 4: Constraints faced in the consumption of selected food categories (n=103)

Constraints	Yes	No	Very Severe	Severe	Not Severe	Mean	Ranking
Inadequate money	76 (73.8)	27 (26.2)	15 (14.6)	33 (32.0)	23 (22.3)	2.11	3rd
Social status of parents/Guardian	57 (55.3)	46 (44.6)	11 (10.7)	20 (19.4)	20 (19.4)	2.18	1st
The environment where food vendors sell	77 (74.8)	26 (25.2)	28 (27.2)	29 (28.2)	17 (16.5)	2.00	5th
Inflation (High cost of food)	72 (69.9)	31 (30.1)	19 (18.4)	30 (29.1)	21 (20.4)	2.00	5th
Peer influence	52 (50.5)	51 (49.5)	13 (12.6)	22 (21.4)	17 (16.5)	2.08	4th
Personal Hygiene of the vendor	80 (77.7)	23 (22.3)	28 (27.3)	34 (33.0)	8 (7.8)	1.71	10th
Food colour	79 (76.7)	24 (23.3)	28 (27.3)	28 (27.3)	11 (10.7)	1.75	9th
Food flavour	78 (75.7)	25 (24.3)	26 (25.2)	24 (23.3)	18 (17.5)	1.86	7th
Food taste	85 (82.5)	18 (17.5)	25 (24.3)	32 (31.1)	17 (16.5)	1.87	8th
The low economic status of parents	66 (64.1)	37 (35.9)	14 (13.6)	22 (21.4)	25 (24.3)	2.15	2nd
The environment where food is being sold	80 (77.7)	23 (22.3)	28 (27.2)	27 (26.2)	14 (13.6)	1.75	9th
Others	19 (18.4)	84 (81.6)	5 (4.9)	4 (3.9)	4 (3.9)	1.92	6th

Source: Fieldwork, 2023 *The figures in parenthesis are the percentage

CONCLUSION

This study draws attention to the unhealthy eating habits of secondary school students in Oyo State, Nigeria, using the second-year students at NIHORT-adopted schools in Ibadan, Oyo State as a case study. On average, students only eat vegetables and fruits once or twice a week, whereas snacks and sweets are consumed daily. The study also found that most students have a limited budget for food purchases, limiting their access to healthier options. The results point to an opening for nutrition education and policies aimed at boosting healthy dietary food intake, such as encouraging more wholesome packed lunches from home and better school snacks.

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MONTH OF COPPICING IN ENHANCEMENT OF CHUPON SURVIVAL, ESTABLISHMENT AND GROWTH PERFORMANCE OF CACAO (*Theobroma cacao* L) IN EDO STATE, NIGERIA

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ABSTRACT

Most plantations in cocoa ecologies of Nigeria are old and rehabilitation of such cocoa farms through coppicing is inevitable. Therefore, investigation was carried out between 2017 and 2019 to evaluate coppicing at different months of the year on cocoa (Theobroma cacao L) chupons survival, establishment and growth performance in Cocoa Research Institute of Nigeria (CRIN), Uhonmora Station, Edo State. The months of coppicing considered as treatments were December 2017 to November 2018 while, data collection was terminated in May, 2019. The experiment was laid in Randomized Complete Block Design (RCBD) with three replications. Data were collected on chupon survival count, number of chupons , chupon height, chupon number of leaves, chupon diameter, leaf area and number of branches. Survival counts were carried out between 1 and 6 months after coppicing (MAC) across the coppicing periods. Data collected were subjected to analysis of variance (ANOVA) as well as descriptive statistics, and significant means were separated by Duncan Multiple Range Test (DMRT) ($P<0.05$). This study revealed that old cocoa trees coppiced in the months of March, April, June, September, October and December significantly ($P<0.05$) enhanced the survival count of regenerated chupons relative to other treatment months at one month after coppicing. Only cocoa plants coppiced in the month of April steadily maintained 100% survival count from the first month to the 6th month after coppicing. The cocoa coppiced in the months of April, generally recorded the highest success in all the growth parameters considered. Therefore, the month of April is recommended as the appropriate month to coppice old cocoa trees for the optimum growth performance of the generated chupons of cocoa in Uhonmora area of Edo-State, Nigeria.

***Keywords**: Chupon, coppicing, growth, old cocoa, rehabilitation, survival.*

INTRODUCTION

Cocoa was one of the main sources of income in Nigeria prior to independence. However, this changed following the exploration of crude oil in commercial quantities in the ’70s. Five decades later, oil has contributed more than agriculture to the nation’s foreign exchange earnings and as at the first quarter of 2022; the agriculture sector contributed just 4.96% to total trade, while the oil sector contributed 63.77% (ICCO, 2022). Over 50% of all exports in the 1970s and over 60% in 1980 were made up of cocoa. But during the 1990s, cocoa contribution steadily decreased, falling from 49 percent in 1989 to 22% in 1998. However, between 2015 and 2020, Nigeria was able to increase cocoa production by 25% to 250,000tons, compared to Cote d’Ivore, which had been able to increase production volume by 33% to 2,105,000 tons, and Cameroon, it increased by 32.7% to 280,000 tons (ICCO, 2022) while in Ghana, the Ghana Cocoa Board, despite the COVID-19 pandemic, reported a total production of 771,000 tons for the 2019/20 cocoa season as at November 2020, which was just 0.9% decline in cocoa production since 2015 (ICCO, 2022) . The cocoa production in Nigeria still remain low because most cocoa farms and farmers are aged, while the youths are not ready to farm because of the increasing insecurity in the farmlands, the cost of maintaining the existing cocoa farms is high, this is coupled with adverse effects of climate change, technological modernization and challenges in having access to finance.

Coppicing is one of the rehabilitation methods in cacao. It is the process of bringing unproductive cacao plants and plantations back to economic productivity or process of restoring yield by improved cultivation and management of existing mature trees. It is generally done by removal of the main stems of cacao trees (30 cm from cacao trees base) to encourage the regeneration of the canopy by chupon growth (Adejobi *et al*, 2014). It has been rightly observed by many authors that most plantations in cocoa ecologies of Nigeria are old, many are over 50 years of age, rehabilitation of such cocoa farms becomes inevitable if optimum yield is to be maintained (Olaiya, 2001; Olaiya *et al.,* 2003; Ogunlade *et al.,* 2017; Adebiyi *et al.,* 2021). Sheperd (1955) considered rehabilitation to be the restoration of the yields to the peak by systematic replacement of the inferior trees on a plantation. Low bean yield of about 400 kg/ha obtained in most cocoa plantations in Nigeria has been attributed to old age of the cocoa plantations and coupled with poor management practices. As it is applicable to all crops, there is a maximum age conditioned by varieties, soils, general plantation management, diseases, insects and other factors beyond which a plantation ceases to be of economic interest. Montgometry (1981) reported that optimalcocoa yields are achieved between 15 and 25 years of age; while Krung and Quartey-papafio (1964) after conducting cocoa survey throughout the growing regions of the world reported 30 to 40 years as the average economic life span of a cocoa tree. Olaiya (2001) suggested that apart from age consideration, a plot could be declared unproductive if the yield has declined to about the quarter of what is obtainable at the peak period (10 – 15 years), while Oduwole (2001) recommended the use of cost/benefit ratio of conducting rehabilitation.

Rehabilitation through coppicing and chuppon regeneration has been reported to improve growth and yield of cocoa (Olaiya, 2003). Odegbaro and Folarin (1974) had reported that budded and grafted F3 Amazon trees came into fruiting faster than the generated Amelonado trees and that by the sixth year, yield of F3 budded and grafted trees would have doubled that of the generated amelonado. However, there was no information on the months of the year that coppicing could be carried out for optimum performance. Therefore, this work was carried out to know the best month of the year to coppice cocoa trees for uptimum growth performance of generated cocoa chupons under field condition.

MATERIALS AND METHODS

Study area

Field experiment was carried out at the experimental farm of Cocoa Research Institute of Nigeria (CRIN), Uhonmora Substation in Edo State between 2017 and 2019, covering two consecutive rainy seasons and two dry seasons. The location lies between latitude 6'5N and longitude 5'50'E; a derived savanna zone of Nigeria. The rainfall is between 1000 – 1500 mm per annum. The maximum temperature ranges between 26 and 35 ^{0}C with average of about 30 ^{0}C; while minimum temperature ranges from 15 to 25 ^{0}C with average of 20 ^{0}C. Relative humidity is high during the rainy season; it ranges from 50 to 85% with average of 75%. However, there are seasonal variations in the values of relative humidity, which varies from 65 to 89% during the rainy season and 46 – 70 % during the dry season. The rainy season runs from April to October and characterized by heavy rain, low ambient temperature and high humidity; while the dry season is from November to March, is characterized with little or no rain, high ambient temperature and very low humidity.

Acquisition and preparation of experimental materials

About 50 x 30 m land area of old cacao plantation of fifty years was selected for the experiment. Plantain suckers used as shade crop for regenerated chupons were collected from experimental plots in the Station. Other materials used for the experiment were: Chain saw for cutting down of the cacao trunks, Long ruler for measurement of cacao coppicing height, vernier caliper for measuring the stem girth, red paint to paint the cut surfaces against pest and disease infestation and infection, respectively. The experiment was laid out with an average of 144 stands of cacao trees.

Treatments and experimental design

The field experiment had 4 trees randomly selected for each treatment, for a total of 48 and 144 cacao stands per block and experimental site respectively. The months of coppicing considered as treatments were: December, 2017 to November, 2018 twelve treatments. Two stands were eventually tagged per treatment for data collection. The experiment was laid in Randomized Complete Block Design with three replications and 144 plantain suckers were planted at 3 x 3m spacing as shade crop. The experiment was monitored for 22 months after coppicing.

Experimental lay-out, pegging and holing for plantain suckers were carried out before coppicing of tagged cocoa trees. The rehabilitation through coppicing was carried out on treatment and monthly basis by complete removal of the main stems of cocoa trees at 30 cm from the trunk base to encourage the regeneration of chupons, while the cut surface was painted with red paint contains red oxide to prevent infestation and infection of pest and disease. Chain saw was used to cut the trunk in a slant position at angle 45^O. Chupon growth commenced after a month of coppicing, which were left for 3 months in order to count the number of chupon per cacao trunk and the chupons were pruned to retain the 2 strong basal shoots which were allowed to develop to mature canopies.

Data collection and analysis

Data were collected on chupon survival count by visual count, chupon height using a meter rule from the ground surface to the tip of the main stem; chupon number of leaves. chupon diameter using vernier 'caliper at 30 cm above the ground level, leaf area (cm^2), and number of branches by visual counting. These growth parameters were taken monthly from 3 months after coppicing (3 MAC), while survival counts were carried out between 1 and 6 MAC. Data collected were statistically analyzed using analysis of variance (ANOVA) as well as descriptive statistics and significant mean differences were separated by Duncan Multiple Range Test (DMRT) ($P<0.05$).

RESULTS AND DISCUSSION

The results of the growth parameters on monthly basis (Tables 1-6) revealed that, coppicing old cocoa trees in the months of March, April, June, September, October and December significantly ($P<0.05$) enhanced better survival count of regenerated chupons relative to other treatments at one month after coppicing, but invariably, only cocoa plot coppiced in the month of April steadily maintained 100% survival count from the first month to the 6th month after coppicing (Table 1). This trend could be attributed to the fact that, by April, rain had just begin and nutrients, especially N, is steadily available in the soil. This might have aided healthier chupons generated and growth. The cocoa trees coppiced in January had the lowest chupon survival (Table 1). This might be attributed to the inherent dry spell of and hot weather conditions of that period which might have d led to scorching of most regenerated chupons. The month of January is the peak of dry season in the study area.

Table 2 showed that coppicing from January to December had between 3 – 15 chupons. Chileshe and Kitalyi (2002) observed that coppicing would enhance regrowth to produce many chupons and that the practice can help to improve the amount of leaves and branches. The cocoa trees coppiced in April significantly ($P<0.05$) enhanced number of chupon, chupon height, number of leaves per chupon relative to other months as treatments at 1MAC (Tables 2, 3 and 4). This trend continued for chupons height at 2, 3, 4, 5 and 6 MAC (Table 3). The highest number of chupons regrowth was recorded for the months of February and June (Table 2), however, there were some dieback across in all the months except for April (Table 1). The Cocoa coppiced in the month of April, generally recorded the highest growth parameter values probably because the coppicing was done at the onset of rain coupled with available soil nutrients. Low percentage of success in farmers' farm has been attributed to failure of farmers to follow due processes and good agricultural practices in coppiced cocoa plots (Adenikinju *et al.,* 1989; Olaiya, 2007; Akinnagbe, 2021). This might be as a result of choosing to coppice in the wrong month, as revealed in this study.

CONCLUSION AND RECOMMENDATION

This study revealed that cocoa rehabilitation through coppicing is a promising way of bringing old and unproductive cocoa plantation o economic productivity. That for coppicing to be successful, the timing and associated circumstances have to be considered painstakingly. Cocoa farmers in Nigeria therefore need being sensitized on rehabilitation through coppicing and the appropriate months of the year that coppicing can be carried out in the different regions and agro-ecologies of Nigeria, considering the prevalence of the climate change. Governments at all levels and non - governmental organizations should come to cocoa farmers' aid on this need. From the study, the month of April is the appropriate month to coppice old cocoa plantation for growth performance of cocoa trees in Uhonmora, area of Edo-State, Nigeria and is strongly advised to farmers in the area.

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Table 1: Effect of month of coppicing on cacao survival (%) at 1 - 6 MAC

Treatments	Months after coppicing					
Month	**1**	**2**	**3**	**4**	**5**	**6**
January	50.00c	50.00c	50.00c	25.00c	25.00d	25.00d
February	75.00b	75.00b	58.33bc	50.00bc	58.33cd	58.33c
March	100.00a	100.00a	83.33a	83.33a	83.33ab	66.67bc
April	100.00a	100.00a	100.00a	100.00a	100.00a	100.00a
May	83.33a	83.33a	83.33a	83.33a	83.33ab	83.33ab
June	100.00a	100.00a	100.00a	100.00a	83.33ab	83.33ab
July	75.00b	75.00b	75.00b	75.00ab	75.00bc	58.33c
August	75.00b	75.00b	75.00b	75.00ab	75.00bc	58.33c
September	100.00a	83.33a	83.33a	83.33a	83.33ab	66.67bc
October	100.00a	100.00a	100.00a	83.33a	83.33ab	66.67bc
November	83.33a	83.33a	83.33a	83.33a	83.33ab	66.67bc
December	100.00a	83.33a	83.33a	83.33a	83.33ab	66.67bc

Means followed by the same letters in each column bars are not significantly different by Duncan Multiple Range Test (DMRT) ($P<0.05$); MAC = Months after coppicing

Table 2: Effects of months of coppicing on Number of chupons per stand at 1 - 3 MAC

Treatments	Months after coppicing		
Month	**1**	**2**	**3**
January	5.67cde	6.00cd	10.00ab
February	4.67d	16.33a	16.67a
March	7.00bc	5.67d	9.67ab
April	16.00a	14.33b	10.67ab
May	10.33b	9.67c	13.00ab
June	5.67cde	15.00ab	15.67a
July	10.33b	9.00c	9.00ab
August	3.00e	5.67d	5.00b
September	5.33cde	15.33a	14.33b
October	8.67bc	5.00d	5.00b
November	8.33bc	4.00d	6.00b
December	7.67bcd	10.00ab	10.67b

Means followed by the same letters in each column are not significantly different by Duncan Multiple Range Test (DMRT) ($P<0.05$), MAC = Months after coppicing

Table 3: Effects of months of coppicing on chupons height (cm) at 1 - 6 MAC

Treatments	**Months after coppicing**					
Month	**1**	**2**	**3**	**4**	**5**	**6**
January	13.33b	21.33c	40.33abcd	52.00bcd	98.67bc	100.00a
February	25.00ab	44.67ab	51.67abc	74.33abc	76.33d	149.67a
March	15.30b	35.00bc	49.00abcd	54.67bcd	80.67cd	101.00a
April	43.33a	57.33a	68.33a	96.67a	125.00a	149.67a
May	22.67ab	43.00ab	56.00abc	65.00abcd	92.33c	105.00a
June	19.67b	21.67c	63.00ab	82.00ab	118.00ab	101.67a
July	16.00b	31.00bc	59.33abc	81.00ab	91.00cd	99.67a
August	16.00b	34.33bc	44.00abcd	57.33bcd	73.00d	93.33a
September	13.33b	39.00abc	53.00abc	68.00abcd	85.00cd	93.00a
October	11.33b	21.33c	31.33cd	42.33cd	80.00cd	102.33a
November	10.67b	19.00c	20.00d	45.33bcd	51.33e	82.33a
December	22.33ab	29.33bc	38.67bcd	34.00d	106.00ab	136.00a

Means followed by the same letters in each column are not significantly different by Duncan Multiple Range Test (DMRT) ($P<0.05$); MAC = Months after coppicing

Table 4: Effects of months of coppicing on Number of leaves per chupon at 1 - 6 MAC

Treatments	**Months after coppicing**					
Month of Coppicing	**1**	**2**	**3**	**4**	**5**	**6**
January	7.33b	9.33f	20.67ef	21.00de	37.33ef	26.33g
February	12.33ab	31.67a	34.67abc	34.00bc	39.00cdef	54.33cde
March	8.33b	18.67bcde	33.67abcd	31.00cd	35.33ef	40.00efg
April	18.33a	22.67bc	37.67a	51.33a	53.00abcd	74.67ab
May	9.33b	16.67cde	20.33ef	34.67bc	34.33ef	73.67ab
June	7.67b	16.33de	30.00ab	35.33bc	56.00abc	65.00abc
July	9.00b	16.33de	22.67ef	30.00cd	45.33bcde	42.33def
August	9.00b	16.67cde	26.00bcde	19.33e	25.33f	36.00efg
September	8.00b	24.00b	36.00a	30.33cd	30.67ef	33.33fg
October	8.33b	13.33ef	15.67f	19.67e	39.33cdef	58.67bcd
November	8.67b	13.67ef	25.67cde	26.33cde	38.33def	50.67cdef
December	7.33b	16.33de	24.33def	43.00ab	61.33a	78.33a

Means followed by the same letters in each column are not significantly different by Duncan Multiple Range Test (DMRT) ($P<0.05$), MAC = Months after coppicing

Table 5: Effects of months of coppicing on chupons diameter at at 1 - 6 MAC

Treatments	**Months after coppicing**					
Month	**1**	**2**	**3**	**4**	**5**	**6**
January	0.60bc	2.07abcde	2.33abcd	2.37abc	3.23abc	3.63ab
February	1.73a	3.00ab	2.27abcd	3.93a	4.07a	4.40a
March	1.27abc	1.63cdef	2.90abc	3.93a	3.93ab	3.33ab
April	1.07abc	3.20a	3.40a	3.87a	3.63ab	4.27a
May	0.93abc	2.70abc	3.17ab	1.80bc	2.07bc	2.17ab
June	1.40ab	1.97bcde	1.73bcd	3.27ab	2.30abc	2.47ab
July	1.10abc	1.37def	2.40abcd	3.07ab	2.00bc	3.03ab
August	1.00abc	1.90bcdef	1.83bcd	1.77bc	2.67abc	3.33ab
September	0.93abc	1.13ef	1.13d	1.70bc	2.47abc	2.57ab
October	0.50bc	1.00ef	1.33d	1.87bc	2.17abc	2.47ab
November	0.47bc	0.77f	1.00d	1.27c	1.37c	1.67b
December	0.30c	2.50abcd	1.63cd	1.90bc	2.20abc	2.70ab

Means followed by the same letters in each column are not significantly different by Duncan Multiple Range Test (DMRT) ($P<0.05$), MAC = Months after coppicing

Table 6: Effects of months of coppicing on Number of branches per chupon at 3 - 8 MAC

Treatments	**Months after coppicing**					
Month	**3**	**4**	**5**	**6**	**7**	**8**
January	0.60bc	2.07abcde	2.33abcd	2.37abc	3.23abc	3.63ab
February	1.73a	3.00ab	2.27abcd	3.93a	4.07a	4.40a
March	1.27abc	1.63cdef	2.90abc	3.93a	3.93ab	3.33ab
April	1.07abc	3.20a	3.40a	3.87a	3.63ab	4.27a
May	0.93abc	2.70abc	3.17ab	1.80bc	2.07bc	2.17ab
June	1.40ab	1.97bcde	1.73bcd	3.27ab	2.30abc	2.47ab
July	1.10abc	1.37def	2.40abcd	3.07ab	2.00bc	3.03ab
August	1.00abc	1.90bcdef	1.83bcd	1.77bc	2.67abc	3.33ab
September	0.93abc	1.13ef	1.13d	1.70bc	2.47abc	2.57ab
October	0.50bc	1.00ef	1.33d	1.87bc	2.17abc	2.47ab
November	0.47bc	0.77f	1.00d	1.27c	1.37c	1.67b
December	0.30c	2.50abcd	1.63cd	1.90bc	2.20abc	2.70ab

Means followed by the same letters in each column are not significantly different by Duncan Multiple Range Test (DMRT) ($P<0.05$), MAC = Months after coppicing

CAPACITY BUILDING ON POST-HARVEST HANDLING AND USE OF RAISED-PLATFORM TOMATO DRIER FOR REDUCTION OF POST-HARVEST LOSSES AMONG TOMATO STAKEHOLDERS IN NASARAWA STATE

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Abstract
Tomato processing into value added products is crucial to mitigation of post-harvest losses, promotion of food security and household livelihood. The study evaluated effects of training on post-harvest handling and perception of stakeholders on the use of Raised-Platform Dryer for management of post-harvest loss in tomato. A random sampling technique was used to select 99 stakeholders out of the 160 trained in two local government areas of Nasarawa state. Data were collected with the aid of structured questionnaire and analyzed using descriptive statistics and probit regression. The result showed that most of the stakeholders were female (69.7%), with average age of 35 years and had secondary level of education (38.4%); and also, 59.6 percent were producing and processing tomatoes (59.6%). Findings revealed that 41% have adopted drying tomato with the aid of Raised-Platform Dryer. Majority of the stakeholders were of the opinion that the post-processing colour of the product developed was adequate (72.7%), and price offered for the product was commensurate (71.7%). The most important factors affecting the adoption of the Raised-Platform Dryer were size of tomato farm and years of experience in tomato production. The study recommends scaling out of the training to other areas of comparative advantage in tomato production to improve tomato handling, minimize post-harvest loss and promote production of hygienic product.
Keywords: *Tomato, Post-harvest losses, Handling, Raised drier, Nasarawa*

INTRODUCTION

Tomato (*Lycopercicon lycopercison*) is an important and outstanding vegetable due to its importance in daily diet (Babalola *et al*, 2010). Nigeria consumes an estimated 2.3 million tonnes of tomatoes annually with tomato consumption per capita standing at 12kg in 2016 (Helgilibrary, 2017). Lack of proper storage, packaging and processing are among the factors leading to post-harvest losses in the country (Bolarin and Bosa, 2015). Thus, domestic supply cannot meet domestic demand for fresh tomatoes which is estimated to be more than 2 million tonnes (demand) or $2.55 billion annually. The country supplement local demand for fresh tomatoes with #360 million (over 300,000 metric tonnes) of imported tomato paste annually. A lot of farmers have lost a substantial amount of revenue that should have accrued to them due to absence of storage and processing facilities in the country (Abass *et al*, 2018). Most farmers/processors use traditional methods of drying, especially drying tomatoes on bare ground (NIHORT, 2018). The National Horticultural Research Institute recently introduced a low cost Raised-Platform Dryer that may be used for drying tomato. Further to this the Institute organized training for tomato stakeholders at Nassarawa state to socialize the invention and build capacity on the use of the low-cost Raised-Platform Drier. The study therefore set out to profile the opinion of the stakeholders about the relevance and impact of the training, regarding post-harvest technique and management practices, skills, and adoptability.

METHODOLOGY

The study was carried out in Nasarawa State and the state is one of the North Central States of Nigeria. The state has thirteen local government areas and its capital is Lafia. A random sampling technique was employed to select 99 respondents from a total of 160 stakeholders earlier trained on tomato post-harvest handling and use of Raised-Platform Drier from Lafia and Obi Local Government Areas of Nasarawa South Senatorial District. Structured questionnaire was used to obtain information on opinion of the stakeholders about the usefulness of the training, appropriateness towards post-harvest technology and management practices, skills and adoptability of the technology introduced. Descriptive statistics and Probit regression was used to analyze data collected.

RESULTS AND DISCUSSION

Stakeholders' characteristics

Most of the stakeholders were female (69.7%), had secondary level of education (38.4%), married (57.6%) with mean age of 35.2±6.3. The respondents had average household size of 6.7. The average year of experience in tomato production and processing were 6.6 and 4.6 respectively. Majority of the respondents had farming as their major occupation (82.8%) and had been involved in tomato production and processing (59.6%); moreover, 73.7 percent and were members of cooperative society (73.7%) and have processed average of 780kg of tomato weekly during the peak season of tomato production (Table 1).

Perception of stakeholders on aspects of processing operations trained.

The most important aspect of the training involved washing (86%), followed by sorting (71%) and packaging in impermeable material (60%). Other important aspects of the training were drying on raised platform (54%) and cutting using plank (44%). Findings also revealed that most of the stakeholders adopted cutting tomato using plank (48%), drying their tomato using Raised-Platform Dryer to prevent product contamination (41%) and packaging in impermeable materials (36%) which is known to retain the red colour of the product. Additionally, 22% of the stakeholders had adopted sorting of tomato before processing while only 9% adopted washing before processing (Table 2).

Perception of the stakeholders on appropriateness of training and acceptability of product

Stakeholders were of the opinion that the range of equipment demonstrated during the training were adequate (66.7%), duration and content of the training (64.6%) were also adequate. Also, considered adequate was the quality of the product developed (54.5%) and knowledge disseminated by the facilitator (50.5%). Moreover, most of the stakeholders opined that colour of the product developed and the price being offered for the product developed were both acceptable (71.7%). In the same vein, the response of consumers to the product was acceptable by 63.6% of the stakeholders (Table 3).

Factors affecting adoption of the technology.

The result showed that factors that determine the likelihood of participants adopting the Raised-Platform Drier technology were years of tomato production and tomato farm size. Participants with higher scores in years of production were less likely to use the Raised-Platform Drier technology. This could be due to the fact that they were older in the business and used to the traditional way of tomato processing. However, increase in farm size increases the likelihood of adopting the Raised-Platform Drier technology ($p<0.001$). The result implies that participants with larger tomato farm size are more likely to adopt the sun drier technology. This is because larger farm size is expected to have larger yield/ output and may need to deploy technology to mitigate post-harvest loss. (Table 4).

CONCLUSION AND RECOMMENDATION

Most of the stakeholders trained were female had secondary level of education and were into tomato production and processing. Findings revealed that some of the stakeholders had as a fall-out to the training programme adopted the processes and the Raised-Platform technology recommended for tomato drying. Based on the findings from the study, it is recommended that the training should be extended to other areas of comparative advantages in tomato production to improve tomato post-harvest handling and processing and awareness creation on the importance of adequate post-harvest handling practices.

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Table 1: Socioeconomic Characteristics of tomato stakeholders

Variable	Frequency	Percentage
Sex		
Male	27	27.3
Female	69	69.7
No response	3	3.0
Educational status		
No formal	23	23.2
Adult literacy	9	9.1
Primary	12	12.1
Secondary	38	38.4
Tertiary	12	12.1
No response	5	5.7
Marital Status		
Single	19	19.2
Married	57	57.6
Divorced	4	4.04
Separated	4	4.04
Widowed	7	7.1
Prefer not to say	8	8.08
Age (years)		
≤20		
21-30	28	28.3
31-40	47	47.5
41-50	12	12.1
51-60		
>61		
Prefer not to say	12	12.1
Age (mean and standard deviation)	35.1±6.3	
Household size (mean and standard deviation)	6.7 ±4.3	
Average years of experience in Production of tomato	6.6 ±3.9	
Average years of experience in processing tomato	4.6 ± 3.7	
Primary occupation		
Farming	82	82.8
Fishing	3	3.0
Trading	7	7.1
Public service	1	1.0
No response	6	
Stakeholder status		
Producer	31	31.3
Processor	8	8.1
Both	59	59.6
Marketer	-	
No response	1	1.0
Membership of social group		
Cooperative	74	73.7
Savings and credit	20	20.2
Others	-	-
No response	5	5.0
Average quantity of fresh tomato processed monthly	780kg	

Table 2: Perception of stakeholders on aspects of processing operations trained

Variable	Important (%)	Not important (%)	Adoption (%)
Sorting	71	29	22
Washing	86	14	9
Cutting using chopping board/plank	44	56	48
Drying on raised platform	54	46	41
Packaging in impermeable material	60	40	36

Table 3: Perception of the stakeholders on the Appropriateness of training and acceptability of product

Variable	Adequate	Not adequate
Equipment demonstrated	68.7	31.3
Quality of product developed after the training	54.5	45.3
Variable	Acceptable	Not acceptable
Colour of product developed after the training	72.7	27.3
Price being offered to the product developed after the training	71.7	28.3

Table 4: Factors affecting adoption of Raised drier technology.

Variable	Coefficient	z-value	p-value
Age	-0.212	-1.66	0.096
Age squared	0.004	1.86	0.063
Sex (Male=1 0 otherwise)	0.232	0.40	0.686
Educational qualification (0=No formal education, 1 otherwise)	1.268	1.59	0.113
Marital status	0.673	1.06	0.288
Membership of social group (1=Yes, 0 otherwise)	-0.471	-0.85	0.397
Primary occupation (1=farming, 0 otherwise)	0.512	0.86	0.391
Years of tomato production	-0.914	-2.22	0.027**
Tomato farm size (in acres)	0.494	2.47	0.014**
Constant	2.813	1.42	0.157

Log likelihood -21.929
Prob>Chi2 0.0006
Pseudo R2 0.3996
No of observations 99

Source: Stata output

PROSPECT AND PROBLEMS OF COFFEE PRODUCTION IN NIGERIA

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ABSTRACT
This study examined the production constraints and the prospects of coffee production in Nigeria. Desk research was carried out using past published literature. The research established the fact that coffee production has suffered setbacks in Nigeria over the years with production fluctuating from one year to the other. The fluctuation was attributed to factors such as old coffee trees, coffee plantation with little rehabilitation, poor finance or capital, climate change, problems associated with marketing and so on. The study, however, gave a high hope of coffee production in Nigeria if the subsector is revamped. It was recommended that coffee farmers in Nigeria should embark on rehabilitation or complete renovation of their coffee plantation to boost production. Cheap credits should also be made available to coffee farmers to purchase farm inputs and to cope with climate variability militating against coffee production in Nigeria.
Keywords: *Coffee production, Climate change, Plantation, Credits, Caffeine.*

INTRODUCTION

Some species of shrubs or trees of the genus *Coffea* are known to produce berries from which coffee is obtained. They are evergreen trees or shrubs which could grow up to 5 meters when not pruned. Coffee plants are native to Africa. However, the two major species of coffee commercially grown are *Coffee robusta* and *Coffee arabica* (Botanical Aspects, 2009). *Coffee arabica* was believed to have originated from Ethiopia while *coffee robusta* was traceable to Central African Republic. Coffee is cultivated or grown in over 70 countries, mostly in the Americas, the Indian subcontinent and Southeast Asia. However, Consumption of coffee mostly takes place in industrialized countries. Coffee is considered to be the most widely consumed hot beverage worldwide (Gichimu *et al,* 2010). Over 90 percent of coffee production takes place in developing countries mainly South America. Globally, Brazil is driving the coffee production and trade growth. The world coffee production experienced a growth rate of 6.4% in the year 2020 while Brazil's coffee production grew by 18.5% (ICO,2021). A significant revenue crop for many poor nations is coffee. It has also created several million jobs in many producing countries where more than nine million tons of green beans are produced annually (ICO, 2022). Coffee has become the main export and pillar for African countries like Uganda, Burundi, Rwanda, and Ethiopia as well as many Central American countries (Cousin, 1997). Small farm holders are the main actors along the coffee supply chain in many of the developing countries, including Nigeria.

The Health Benefits of Coffee

Coffee contains high quantity of B vitamins, niacin and riboflavin as well as magnesium. (Full Report, 2016). Coffee contains a psychoactive chemical which is caffeine. Caffeine is known for its stimulating effects *(Cappelletti et al*, 2015). According to a 2017 assessment of clinical trials, consuming three to four cups of coffee daily is generally safe at ordinary intake levels and is more likely to improve health outcomes than to have negative effects.

Objectives of the Study

This research work was carried out to determine the prospects and problems of coffee production in Nigeria. It could however be observed that the production of coffee in Nigeria is facing a downward trend despite the contribution of coffee export to the country's GDP and livelihoods for many families in the production and along the value chain. This study therefore finds it quite imperative to determine the problems associated with the downward trend in the production of coffee in Nigeria.

Justification for the Study

Coffee is considered to be a cash crop which serves as means of livelihoods or has created several million jobs in many producing countries where more than nine million tons of green beans are produced annually (ICO, 2022). Coffee also plays an important role in the balance of trade between developing and developed economies or countries since it is an important source of foreign exchange thereby contributing in different measures to each country's national income. However, according to ICO report 2009, coffee exports have been increasing. It has also been observed that the production of this valuable crop in Nigeria has been dwindling over the years. Since a lot of folks ranging from the producers (farmers) to processors, marketers, transporters and so on depend on coffee for their sustenance and livelihoods, there is however, the need to carry out scientific investigation as to the reasons for the dwindling production of this valuable crop in Nigeria.

METHODOLOGY

This research work adopted desk literature using findings from various past published literatures. The study areas were states where coffee is being produced in Nigeria. The study seeks to find out the constraints or problems bedeviling coffee production in Nigeria and the reduction in the production of this valuable crop.

Coffee Production Trend in Nigeria since Independence

Figure 1 below shows the production in tons of coffee in Nigeria from year 1961 to 2020. The annual production of coffee rose sharply from 1080 tons in 1961 to 5700 tons in 1964. But this production figure dropped sharply to 2700 tons in 1965 and since then the production of coffee in Nigeria has been fluctuating year after year until it gets to 1984 where it rose again sharply from 2520 tons in 1984 to 5700 tons in 1988. From 1988, it maintained a plateau shaped structure from 1988 to 1992 where it dropped sharply again to 2400 tons in 1993. However, from 1993, it started fluctuating in a downward trend until it reached the lowest level of 1000 tons in 2020. Generally, from the figure 2, it can be observed that there was an appreciable value in the quantity of coffee produced in Nigeria while from 1993, the coffee production continued to decrease drastically. Hence, there is a need for a quick intervention in the production of coffee in the country.

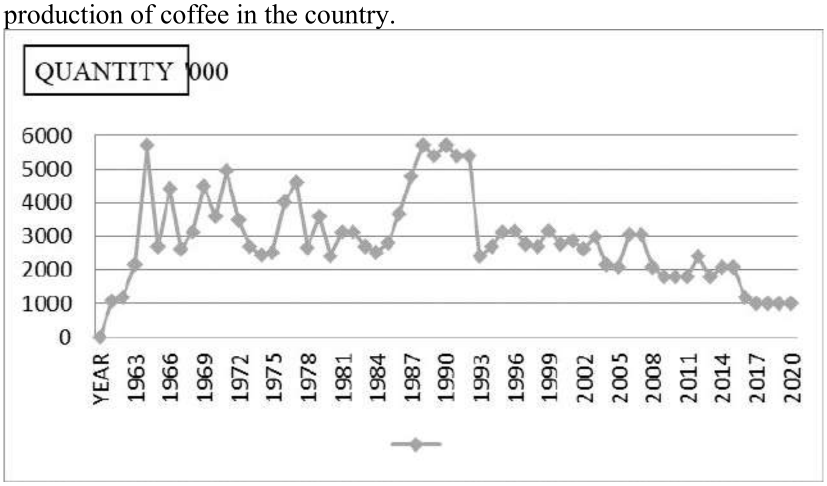

Figure 1: FAOSTAT, 2020

Production Constraints of Coffee in Nigeria

In Nigeria, the rise and fall of coffee production over the years are as a result of several factors among which are:

1) Moribund coffee trees: Majority of the coffee plants in Nigeria are already aged and have passed their fruitful ages. Most of these trees were planted some 40 years ago. Some of these coffee farms were actually acquired through family inheritance (Aderolu *et al.,* 2014).
2) Climate change: The devastating effects of climate change on crop production globally is alarming. Drought as a result of low level of rainfall and high temperature has negatively impacted coffee production in Nigeria. This is because drought negatively affects germination of seeds and inhibits photosynthesis as well as general growth of coffee trees (Bhutia *etal.*,2018).
3) Inadequate capital and poor access to credit: Access to credit at low interest rate goes a long way to increase coffee production. In other words, access to credits by small farm holders helps to procure capital assets and farm inputs which their savings alone cannot purchase. According to Kegode, (2005), research has shown that farmers have difficult access to financing, and borrowing has significant interest costs.
4) Marketing problems: According to Akinfenwa (2019), marketing problem is the most important challenge causing decline in coffee production in Nigeria which is attributable to inadequate

market information and poor pricing of coffee. Processed coffee beans are poorly priced in Nigeria as a result of low quality beans due to bad handling in various processing stages. This inevitably led to the refusal to buy most of the coffee beans produced in Nigeria in the international market due to it poor quality.

Prospect of Coffee Production in Nigeria

There is high hope of increased coffee production. This is achievable through the following:

1) It has been established that most coffee plants in Nigeria have become aged and surpassed their fruitful age. There is, however, a need to sensitize coffee farmers in Nigeria to embark on massive rehabilitation of their coffee farms so that the trees can rejuvenate and produce good yields. However, in situation where the coffee farms have gone beyond rehabilitation, the farmers can engage in complete replanting which means complete removal of old coffee trees and replanting with young and high yielding and disease resistance cultivars. This would go a long way to increased coffee production in the country.
2) The devastating effects of climate change and variability is real in Nigeria. The heat waves and low precipitation impact negatively on coffee trees. There is, however, the need to develop and adopt adaptation strategies for coffee trees. These include the development and adoption of drought resistance varieties. Also mulching of young seedlings and irrigation should be practiced.
3) Another factor to consider in revamping coffee production in Nigeria is the use of adequate farm inputs. For instance, correct application of recommended fertilizer at the appropriate time would inevitably increase coffee yield. The same applies to other farm inputs such as fungicide and other pesticides to control the incidence of coffee diseases and pests. However, these agrochemicals should be made available to farmers at subsidized rates.
4) Most of the coffee farmers in Nigeria are small farm holders with limited access to farm credits due to collateral issues and poor understanding of procedures to obtain loans. However, to boost coffee production in Nigeria, coffee farmers should be properly educated on the right procedures to follow in obtaining credits from financial institutions. Also, monetary policies should be tailored toward making cheap and quick loans available for agricultural productions especially coffee production.

CONCLUSION

Coffee production in Nigeria has suffered decline over the years in spite of the huge benefits derivable from its production in terms of foreign exchange to the country as well as being source of income to many farm families which depend on coffee farming as means of livelihoods. This is attributable to the various challenges faced by coffee farmers such as poor finance, moribund coffee trees, marketing problems, climate related issues and so on. It is, however, recommended that in order to revamp coffee subsector of the country's economy, the federal government as well as the necessary NGO's should take proactive steps in widening the scope of production of this crop as well as proffering solutions to the various marketing and other problems faced by coffee farmers in Nigeria.

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SYNERGETIC EFFECT OF *Physalis angulata* AND *Tithona diversifolia* AQUEOUS EXTRACTS FOR THE MANAGEMENT OF *Podgrica* spp. INFESTATION ON CUCUMBER (*Cucumis sativus*)

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ABSTRACT

Insect pest infestation is a major factor militating against cucumber production and farmers generally adopt synthetic insecticides for its management. A field trial was undertaken to evaluate the insecticidal potency of P. angulata + T. diversifolia for the management of Podagrica spp. insect pest of cucumber. The treatments consisted of aqueous leaf extracts of sole application of P. angulata, T. diversifolia, mixture of P. angulata + T. diversifolia and Cypermethrin as check; laid out in Randomized Complete Block Design and replicated three times. Data was collected on insect population before treatment application and 3 days after spraying of insecticides at 6, 7, 8, and 9 weeks after planting (WAP). Results obtained showed that the plant extracts exhibited effectiveness in reducing the insect population The order of effectiveness in decreasing sequence was found to be Cypermethrin > P. angulata + T. diversifolia, P. angulata and T. diversifolia crude extracts could be explored as promising insecticidal agents to provide valuable alternatives to chemical control of insect infestation on cucumber. Further study is recommended to determine the chemical constituents responsible for the plant insecticidal activity.

Keywords: *Aqueous extracts, insecticidal agents, insect infestation, Physalis angulata¸ Podagrica spp*

INTRODUCTION

Cucumber (*Cucumis sativus* L.) is an important vegetable and one of the most popular members of the Cucurbitaceae family (Lower and Edwards, 1986; Thoa, 1998) grown for its fruits, which are eaten either fresh or pickled in most countries (Lower and Edwards, 1986; Thoa, 1998). Cucumber is the fourth most important vegetable crop after tomato, cabbage and onion (Tatlioglu and Eguchi, 1998). In Nigeria, bulk production from northern Nigeria sustains demand from southern Nigeria, where these salad vegetables augment high intake of carbohydrate, hence high prices (Ayoola and Adeniran, 2006). Cucumber is susceptible to several chewing and sucking insect pests during the whole cultivation period and may cause damage to up to 80% (Rahman and Uddin, 2016) leading to great loss in quality and yield (Kaiser and Ernst, 2018). *Podagrica* spp is one of the most damaging insect pests causing the yield losses up to 30-100%, being polyphagous, adult stages are harmful to crop as they feed voraciously in leaf making irregular holes thus causing decline in the crop photosynthetic proficiency (Odebiyi, 1980). The insects correspondingly act as vectors of mosaic viral diseases (Fasunwon and Banjo, 2010). Thus, these major insect pests are becoming the foremost threat in cucumber cultivation and these might be one of the reasons for the lower yield and reasons why farmers are discouraged to cultivate the crop.

Farmers in Nigeria and other tropical countries exclusively depend on the use of synthetic insecticides to control the insect pest infestation in horticultural crops to considerably reduce yield losses. However, repetitive and constant uses of these toxic insecticides has some grave disadvantages. The injurious effects and increased cost–benefit ratio of synthetic insecticides have inspired scientists to advance substitutes to chemical control in insect pest management. Consequently, the focus has now been shifted in the direction of integrated pest management (IPM) such as the use of plant materials. Plants extracts may offer an alternative to the presently used conventional insecticides for the control of agriculturally important insect pests, as they constitute a rich source of bioactive chemicals compounds (Daoubi *et al*., 2005), that are practically an unexploited pool of insecticides that can be used as veritable substitutes for synthetic pesticides. Consequently, the present research was conceived to assess the effectiveness of *P. angulata* and *T. diversifolia* aqueous extracts as bio-insecticide against insect pests infesting cucumber.

MATERIALS AND METHODS

Experimental site

The study was conducted on a 15 m×10 m (150 m^2) area of land during the wet season of 2022 and at the Teaching and Research Farm, Faculty of Agricultural Technology, Rufus Giwa Polytechnic, Owo, Ondo State, Nigeria.

Collection and preparation of plant extracts

Physalis angulata and *Tithona diversifolia* were collected from different locations in Owo and its environs. The whole plants excluding the roots were washed with clean water to remove dirt and allowed to drain. Thereafter; 8 kg of the plant shoot and leaves was weighed using electronic balance and was pounded thoroughly using mortar and pestle to produce fine crushed materials. The pounded plant materials were in 10 litres of borehole water in plastic bucket for 24 hours, vigorously stirred to form a thorough mixture occasionally and filtered using muslin cloth ready for spray (Oparaeke, 2006). The procedure was repeated each week the spray operation was carried out.

Crop establishment and Field Layout

The field experiment laid out in Randomized Complete Block Design (RCBD) replicated three times per treatment consisting of five treatments namely: sole application of *P. angulata*, *T. diversifolia*, mixture of *P. angulata* + *T. diversifolia* crude aqueous extracts, synthetic insecticide (Lambda cyhalothrin) used as check to monitor the effectiveness of the plant extracts and control with no treatment (Adesina and Afolabi, 2014). The block size was 2m x 15m and each treatment was allocated to a plot of 3.7 × 2m and each plot size had three main and two discard rows (one on either side of the main rows). Each plot was separated by a 1.0 m wide border margin to check spray drift. Two seeds of market more cucumber variety were sown per hole at 60cm x 60cm spacing, which was later thinned to one vigorous stand; supplying was carried out a week after planting. Weeding was done as necessary but no fertilizer application was made.

The treatments were applied at 21 days after sowing (DAS) by preparing 10% concentration of the extracts from the stock solution, using Spray well 16 L Knapsack sprayer model under fairly calm weather condition to avoid drifting to adjacent plots. Subsequent application of the treatments was carried out at weekly intervals. Synthetic insecticide (Cypermethrin 25 EC) was applied at the rate of 0.25 kg active ingredient (a.i) per ha to serve as check to compare the efficacy of the plant extracts.

Data collection and statistical analysis

To assess the effect of the treatments on the *Podagrica* beetles counting of the insect was carried out early in the morning (6.00 – 7.00 am) daily (Adesina, 2013). Number of *Podagrica* spp was counted prior before treatment application, number of *Podagrica* spp third day post application of treatment and on five randomly selected plants per plot. Data collected were subjected to analysis of variance and treatment means were separated using Least Significant Difference at 5% probability level.

RESULTS

Effect of sole application and mixture of *Physalis angulata* and *Tithona diversifolia* aqueous extracts on *Podgrica* spp. Population at 6 WAP

The result in Table 1 shows *Podagrica spp.* population on okra before the application of the aqueous plant extracts treatments. *Podgrica* spp. population before spraying was slightly significantly different (P>0.05) in the plots assigned to the treatments evaluated. Though, plot assigned to be treated with *T. diversifolia* had the highest *Podagrica spp* population (2.46 insects/plant), while plot assigned to be sprayed with *P. angulata* and Cypermethrin had similar population respectively.

Sole application of *P. angulata* and *T. diversifolia* aqueous extracts and their mixture significantly influenced *Podgrica* spp. population at 7 WAP (Table 1). Highest population was found in control plots (2.31), least insect population was observed in the cucumber sprayed with cypermethrin and mixture of the extract (0.74) and was not significantly different from those observed from sole application of *P. angulata* extract (0.79). At the third day post application of the treatment after second spraying regime (7 WAP), insect population in control plot still remain the highest (1.99), followed by sole application of *T. diversifolia* (0.88) and *P. angulata* (0,86) which was not statistically different from each other. Cypermethrin and mixture of the extracts recorded the lowest (0.74) insect population. However, the insect population observed from both Cypermethrin and mixture of the extracts was not significantly different (Table 1).

Table 1: *Podagrica spp. infestation* at the commencement of treatment (6 WAP), 7 WAP and third day after spraying

Treatment	Pre spraying at 6 WAP	3rd day after 1st spraying	Insect population at 7 WAP	3rd day after 2nd spraying
Control	0.82c	0.74	2.31a	1.99a
P. angulata + *T. diversifolia*	0.85c	1.0	0.74c	0.74c
Cypermethrin	1.07b	0.85	0.74c	0.74c
T. diversifolia	2.46a	0.96	0.79c	0.88b
P. angulate	1.21b	1.0	0.86b	0.86b

Treatments with the same letter in column are not statistically significant different from each other.

Effect of sole application and mixture of *Physalis angulata* and *Tithona diversifolia* aqueous extracts on *Podgrica* spp. Population at 8 and 9 WAP

Result in Table 2, shows that application of *P. angulata* + *T. diversifolia* extract recorded the least *Podgrica* spp. population (0.92) T 8 WAP closely followed by a non-significant population observed in plots treated with Cypermethrin (0.94). Cucumber treated with sole application of *P. angulata* (0.99and *T. diversifolia* (0.86) extracts recorded significantly reduction in *Podgrica* spp. population compared to control. Similar trend was observed third day post treatment application as plant extracts and cypermethrin significantly caused a reduction in the insect population. Cypermethrin, sole and mixture of the extracts significantly suppressed the insect population in comparison with control at 9 WAP (Table 2). Non-significant difference was observed in the insect population from cucumbers in plots treated with Cypermethrin and *P. angulata* + *T. diversifolia* mixture. Third day after the fourth spraying regime, insect population recorded from plots treated with Cypermethrin, *P. angulata* + *T. diversifolia* mixture and sole application of *T. diversifolia* recorded statistically same number of insect population. However, this population was significantly different from what was obtainable from sole application of *P. angulata* and control.

Table 2: Insect population at 8 WAP and 3rd day after third spraying

Treatment	Insect population at 8 WAP	3rd day after 3rd spraying at 8 WAP	Insect population at 9 WAP	3rd day after 2nd spraying
Control	2.18	1.11	1.78	1.02
P. angulata + *T. diversifolia*	0.92	0.73	0.84	0.81
Cypermethrin	0.94	0.62	0.85	0.82
T. diversifolia	0.86	0.86	0.94	0.81
P. angulate	0.99	0.90	0.92	0.86

Treatments with the same letter in column are not statistically significant different from each other.

DISCUSSION

In Nigeria, cucumber cultivation has become a booming activity in urban and peri-urban cities these recent years. Unfortunately, insect pests are real problems for farmers because of the damage they cause and synthetic insecticides are most often used for the control of insect pests of cucumber. Because of the intensive and indiscriminate use of chemical pesticides, which has led to residual issues and the development of resistance to many common insecticides, there is a constant need for the search of environmentally benign insecticides from natural sources, particularly plants. Botanical insecticides contain compounds with properties that repel, deter or disrupt the growth, feeding or reproductive activities of insect pest on crops (Degri et al 2012). It can be inferred from the results of present investigation that the field evaluation of insecticides and biopesticides against insect infestation exerted variable efficacy in reducing the insect population. Though, the sole and combined application of the botanical extracts contributed in reducing the number of *Podgrica* spp. on treated cucumber. The mixture of *P. angulata* + *T. diversifolia* were relatively more effective against crops infestation compared to their sole application, therefore, seem to have potent insecticidal properties for checking *Podgrica* spp. infestation and population increase. This support the findings of Sapkota *et al.* (2010) who stated that application of mixture of leaf extract of many plants to be the most superior in terms of quality, size, yield and reduction in fruit infestation. Russel and Lane (1993) opined that plant extracts often consist of complex mixtures of bioactive constituent's plant metabolites may produce toxic effects if ingested leading to rejection of the host plant.

Cucumber plants in the plots sprayed with plant extracts were less invaded by insects and were at par with plots sprayed with synthetic insecticides. This study confirmed previous study by Adesina and Idoko (2013) who reported on the efficacy of *Chenopidium ambrosiodes* and *Spondia mobin* crude extracts in suppressing flea beetle infestation on okra plants. High effectiveness of Cypermethrin compared to crude aqueous extracts could be attributed to non-degradability of the active ingredient formulation that possesses immediate knock down effects on the target insects (Oladimeji and Kannike, 2010; Alao *et al.*, 2011). The organic products might have created a hostile environment for insects and a physical barrier to infestation, hindered feeding activities of the insects. These effects might be attributed to characteristic offensive odour perceived during application. The high infestation recorded in the control plot post treatment application is an indicative of the insect finding a refuge in the untreated cucumber to feed on the plant foliage.

CONCLUSION

The finding from this study confirmed that there is a vast array of plant materials with insecticidal properties that could be screened for reducing insect pest depredation to cucumber in the field. The utilization of *P. angulata* + *T. diversifolia* aqueous extracts mixture had positive toxicity impact in decreasing the rate of *Podagrica spp.* infestation which would ultimately reduce leave damages and increased cucumber fruit yield. Thus act as promising insecticidal agents as it compares favourably with Cypermethrin and they could provide valuable alternatives to synthetic insecticides in the integrated management of *Podagrica spp.* The effectiveness of the crude plant extracts and synthetic insecticides was found in the following order Cypermethrin > *P. angulata* + *T. diversifolia* > *P. angulata* > *T. diversifolia*. Therefore, resource-poor farmers are enjoined to adopt the utilization of mixture of *P. angulata* + *T. diversifolia* extracts to suppressed *Podagrica spp.* infestation and increase cucumber fruit yield. Further study is recommended to determine the extracts mode of actions and biochemical constituents responsible for the insecticidal activity of the plants.

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PROFITABILITY ANALYSIS OF BELL PEPPER PRODUCTION UNDER SCREENHOUSE PRODUCTION SYSTEM IN AKURE NORTH LOCAL GOVERNMENT

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ABSTRACT
Greenhouse technology is a technique for regulating the environmental factors for the benefit of the plants (bell pepper) under protective cultivation. The study aims to analyze of cost of production and profitability of bell pepper under a screen house production system. Data were obtained from farm records and operational system of a screen house production system in Akure north area of Ondo State. Data collated were obtained from 4 production cycles during the period the two years evaluated. Despite the initial high cost of investment, screen house productivity is high. Cost of inputs constituted 59% of the variable costs of production while labor cost constituted 29%. Production of bell pepper under screen house system resulted in high gross margin of approximately 81-86% depending on the level of productivity
Keywords: *Bell pepper, greenhouse, profitability, fertigation*

INTRODUCTION

Agricultural production system in Africa is faced with a myriad of problems including climate change, edaphic factor, ecological and biotic factors (pest and diseases). Majority of crop production system depends on natural or rainfed production system with consequent effect on yield limitation. To achieve competitive production, farmers must be able to manage their farms to mitigate the effect of those limiting factors that prevent their crops from attaining the potential yield as dictated by the genetic composition. The most limiting factor of production usually determine the crop performance. In the face of the current challenges with climate change, farmers can shift to more climate smart production system under controlled or partially controlled production system as in the case of greenhouse or screenhouse production systems often referred to as controlled atmosphere agriculture (CEA). Greenhouse crop production which is now a growing reality throughout the world according to FAO (2013) was explained by Mohammed and Dulamin (2021) as protected agriculture, one of the important and advanced production systems in terms of the use of scientific methods and technological equipment that ensure the provision of appropriate climatic conditions for the growth and development of the crop outside its normal niche and production times or seasons.

Capsicum (*Capsicum spp*) is an important vegetable cum spice crop grown in almost all parts of tropical and subtropical regions of the world (Reddy *et al*., 2022). Pepper is an annual vegetable crop which ranks next to potatoes and tomatoes in order of production. It belongs to the family *Solanaceae* and genus *Capsicum* which comprises 20-30 species. Pepper grows in most countries and covers 1.93million ha (FAOSTAT, 2022). Based on their culinary purposes and organoleptic features, pepper fruits are normally classified as two kinds: Bell pepper, a non-pungent, chunky sweet pepper type and Chilli pepper with pungent fruits (De, 2003). Sweet pepper (*Capsicum annum* L.), commercially known as bell pepper is an annual herb or shrub, 0.5-1.5m tall, erect and highly-branched crop with fruits harvested at green matured stage or at red and/or yellow ripened stage. It is rich in Vitamin A, Vitamin C and minerals like Calcium, Magnesium, Phosphorus and Potassium (Kelley and Boyhan, 2009).

Pepper is a crop grown extensively under rain-fed conditions with very high yields when the rainfall is about 600 to 1250 mm. The climatic changes will continue to exacerbate soil moisture and thermal stresses during the dry season with implications for crop performance (Tombesia *et al*., 2018, Agele, 2021). The inability to meet this moisture requirements has resulted in the adoption of irrigation to sustain plant growth. Adopting ways of increasing production of pepper has brought to the light the use of controlled environment (greenhouses, polyhouses etc.). Greenhouse is becoming a popular farming system among pepper farmers. Greenhouses increase crop yields by as much as two to five times as plants grown under open field conditions; the quality of the product is normally higher than open field and the incidence of pest and disease is reduced (Olatunji and Akeem, 2002). It can give manifold production of quality produce round the year from small landholdings, compared to the open field cultivation (Murthy *et al*. 2009; Rao *et al*. 2013).

With challenges experienced in the availability of vegetable crops especially pepper and tomatoes and the associated high price in the recent years, vegetable production in the southwestern part of Nigeria has increased. Ondo state has become a growing of hub of vegetable production in the Southwest Nigeria especially tomato and pepper. This is not only supporting the local market but marketers from Lagos, Edo and Delta states also source their fresh vegies from the state. However, majority of the tomatoes and pepper are produced under open field production system with some little supplemental irrigation in the dry season. The unstable pattern of the weather and climate change often results into losses when unexpected rain cessation occur. The use of protected cultivation or partially protected cultivation in the state is becoming visible in some part of the state but the adoption of such farming system is still low due to initial cost high cost of investment. The profitability of greenhouse farming depends on a number of factors, including the crops grown, the location of the greenhouse, the cost of construction and operation, and the market for the produce. In general, greenhouse farming can be more profitable than traditional field farming.

Crop Production in greenhouse or screen house is a capital intensive production technology that require substantial initial capital outlay / investment (Kumar *et al*., 2016, Prakash *et al.,* 2020). Peet *et al*., (2005) also asserted that greenhouse production is more expensive than producing the same crop in the open field. The most important factors determining costs are depreciation of the structure and equipment, labor, energy, and variable costs such as planting material, substrate, and fertilizer (Olatunji and Akeem). Despite the initial high capital outlay, the return on investment is high due to high productivity and opportunity of growing crops off season when the price will be high. The study was conducted with the aim of examining the cost components and profitability of growing bell pepper under a screen house production system in Akure, Ondo State.

METHODOLOGY

The study and data collection for the analysis were obtained from a screen house farm located in Akure sub-burb (coordinates: 7.266, 5.317). Akure is a cosmopolitan city located in the humid rainforest zone of Southwestern part of Nigeria. The operational system of the farm was monitored for a period of two years when production started. Data were collected regularly from the records of production and sales from the farm. The farm site where data were collected comprise of four production units of screen houses each measuring 10 x 30 m (300m^2). Data were obtained on cost of investment, cost of production, outputs and price for production cycle. Typically, 5 to 6 months are required for one crop cycle of bell pepper production in a screen house, and hence, two cropping cycles obtainable in a year. For this study, two years production records (four production cycles) were documented. Data used were actual data extracted on cost of investment (cost of fabrication and other components), cost of production (inputs, labor and other variable cost in the current price obtainable). Crop prices were averaged prices that were prevalent in the current season. Total revenues (gross income) were calculated per cycle of production for the number of production unit as the products of treatment yield and average price. Variable costs were the actual cost incurred in the production. Gross margin per cycle of production were calculated as the difference between gross income and total variable cost. In constructing the budget, no charges were included for land. Formulae for estimating economic indices used were:

1. Total Variable Cost (TVC) = Labor cost + Cost of inputs + other operating cost
2. Revenue = Average yield/kit x farm gate price (₦/kg)
3. Gross margin) = Total Revenue (TR) – Total variable Cost (TVC)

RESULTS AND DISCUSSION

Table 1 shows the cost of investment on infrastructure required for production under the screen house system. 79% of the cost is for fabrication of the main protected structure. An average of ₦3, 417,500 is invested per production unit. The variable cost comprising of the cost of inputs, labor cost and other operation cost averaged ₦513, 000 per production cycle of 5-6 month/cycle (Table 2). Cost of inputs constituted 56% of the variable cost while 29% of cost is spent on labor. The cost soluble fertilizers deployed in weekly fertigation constituted 31.8% of the variable cost while cost of plant protection chemicals (pesticides) constituted approximately 11.5%.

The yield obtained under the production system per unit of production (300sqm screen house unit) rages from 1500-2000 kg of marketable fruits of bell pepper per cycle depending on the plants response as affected by micro-climate fluctuation with season and management (irrigation, pest and other agronomic management practices). The gross margin per production unit, a portion of the business revenue left after direct cost are subtracted varies from ₦2, 186,500 to ₦3, 086,500). This translate to a gross margin of ₦4, 373,000 to ₦6, 086,500 per production in year (2 production cycle). The Gross margin expressed in percentage is approximately 81-86%. The gross margin increased with the productivity of the crop.

CONCLUSION

It is observed from the study that despite the higher cost of investment on screen house, cultivation of high value vegetable crops in this case, bell pepper is found profitable with high gross margin.

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Table 1: Cost of establishment of screen house structure (4 production units)

S/n	Particulars	Cost (₦)	% of total cost
i	Screen house main structure fabrication and installation	10,800,000	79.01
ii	Drip irrigation kit and installation	1,080,000	7.90
iii	Irrigation water storage reservoir	240,000	1.76
iv	Tank stand	400,000	2.96
v	Water sourcing (well and pump)	600,000	4.39
vi	Water reticulation and materials	200,000	1.46
vii	Generator	350,000	2.56
	Total	**13,670,000**	**100**
	Average cost of establishment per unit of screen house	**3,417,500**	

Table 2: Variable cost of production per cycle of bell pepper under 4 production units screen house in Akure.

S/n	Particulars	Cost (₦)	% contribution
1	**Variable cost**		
A	Cost of inputs		
i	Seeds	108,000	5.26
ii	Potting mixture	36,000	1.75
iii	Plant protection chemicals (pesticides)	236,000	11.49
iv	Soluble fertilizers	654,000	31.84
v	Granular fertilizer (N.P.K. 15.15.15)	40,000	1.95
vi	Manure	24,000	1.17
vi	Staking rope	56,000	2.73
	sub-total (A)	1,154,000	
B	Cost of labor		
i	Operation labor (2 permanent staff @25,000/month)	300,000	14.61
ii	Agronomist cum manager (1 @ 50,000/month)	300,000	14.61
	sub-total (B)	600,000	
C	Other operating cost		
i	Cost of fuelling +lubricants for generator	220,000	10.71
ii	Marketing cost (packaging bags + local transport)	80,000	3.89
	Sub-total (C)	300,000	
	Total Variable Cost (A+B+C)	**2,054,000**	100.00
	Average TVC per unit of screen house	**513,500**	

Table 3: Returns from bell pepper production per cycle of production under 4 production units of screen house

S/n	Particulars	Return for 4 production units	
		Moderate output scenario	**Good output scenario**
i	Yield (kg) per production (1500-200kg/unit/cycle)	6000	8000
ii	Price per kg (₦)	1800	1800
iii	Revenue (₦)	10,800,000	14,400,000
iv	Total Variable cost (₦)	2,054,000	2,054,000
	Gross margin ((₦) (for the 4 units of production for the enterprise	**8,746,000**	**12,346,000**
	Average gross margin (₦) per production unit of screen house	2,186,500	3,086,500
	Gross margin (%)	80.98	85.74

EVALUATION OF SOME F_5 SEGREGANTS OF TOMATO (*Solanum lycopersicum*) SELECTED FROM INTER-SPECIFIC CROSSES

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ABSTRACT
The field trial was conducted at Vegetable Research field of National Horticultural Research Institute, (NIHORT), Ibadan, Nigeria during the cropping season of the year 2019. The aim was to evaluate the agronomic and yield performance of 15 F_5 segregants of tomato selected from inter-specific crosses. These were laid out in a randomized complete block design with three replications using a spacing of 0.5m x 0.6m. The analysis of variance revealed significant differences for all the characters examined among the 15 F_5 segregants except for days to flowering, first day to fruiting and number of branches per plant which indicated sufficient variability for selection in future breeding plan. The earliest segregant was S15 while the latest was S8. The highest number of fruits per plant was recorded in S8 (78.75) whereas the least was observed in S10 (4.25). Segregant 8 had the heaviest fruit weight per plant (1,391 g) while the lightest weight was recorded in S10 (50.5g). Based on overall assessment, S1, S2, S3, S4, S6, S8, S11, S12, S13 and S15 were selected for advancement to F_6 generation for further selection and future release.
Keywords: *segregants, agronomic, yield, characters and selection*

INTRODUCTION

Tomato (*Solanum lycopersicum* **L.)** is one of the most important vegetable crops in Nigeria (FAO, 2010). Although, it is native to South America, it is produced and consumed all over the world (Arah, 2015). The red pigmentation in its fruit called lycopene is a vital anti-oxidant which helps in the fight against cancerous cells formation in human body and other health complications. It neutralizes the free radicals in the body (Bhowmik *et al*., 2012). It has been reported that African countries such as Nigeria and Angola have low yield of tomato production with 3.9 tons/ha and 2.7 tons/ha respectively when compared to European countries with over 400 tons/ha of tomato. Netherlands, Belgium and United Kingdom recorded 416.19 tons/ha, 507.04 tons/ha and 506.90 tons/ha respectively (FAO, 2016). Part of the cause of Africa's low production is attack of pests and diseases and poor post-harvest handling (Claudius *et al*., 2015). Hence, there is need for breeding improved varieties with resistance or tolerance to diseases of economic importance which would improve the yield of tomato production in Africa, especially in Nigeria. This study had started with breeding of improved tomato lines that are tolerant to *Fusarium* wilt disease and of high yield and good nutritional quality. In order to evaluate the agronomic and yield performance of the developed segregants, the research was conceived. The objectives of the study were therefore to determine the variations that exist among the 15 F_5 segregants of tomato with relation to yield and agronomic characters and to select the 10 top yielders with other related characters for further advancement in future breeding plan.

MATERIALS AND METHODS

Four moderately susceptible tomato landraces and four most tolerant landraces to *Fusarium* wilt disease were selected from screening experiment for resistance to *Fusarium* wilt disease at NIHORT, Ibadan. The list of names and codes of the tomato landraces and the hybrids used for selection of the segregants are presented in Table 1. The landraces were crossed using North-Carolina Design II at NIHORT screen house during the cropping season of the year 2016 to generate F_1. The F_1 generated were advanced to F_4 generation through selfing. Twenty-one (21) F_4 segregants selected based on yield and agronomic traits were advanced to F_5 generation. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications using a spacing of 0.5m between plants and 0.6m within rows.

Data Collection

Data were collected on some agronomic and yield related characters viz: plant height (PH), number of leaves per plant (NLVSPP), number of branches per plant (NBPP), days to first flowering (DSFL), days to first fruit set (DSFR), number of fruits per cluster (NFCL), number of fruits per plant (NFPP) and fruit weight per plant (FWTP). The agronomic data were collected at 100% flowering while yield were recorded per harvest.

Data Analysis

The data collected were analysed using R-statistics, version 4.1.0.

RESULTS AND DISCUSSION

The analysis of variance revealed significant variations (P<0.5) for all the characters examined among the 15 F_5 segregants of tomato except for days to first flowering and days to first fruit set (Table 2). Variation is a good indicator for selection in any breeding programme. The variations observed in most of the agronomic and yield characters in this study indicated sufficient variability for breeder's selection and advancement in future breeding plan. Figure 1 presents the agronomic performance of 15 F_5 segregants of tomato while Figures 2 and 3 shows the number of fruits per plant and fruit weight per plant respectively.

In the present study, Segregant 11 recorded the tallest height (58.58 cm) while the shortest was observed in S8 (33.08 cm). The highest number of branches per plant was recorded in S15 (17.25 branches) while the least was observed in S8 (7 branches). The earliest segregant was S15 which flowered at 67 days while the latest (S8) flowered at 71 days after sowing. S8 had the highest number of fruits per plant (52.5) with the least recorded in S10 (4.25). The heaviest fruit weight was recorded in S8 (1,391g), followed by S13 (1,242.63g) while the lightest weight was observed in S10 (50.5g).

This is in conformity with the report of Haldavanekar *et al*., 2019 who worked on "Generation mean analysis of F_5 progenies of Brinjal (*Solanum melongena* L.). According to their findings, significant variations were observed in plant height, plant spread, number of secondary branches, number of leaves, days to first flowering, days to 50 % flowering, fruit length, fruit girth, number of harvest, harvesting span, number of fruits per plant, yield and per hectare yield except in number of primary branches per plant among 28 F_5 progenies. They concluded that, due to variations in these characters, they can be used to make selection for advancement of the brinjal progenies to F6 generation and 19 treatments were selected.

This study is also in agreement with the work of Gbadamosi *et al*., 2021 who studied Intra-specific crosses in tomato (*Solanum lycopersicum* L.) for improvement of fruit quality. According to their report, significant genotypic variations were reported for plant height, number of branches per plant, number of clusters per plant, number of fruits per cluster, number of fruits per plant, number of days to first flowering, number of days to first fruit set, fruit weight and pericarp thickness at 5 % level of probability for all parents used for the crosses.

CONCLUSION

In conclusion, the agronomic and yield characters observed in this study showed enough significant variations among 15 segregants of F_5 generations obtained from North Carolina Design II. Therefore, 10 top promising lines (S1, S2, S3, S4, S6, S8, S11, S12, S13, and S15) were selected for advancement to F_6 generation and future release.

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Table 1: The list of names and codes of the tomato landraces and the hybrids used in the study

Accession code	Genotype code	Local name	Hybrid
NHSL6	G6	Cherry	G19 x G6
NHSL7	G7	Igede 1	G19 x G7
NHSL12	G12	Alahusa 2	G14 x G23
NHSL14	G14	Alahusa 4	G19 x G23
NHSL19	G19	Beske	G19 x G26
NHSL21	G21	Onitaya 3	G21 x G26
NHSL23	G23	Small Ibadan local 1 (3 lobes)	G21 x G7
NHSL26	G26	Ibadan local 2 (Onitaya)	

Table 2: Means square from analysis of variance for 9 characters in 15 F_5 segregants of tomato

Source	Df	pht	nlvspp	nbrpp	dsfl	dsfr	frtcl	frplant	Fwtplant (g)
Segregants	14	204.23*	715.4**	24.19	3.62	5.77	1.69**	1021.8**	442226**
Rep	1	1.54	197.1	8.47	11.41*	16.88*	1.56	153.3	115243
Residual	29	79.53	236.6	8.83	1.9	3.95	0.55	148.9	136915
CV		18.69	24.66	22.51	1.99	2.7	14.3	44.93	63.74

*, ** significant at 1% and 5 % probability level respectively.

Df=degree of freedom; pht=plant height; nlvspp=number of leaves per plant; nbrpp=number of branches per plant; dsfl=days to first flowering; dsfr=days to first fruit set; frtcl=number of fruits per cluster; frplant=number of fruits per plantand fwtplant (g)=fruit weight per plant

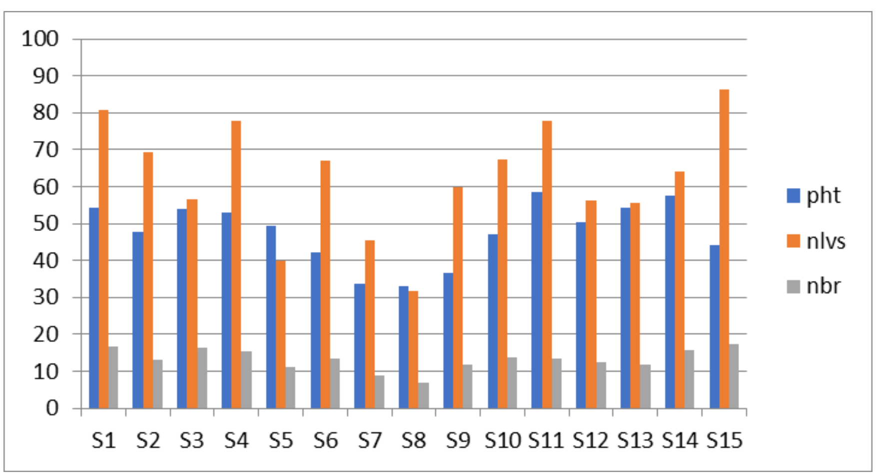

Figure 1: The agronomic performance for 15 F_5 segregants of tomato

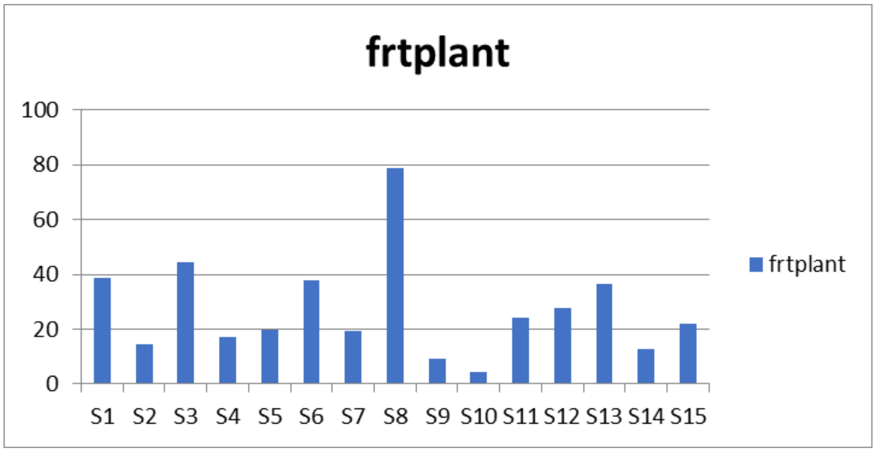

Figure 2: Number of fruits per plant for 15 F_5 segregants of tomato

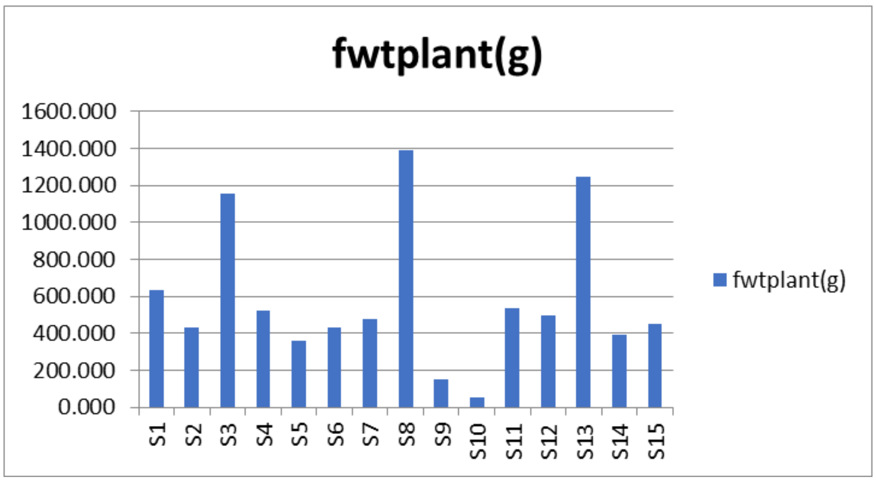

Figure 3: Fruit weight per plant for 15 F_5 segregants of tomato

PRELIMINARY ANALYSIS OF THE COST AND BENEFIT OF THE USE OF COVER CROPS, MULCH MATERIALS AND HERBICIDE INTEGRATION FOR WEED CONTROL IN JUVENILE SWEET ORANGE ORCHARD

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ABSTRACT
A field experiment was conducted on a 24 months old juvenile sweet orange trees orchard to evaluate economic implication of the use of pumpkin (PK) at 1m x 0.5m + (Atrazine 250g/L + Metolachlor 250g/L) at 4L/ha (PK+P), Akidi (AK) at 50cm x 75cm + (Atrazine 250g/L + Metolachlor 250g/L) at 4L/ha (AK+AM), sawdust (SD) at 30t/ha and 4cm depth + glyphosate at 480g ai/L at 6L/ha (SD+GP), cassava peel (CP) at 30t/ha and 4cm depth + glyphosate at 480g ai/L at 6L/ha (CP+GP), (Atrazine 250g/L + Metolachlor 250g/L) at 4L/ha followed by glyphosate at 6L/ha (P+GP) and no weeding (NW) for weed control in juvenile sweet orange orchard at National Horticultural Research Institute (NIHORT). The spacing for Sweet orange was 5m x 5m, while the experiment was laid out in randomized complete block design in four replications. Data were collected on cost of input on cover crops, mulch materials and herbicide integration in sweet orange orchard as well as output at the prevailing market prices. Results revealed that highest cost of production was incurred in CP+GP compared to the combination of SD+GP, AK+AM, PK+AM and NW. Highest revenue of N108,640/ha was obtained in PK+AM. There were negative returns to investment in CP+GP, SD+GP, AM+GP and NW, while benefit to cost ratio was highest (2.4) in PK+AM. The study recommends use of cover crops with herbicide integration for weed management during juvenile stage of citrus due to improved weed suppression and generation of income that may be utilized to manage the orchard during the juvenile stage.
Keywords: *Sweet orange, juvenile orchards, weed management, economic analysis.*

INTRODUCTION

Integrated weed management practices are a system that combines more than one weed management methods at a reduced cost to obtain a level of weed suppression superior to that ordinarily obtained when one weed management method is used (Alamu 2019). The goal of integrated weed management is to optimize benefits and minimize liabilities associated with other weed control methods (Teasdale, 1996). Sustainable weed management employs both proactive and reactive measures to weed control (Sullivan, 2003) which farmers can afford, accept and practice with safety to land, water, crop and other resources. Weeds should be controlled by least expensive available technology that does not interfere with other phases of crop production or other human activities (Rana and Rana 2016). Any weed control measures should be used only when its results are expected to be more economically beneficial than without using any control measure. Farmers compare time and cost of weed control and usually select management tactics having the lowest cost. Therefore, choice of weed control inputs depends not only on its efficacy but also on its cost (Rana and Rana 2016).

There is little information on economics of weed control in sweet orange orchard. Previous empirical work on economics of weed management in Nigeria includes those of Osipitan et al, (2019). The authors analysed economics of weed management methods as influenced by row spacing in cowpea and found that pre-herbicide for weed management could help to optimize yield and increase profitability under a narrow spacing in cowpea cultivation. Samant and Prusty (2014) in India investigated effect of weed management on yield, economics and nutrient uptake in tomato and found that application of straw mulch was economically viable for control of weeds in case of labour scarcity with better nutrient uptake and maximum fruit yield and higher net profit. The present study therefore intends to fill the above gap by analyse the cost and benefits of the selected integrated weed management practices in order to recommended the most sustainable and profitable treatment to citrus producers during the juvenile stage of production.

MATERIALS AND METHODS

The experiment was carried out in an established sweet orange orchard with 24 months (2 years) old sweet orange trees at the National Horticultural Research Institute (NIHORT) Ibadan (07° 24'36.88" N, 003° 51' 16.05" E, 213 meters above sea level). Ibadan lies in the derived savannah of South west Nigeria. The area has a bimodal rainfall distribution which peaks in July and September. Treatment consisted of Cucurbita pepo + atrazine (250 g a.i/L + metolachlor 250 g a.i/L) at 4 L/ha (PK + P), Vigna sesquipedalis (Akidi) + atrazine (250 g a.i/L + metolachlor 250 g a.i/L) at 4 L/ha (AK + P), sawdust + glyphosate isopropylamine salt (480 g a.i/L) at 6 L/ha (SD + GP), cassava peel + glyphosate (isopropylamine salt 480 g a.i/L) at 6 L/ha (CP + GP), metolachlor followed by glyphosate (P + GP) and no weeding (NW) as control. These treatments were applied at the beginning of each cropping year, while the duration of the experiment was two years. The plot size was 10m x 10m, while the spacing for sweet orange seedlings was 5m x 5m within and between rows, with total land area of 2400 m2. The experimental design was a randomized complete block design (RCBD) in four replications. Economic analysis of the performance of sweet orange with the cover crops, mulch materials and herbicide integration treatments were carried out using gross margin analysis, benefit to cost ratio and rate of return to investment.

Gross Margin = TR - TVC

TR = Total Revenue

TVC = Total Variable Cost

BCR = TR/TVC

BCR = Benefit to Cost Ratio

BCR > 1 = Viability of the business

BCR = 1 is breakeven point

BCR < 1 = business not viable.

Gross margin and BCR were computed for each treatment using the prevailing price in the study area. The BCR was used to examine the viability of the investment.

RESULTS AND DISCUSSION

Estimated cost of Production and revenue with the integrated weed control strategies in juvenile sweet orange orchard during the cropping year.

The cost of production of sweet orange as influenced by integrated weed management strategies is presented in Table 1. At first year, with the mulch materials and herbicide treatments plots, highest total variable cost of N95,400/ha was recorded in sweet orange plots mulched with CP + GP, followed by SD + GP (N49,400/ha). Atrazine 250g/L + Metolachlor 250g/L (AK + P) recorded higher total cost of N45,600/ha compared to PK + P (N44,900/ha) with the use of the cover crops. Combination of Atrazine and Metolachlor recorded lower costs compared to the mulch materials and cover crops. Succinctly, costs of production were higher in mulch materials with herbicide integration compared to the cover crops and herbicide integration plots. This may be attributable to the cost of obtaining cassava peel and sawdust, most especially the cost of transporting the materials. There were returns from the cover crops during the cropping season. The highest total revenue of N108,640/ha was obtained from pumpkin plots while N69,600/ha was obtained from Akidi plots. There was no revenue from cassava peel, sawdust and herbicide integration plots.

The results of the gross margin analysis indicated a total of N63,740/ha from the sweet orange + PK + P plots. Alamu et al., (2022) reported that highest gross margin of N106,000/ha was recorded from sweet orange plots interplanted with sweetpotato compared to pumpkin and egusi melon plots. A total of N24,000/ha was also realized from sweet orange + AK + P during the cropping year. There were negative returns in CP + GP, SD + GP, P + GP and the NW plots. Highest negative returns were obtained in CP + GP (95,400/ha) followed by SD + GP plots (49,400/ha), while the least negative returns were recorded for P + GP plots (38,000/ha). This is similar to the report of Alamu et al., (2022).

CONCLUSION AND RECOMMENDATION

This study revealed that alternative use of cover crops, mulch materials integrated with herbicide could reduce the cost of production by reducing the weed pressure and increase economic returns to the farmers.

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Table 1: Partial budget (₦) for a hectare citrus based cropping system as influenced by integrated weed management strategies in sweet orange orchard

Material inputs	PK + AM	AK + AM	CP + GP	SD + GP	AM + GP	NW
Variable costs						
Cost of cover crop seeds	2,300.00	3,000.00	-	-	-	-
Cost of pre-emergence herbicide @ ₦950/L x 4	3,600.00	3,600.00	-	-	3,600.00	-
Cost of glyphosate herbicide @ ₦1,100/L x 4	-	-	4,400.00	4,400.00	4,400.00	-
Cost of cassava peel @ ₦5.00/kg x 10,000 m^2	-	-	50,000.00	-	-	-
Sub – Total	**5,900.00**	**6,600.00**	**54,400.00**	**4,400**	**8,000.00**	**-**
Labour						
Labour cost for sowing seeds	5,000.00	5,000.00	-	-	-	-
Labour cost for herbicide application	5,000.00	5,000.00	10,000.00	10,000.00	10,000.00	-
Cost of packing sawdust	-	-	-	5,000.00	-	-
Labour cost for mulch transportation	-	-	5,000.00	5,000.00	-	-
Labour cost for spreading mulch materials	-	-	6,000.00	5,000.00	-	-
Labour cost for rogueing @ ₦1,000/manday/ha	1,000.00	1,000.00	-	-	-	-
Labour cost for harvesting and processing cover crops	8,000.00	8,000.00	-	-	-	-
Sub – Total	19,000.00	19,000.00	21,000.00	25,000.00	10,000.00	
Total Variable Cost	**44,900.00**	**45,600.00**	**95,400.00**	**49,400.00**	**38,000.00**	**20,000.00**
Cropping system	PK + AM	AK + AM	CP + GP	SD + GP	AM + GP	NW
Average crop yield						
Sweet orange (kg/ha)	-	-	-	-	-	-
Pumpkin (kg/ha)	388	-	-	-	-	-
Akidi (kg/ha)	-	232	-	-	-	-
Total Revenue (₦/ha)						
Sweet orange fruit @ ₦40/kg	-	-	-	-	-	-
Pumpkin @ ₦280/Kg	108,640.00	-	-	-	-	-
Akidi @ ₦300.00/kg	-	69,600.00	-	-	-	-
Total Revenue	108,640	69,600	0	0	0	0
Gross Margin (₦/ha)	**63,740.00**	**24,000.00**	**(95,400.00)**	**(49,400.00)**	**(38,000.00)**	**(20,000.00)**
BCR	**2.4**	**1.5**	**0**	**0**	**0**	**0**
ROI	**1.4**	**0.5**	**0**	**0**	**0**	**0**

Gross Margin = TR – TVC, TR = Total Revenue (₦/ha), TVC = Total Variable Cost (₦/ha)
PK = Pumpkin, AK = Akidi, CP = Cassava peel, SD = sawdust, P = Atrazine + Metolachlor, GP = Glyphosate, NW = No weeding

PROFITABILITY AND ECONOMIC ANALYSIS OF PINEAPPLE-BASED INTERCROPPING SYSTEM IN SOUTH-WEST NIGERIA

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ABSTRACT
In this study, the economic and profitability of pineapple-pepper-cowpea based intercropping system in Akure was evaluated. The experiments evaluated the impact of time of introduction of one of the component crops, cowpea into the intercropping system on the intercrop. Sowing of cowpea into pineapple-pepper intercrop was done at the time of transplanting pepper seedlings into pineapple, at 3, 6 and 9 weeks after transplanting (WAT) pepper seedlings into pineapple. Sole crops of the crop components were also established. The cost of production and returns from each crop combination were aggregated. Economic returns and profitability indices showed that sole pineapple and pineapple-pepper-cowpea intercrop were profitable. Pineapple-pepper intercrop without cowpea and sole pineapple appeared as the preferred options based on their slightly higher net benefits. However, delayed sowing of cowpea into pineapple-pepper intercrop ensures the spread and diversification of produce and income to the farmer in addition to immediate satisfaction of food need of the farmer's family.
Keywords: *pineapple, cost benefit ratio, intercropping, profitability, income diversification*

INTRODUCTION
Pineapple (Ananas comosus (L.) Merrill) is an important tropical fruit characterized by initial slow growth during establishment phase and long gestation period from planting to flowering and fruiting. The lack of immediate returns on investment in a sole pineapple enterprise during the first year of cropping and challenges associated with management of the wide spaces between the rows of pineapple pose a lot of challenges to farmers. However, pineapple intercropping provides an opportunity for resource constraint farmers to optimize their production by growing short duration food crops with pineapple in order to get income more quickly (Uriza et al., 2005). This will improve crop diversity, spreads of labor and their economic profitability. Introduction of Peppers (*Capsicum spp*), a short-term perennial crop within the rows of pineapple during the establishment phase can be practiced to maximize utilization of farm resources. The introduction of another short duration crop such as cowpea (Vigna unguiculata) can further extend the utilization of resources (space, light and water). However, the productivity of the components of the intercropping and the effectiveness of resource utilization will depend on timing and scheduling of the growth phases in which the component crops interact on the field and the seasons. It is imperative to adjust cropping pattern and the timing of introduction of component crops into the pineapple-pepper intercropping system especially the timing of cowpea introduction in order to minimize competition among component crops. The choice of intercrop combination to adopt is the decision of the farmer which may be based economic profitability in addition to other perceived benefits such as internal insurance from crop failure obtained from crop diversity and steady and continuous flow of income. The aim of this paper) is to evaluate the economic and profitability of pineapple-pepper based intercropping system when cowpea is introduced at various intervals.

METHODOLOGY
The economic and profitability of pineapple-pepper-cowpea based intercropping system of experiment an conducted at the Experimental Station of the Federal College of Agriculture Akure, Nigeria between 2014 and 2015 was evaluated. The experiment comprised of four dates of sowing cowpea into pineapple-pepper intercrops namely: sowing of cowpea at the time of transplanting pepper seedlings into pineapple, sowing at 3, 6 and 9 weeks after transplanting (WAT) pepper seedlings into pineapple, pineapple-pepper intercrop without cowpea and the sole crops of pineapple, pepper and cowpea. The cost of production and returns from each crop combination based on one cycle of production were aggregated. A number economic analysis tools were used to evaluate the different treatments. These include: partial budget analysis, benefit to cost ratio, rate of return on investment and profit margin. Crop enterprise budget were

developed for each treatment. Crop prices and operational cost used in the budgets were averaged prices that were prevalent in the study area during the cropping seasons. Total revenues were calculated annually as the products of treatment yield and average price. Variable costs were the actual cost incurred in the production. Net benefits per hectare were calculated as the difference between total revenue and total cost. In constructing the budget, no charges were included for land.

Formulae for estimating economic indices

1. Total Variable Cost (TVC) = Labor cost + Cost of inputs + Transportation/handling
2. Total Cost (TC) = Total Variable Cost (TVC) + Fixed Cost (FC)
3. Gross return/revenue = Average yield/ha x farm gate price (N/kg)
4. Net Benefit (NB) = Total Revenue (TR) – Total Cost (TC)
5. Rate of Return on Investment (RORI) = Net Benefit (NB)
   Total Cost (TC)
6. Benefit to Cost Ratio (BCR) = Total revenue (TR)
   Total Cost (TC)
7. Profit Margin (%) = Net Benefit (NB)
   Total Revenue (TR)

RESULTS

Analysis of economic returns

Gross Returns from intercropping treatment combinations

The Gross Returns of each component crops in the intercropping treatment in relation to the cost of production are presented in Fig. 1. The figure show the trends reduction in the gross returns from pineapple fruits associated with intercropping with cowpea and pepper. The magnitude of reduction in Gross Return recorded for pineapple was minimal when cowpea was introduced at the time of transplanting pepper into pineapple compared with those delayed. The returns from pepper however increased progressively with delayed sowing of cowpea into pineapple-pepper intercrop while returns from cowpea declined with the delay in sowing cowpea.

Budgetary analysis

Tables 1 show the enterprise budget of the different crop enterprises in the experiments. Table 3 shows the summary of economic returns under the different treatments. Positive Net Benefits were obtained except for sole pepper and cowpea with negative net benefits. The lowest Net Benefits (N959, 961) was obtained among the intercropped plots when cowpea was introduced at the time of transplanting pepper into pineapple. Negative net benefits were obtained for pepper and cowpea. Table 2 presents the benefit to cost ratio (BCR) which were in general greater than 1 except for sole pepper and cowpea. The highest BCR (1.91) which was obtained from pineapple-pepper intercrop alone (no cowpea) was not different from BCR (1.90) for sole pineapple. Benefit cost ratio is greater than one (BCR>1) indicates efficient production of crop combination while BCR < 1 indicates an inefficient production. The introduction of cowpea into the pineapple-pepper intercrop tends to reduce the BCR. The BCR > 1 is indicative of efficient production from such crop combination. That is high returns are made as profit for every unit amount invested. BCR value of 1.91 and 1.86 for plots with pineapple-pepper alone and plot with cowpea introduced into pineapple-pepper intercrop at 6 WAP means that for every N1 spent on the enterprise N0.91 and N0.86 were returned as profit respectively. The rate of return on money invested in the crop enterprise follows the same trend as benefit to cost ratio. It is an indication of profitability of an enterprise; it shows the percentage of return on every unit of investment in the enterprise. Moderate profit margins were returned from economic evaluation of the production experiment.

DISCUSSION

Analysis of economic returns

The high slight reduction in the Net Benefit obtained when cowpea was introduced into pepper during the time of transplanting pepper into pineapple resulted from competition experienced by pepper and pineapple from cowpea which grow vigorously and partially shaded them at early stage. Increasing magnitude of Net Benefits followed the trend of increase in the yield of pepper recorded with the delayed sowing of cowpea since higher yield of pepper was obtained with delayed sowing of cowpea. Generally, the higher Net Benefit was obtained could be adduced to higher yield recorded for pineapple. This might have resulted from lower competition and recovery growth after other component crops has completed their growth cycle and subsequent higher yield that follows.

Positive and high rate of return is always desirable in any enterprise. Enterprise with negative net benefit (net loss), RORI and PM should not be undertaken. The profitability ratios such as BCR, RORI and PM indicates that the intercropping of pineapple and pepper with cowpea introduced at later stage of development are all profitable. Olubode *et. al*., (2012a, 2012b) reported profitability of pawpaw-okra and pawpaw-okra-cucumber intercrop. The rates are indicative of profitability of pineapple enterprise and its intercropping combination. In research involving interplanting pineapple with hot jalapeno pepper, dry beans, corn and tomato, Uriza et al., (2002) reported that the benefit/cost ratio was best for pineapple intercrop than when they were alone. Balasubramanian and Sekayange (1990) while citing Zandstra (1979) reported that utilizing different mechanisms in cultural manipulations could assist to maximize profit in intercropping system.

CONCLUSION AND RECOMMENDATIONS

Economic returns and profitability indices showed that sole pineapple and pineapple-pepper-cowpea intercrop were profitable. The performances were just slightly above that of intercropping involving introduction of cowpea into pineapple-pepper intercrop at 6 WAP. Pineapple-pepper intercrop without cowpea and sole pineapple appeared as the preferred options based on their slightly higher net benefits. However, delayed sowing of cowpea into pineapple-pepper intercrop especially by 6 weeks enhanced utilization of growth resources in addition to diversified produce obtained and can be practiced by farmers. Diversity is a form of internal insurance to ensure steady and continuous flow of income and prevention of crop failure that might be associated with mono-cropping. This includes the diversified sources of income and farm products from the farm, spread or distribution of income to the farmer in addition to immediate satisfaction of food need of the farmer's family and the possibility of farmers making high returns from the short duration annual crops such as pepper and cowpea intercropped at the early stage of the establishment of pineapple. This might help to offset initial cost of maintenance because most farmers are resource constrained. The appropriate time to introduce the cowpea is important. Early sowing of cowpea was more detrimental to the other component crops especially pepper. Hence, when the introduction of cowpea into pineapple-pepper intercrop is desired, cowpea should be introduced as from six weeks after transplanting pepper into the mixture

Based on the findings of the study, it can be recommended to pineapple farmers to introduce pepper into the spaces between the rows of pineapple as soon as the pineapple field is planted. Nevertheless, sowing of cowpea should be delayed up to six weeks after transplanting pepper. This practice will expand income base from the minor component crops (pepper and cowpea) while the main crop (pineapple) is getting established.

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Table 1: Enterprise budget of different treatments in 2012 experiment

		0WAT	3WAT	6WAT	9WAT	PINEAPPLE-PEPPER	PINEAPPLE	PEPPER	COWPEA
AVERAGE CROP YIELD (t/Ha)									
PINEAPPLE		60.06	69.06	73.81	61.32	76.17	80.14	-	-
PEPPER		0.15	0.33	1.38	2.08	1.44	-	1.38	-
COWPEA		0.46	0.54	0.49	0.56	-	-	-	0.64
GROSS RETURN									
PINEAPPLE @ farm gate PRICE	50/KG	3003000	3453000	3690500	3066000	3808500	4007000	-	-
PEPPER @ farm gate PRICE	200/KG	30000	66000	276000	416000	288000	-	276000	-
COWPEA @ farm gate PRICE	120/KG	55200	64800	58800	67200	-	-	-	76800
TOTAL REVENUE (N/Ha)		3088200	3583800	4025300	3549200	4096500	4007000	276000	76800
LABOUR COST (N/Ha)									
land preparation (UPROOTING ETC)		350,000	350,000	350,000	350,000	350,000	350,000	350,000	350,000
Planting		279,784	279,784	279,784	279,784	275,304	266,664	16,000	8,000
weed CONTROL		206,000	246,000	246,000	246,000	246,000	246,000	120,000	40,000
pest control		6000	6000	6000	6000	6000	6000	6000	6000
Induction		6000	6000	6000	6000	6000	6000	-	-
Harvesting		124390	124432	124362	126065	101359	83047	40000	40000
COST OF FARM INPUT (N/Ha)									
PINEAPPLE SUCKERS		1,111,100	1,111,100	1,111,100	1,111,100	1,111,100	1,111,100	-	-
PEPPER SEED		2700	2700	2700	2700	2700	-	5000	-
COWPEA SEED		1875	1875	1875	1875	-	-	-	3000
INSECTICIDE		2000	2000	2000	2000	2000	2000	2000	2000
HERBICIDE		7500	7500	7500	7500	7500	7500	-	-
ETHREL		20000	20000	20000	20000	20000	20000	-	-
TRANSPORT/HANDLING		990	1230	2595	3940	2700		5020	960
TOTAL VARIABLE COST		2,118,339	2,158,621	2,159,916	2,162,964	2,130,663	2,098,311	544,020	449,960
FIXED COST		9,900	9,900	9,900	9,900	9,900	9,900	9,900	9,900
TOTAL COST		2,128,239	2,168,521	2,169,816	2,172,864	2,140,563	2,108,211	553,920	459,860
NET BENEFIT (₦/Ha)		959,961	1,415,279	1,855,484	1,376,336	1,955,937	1,898,789	-277,920	-383,060

Table 2: Summary of partial budget analysis and profitability ratios for crop enterprise

Treatments	TVC	FC	TC	TR	NB	RORI	BCR	PM (%)
	------------------------₦/ha-----------------------------							
OWAT	2,118,339	9,900	2,128,239	3088200	959,961	0.45	1.45	31.08
3WAT	2,158,621	9,900	2,168,521	3583800	1,415,279	0.65	1.65	39.49
6WAT	2,159,916	9,900	2,169,816	4025300	1,855,484	0.86	1.86	**46.10**
9WAT	2,162,964	9,900	2,172,864	3549200	1,376,336	0.63	1.63	38.78
Pineapple-pepper	2,130,663	9,900	2,140,563	4096500	1,955,937	0.91	1.91	**47.75**
Sole pineapple	2,098,311	9,900	2,108,211	4007000	1,898,789	0.90	1.90	**47.39**
Sole pepper	544,020	9,900	553,920	276000	-277,920	-0.50	0.50	-100.70
Sole cowpea	449,960	9,900	459,860	76800	-383,060	-0.83	0.17	-498.78

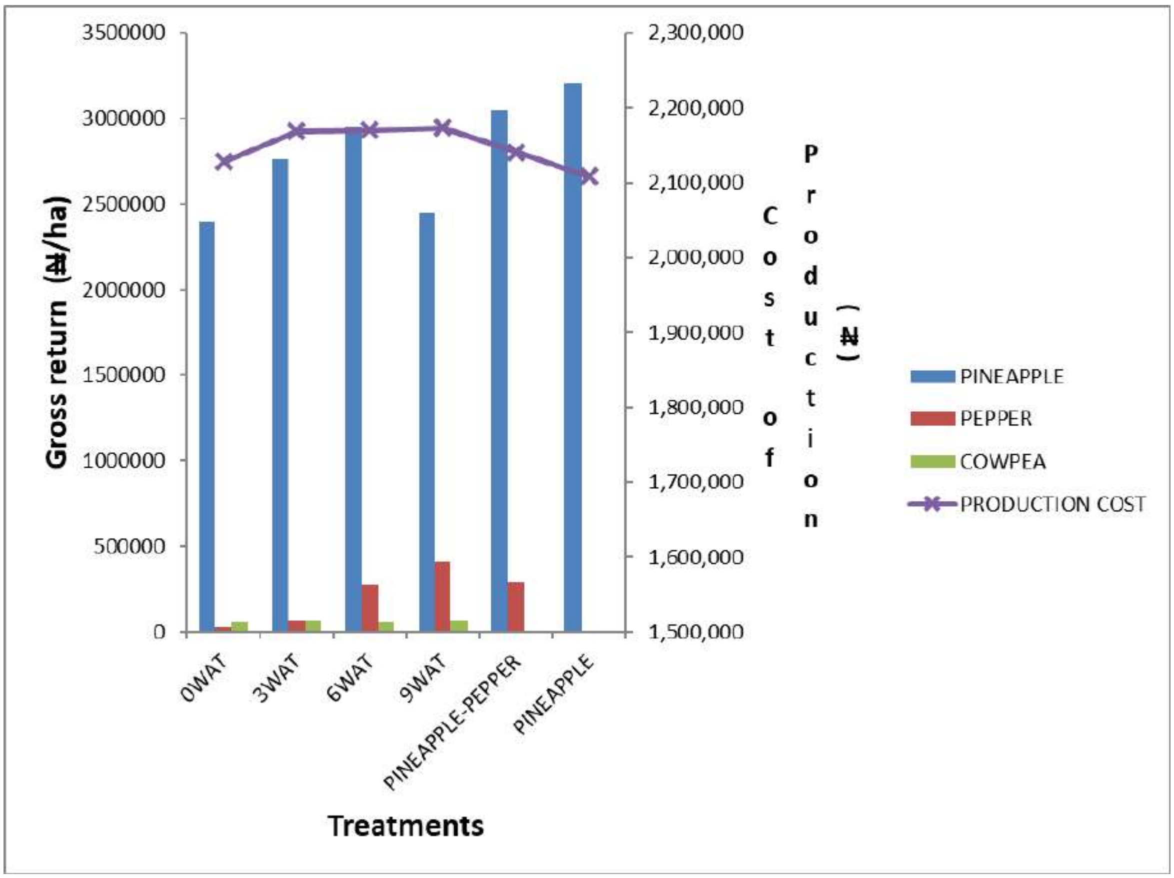

Fig. 1: Economic returns from component crops and the cost of production for each intercrop treatment.

SOIL FERTILITY EVALUATION AT THE INSTITUTE FOR AGRICULTURAL RESEARCH HORTICULTURAL GARDEN SAMARU USING THE NUTRIENT INDEX SYSTEM: A RESEARCH INVESTIGATION

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ABSTRACT
The research study aimed to evaluate the fertility status of the soils using fertility indicators and soil nutrient index. The findings showed that the soil samples had a slightly acidic soil reaction. The organic carbon content ranged from low to medium levels, varying from 0.80 to 9.20 g/kg. Similarly, the total nitrogen and available phosphorous contents were in the low range, with values ranging from 0.10 to 1.15 g/kg and 2.98 to 5.95 mg/kg, respectively. The soil nutrient index value (NIV) calculated for soil organic carbon, total nitrogen, available phosphorus, extractable magnesium, and extractable potassium indicated a low category, with a value less than 1.67. The NIV for pH and extractable calcium content fell into the medium category, with values of 1.71 and 1.72, respectively. The study recommends the utilization of both organic manure and inorganic fertilizers to enhance the fertility status of the soil.
Keywords: *Organic carbon, Fertility, Minerals and Nutrient index,*

INTRODUCTION
The productivity of crops in sub-Saharan Africa is hindered by poor soil fertility, primarily due to inadequate soil nutrient management strategies (Mugo *et al*., 2020). Continuous cultivation without proper nutrient replenishment leads to nutrient deficiencies, as crops extract large amounts of essential nutrients from the soil. Assessing soil fertility is crucial for sustainable nutrient management, as it allows for the measurement of available nutrients and estimation of the soil's capacity to supply nutrients to crops. Soil fertility plays a vital role in determining crop yield and productivity, and nutrient deficiencies are major obstacles to soil sustainability and productivity (Kumar *et al*., 2013). However, there is limited information on soil fertility and nutrient analysis in the garden soils of the Institute for Agricultural Research (IAR) in Zaria. Therefore, this study aims to fill this knowledge gap by investigating the fertility status of the garden soils to provide appropriate fertilizer recommendations and promote sustainable agricultural development. Conducting soil testing and nutrient analysis will provide valuable information for strategic planning and enhance cultivation practices, particularly for horticultural crops. By understanding the nutrient availability in the garden soils, this research will contribute to maximizing crop yields and maintaining optimal soil fertility over time.

METHODOLOGY
The Study area
The present study was carried out at the Botanical Garden of Institute for Agricultural Research (IAR) Samaru, Kaduna State of Nigeria Experiment site is located on 11° 10.37.0'N latitude and 7° 37.88.1'E longitudes with an altitudinal 698 m above the sea level in the northern guinea savanna ecological zone of Nigeria. The climate is characterized as sub humid tropical region with two distinct wet and dry seasons The botanical gardens grow different fruits and agriculture crops in 6.41 hectare area. The garden has several hybrid fruit trees: guava, mango, cashew, grape vine, pawpaw, coconut, apple, oil palm, jack fruit, avocado pear, custard apple, kola nut, cocoa, coffee, orange, banana, among others. The garden is well laid out and bifurcated for the nursery and permanent plots for specific tree species.
Field Observation

Two profile pits were randomly dug within the garden and a total of seven (7) soil samples were collected from the pedogenic horizons for soil characterization. Bulk soil samples were also collected from each genetic horizon for laboratory analysis.

Laboratory analysis

Bulk soil samples collected from each genetic horizon were air dried, ground and sieved to remove materials greater than 2 mm in diameter. The less than 2 mm separates were used for laboratory analysis. Soil reaction (pH) was determined in water in a 1:2.5 soil solution ratio, using a Pye Unicam model 290 MK pH meter (Agbenin, 2005). The acid dichromate wet oxidation method of Walkley and Black as described by Nelson and Sommers (1986) was used in the determination of organic carbon. Total nitrogen was determined by the Macro Kjedahl method (Bremmer and Mulvaney, 1982). Available phosphorus was determined by the Bray-1 method as described by Bray and Kurtz (1945). Exchangeable bases (Ca, Mg and K) and cation exchange capacity (CEC) were determined by neutral (pH 7.0) ammonium acetate (NH_4OAc) solution as described by Anderson and Ingram (1993). Base saturation (BS) was calculated by dividing the sum exchangeable bases (Ca, Mg, K and Na) by the CEC as follows:

$$BS = \frac{Sum\ of\ exchangeable\ bases}{CEC} X100$$

Nutrient index

Nutrient index value is a measure of nutrient supplying capacity of soil to plants (Amara *et al*., 2017). The nutrient availability Index was calculated based on the Federal Ministry of Agriculture and Rural Development, (2012) fertility rating chart (Table 1). An index refined by (Kumar *et al.,* 2013; Amara *et al*., 2017) was used to compare soil fertility levels in the garden.

$$Nutrient\ index = \frac{(1 * X) + (2 * Y) + (3 * Z)}{Total\ Number\ of\ Samples}$$

Where X is the No. of samples in the lower category

Y is the No. of samples in the medium category

Z is the No. of samples in the High category

The nutrient index value 1.67 to 2.33 is considered as medium. The NIV less than 1.67 is considered as low and greater than 2.33 is as high. The NIV is evaluated for pH, OC, Total N, Available P, exchangeable K, Ca and Mg.

RESULTS AND DISCUSSION

Fertility status of Soils at IAR Horticultural Garden

Soil pH is the single most factor affecting soil nutrients due to its effects on availability of essential plant nutrients (Mugo *et al*., 2020; Sachan and Krishna., 2021). The pH of the soil samples in salt medium ranged from 4.60 to 5.90 (Table 2) similarly, the pH in a natural medium ranged from 5.70 to 6.40. This shows a low acidic soil reaction (pH) The pH range of soil are within the range of plant available nutrient which implied that nutrients are likely to be available for crop uptake (Aliyu 2023). The organic carbon content of soil samples examined province ranged between 0.80 and 9.20 g/kg. (Table 2). Low organic carbon status of the soil could be due to degradation of plant parts, litter, crop, and animal residues via the mineralization process (Aliyu, 2023). Nitrogen is an essential nutrient for plants and ranged between 0.10 and 1.15 g/kg (Table 2). This indicates the low status of nitrogen. The available phosphorus in soil samples ranged between 2.98 and 5.95 mg/kg (Table 2). This indicates the low status of the available phosphorus. The range may be attributed to variations in soil pH and organic matter content, (Shobayo *et al*., 2019). The exchangeable calcium of the analysed soil samples varied from 0.80 - 1.80 cmol/kg (Table 2), this indicates low to medium exchangeable calcium. Calcium content of soils depends upon the parent material and weathering status of the soil (Prasad and Shivay, 2020). The exchangeable magnesium of soils of the analysed soil samples from 0.20-0.50 cmol/kg (Table 2) indicating its low. The available Potassium of the analysed soil samples varied from 0.12-0.27 cmol/kg (Table 2). This indicates low to medium status of the available potassium. Low to medium extractable potassium in the farm might be due to the optimum application of potash as well as less loss of potassium ions from the soil (Aliyu, 2023). The cation exchange capacity (CEC) of soils of the analysed soil samples ranged from 5.70-9.60 cmol/kg (Table 2) indicating a moderate CEC. The moderate CEC of the soils could be attributed to nature of the clay minerals having mixed mineralogy (Shobayo *et al*., 2019). Moderate CEC implies that moderate plant nutrient will be retained. Base saturation in the garden soils was rated low, it fell within the range of 19.24 to 37.85 %. FAO (1999) reported that soils with base saturation of > 50 %

are regarded as fertile soils while soils with less than 50 % were regarded as not fertile soils. Based on this therefore, the soils are generally not fertile.

Nutrient Status of Soil in IAR horticultural Garden

The soil samples nutrient values were rated using the soil nutrient rating chart. The results are presented in Table 3. The NIV calculated for pH measured in water (1.72) and exchangeable calcium (1.74) were greater than 1.65 thus classified in the medium category. The NIV calculated for pH measured in salt, organic carbon, available nitrogen, exchangeable magnesium, and potassium content were in the low category with values of 1.00, 1.00, 1.00, 1.00, 1.00 and 1.29, respectively.

CONCLUSION

This study evaluated soil fertility status of soil using nutrient index method at IAR Horticultural Garden with low content of organic carbon, Total nitrogen, available phosphorus. Low to medium extractable calcium and potassium and moderate cation exchange capacity. The nutrient index varies from low to medium. Given the depleted state of plant nutrient in the garden, this study recommends management practices such as manure or compost incorporation, crop residue retention, green manuring, urea application, and potash.

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Table 1: Soil rating chart and their nutrients indices.

Soil properties	Units	Range		
		Low	Medium	High
Soil pH		5.5-6.0 Moderately acidic	6.1-6.9 Slightly acidic	7.1-8.5 Slightly alkaline
Organic carbon	g/kg	20	20-30	>30
Total nitrogen	g/kg	<15	15-20	>20
Available phosphorus	mg/kg	<15	15-25	>25
Exchangeable potassium	cmol/kg	<0.2	0.2-0.4	>0.4
Exchangeable calcium	coml/kg	<1.5	1.5-4.5	>4.5
Exchangeable magnesium	cmol/kg	<1.5	1.5-4.5	>4.5

Source: FMARD (2012)

Table 2: Chemical properties of the soils of IAR Horticultural Garden

Horizon	Depth	pH		OC	TN	Av.p	Ca	Mg	K	CEC	BS
	Cm	H_2O	$CaCl_2$	g kg^{-1}		$mgkg^{-1}$		$cmolkg^{-1}$			%
Pedon 1											
Ap	0-16	6.10	5.80	6.80	0.85	5.43	0.80	0.20	0.23	5.70	23.16
BA	16-36	6.10	5.70	2.90	0.36	2.98	0.80	0.22	0.12	6.60	19.24
Bt	36-97	6.40	5.90	1.20	0.15	3.50	1.80	0.49	0.17	9.60	26.46
Btc	97-166	6.00	5.80	0.80	0.10	3.50	1.60	0.43	0.27	9.40	26.91
Pedon 2											
Ap	0-23	6.20	5.80	9.20	1.15	5.95	1.40	0.38	0.13	8.40	23.33
AB	23-70	5.80	5.60	2.70	0.34	4.90	1.80	0.47	0.14	6.50	37.85
Bt	70-137	5.70	4.60	1.00	0.13	4.03	2.20	0.59	0.12	8.30	36.51

Table 3: Status of nutrient index value (NIV) of Soil in IAR Horticultural Garden

	pH (H_2O)	pH ($CaCl_2$)	OC	TN	Av.p	Ca	Mg	K
NIV	1.71	1.00	1.00	1.00	1.00	1.72	1.00	1.29
Ratings	Medium	Low	Low	Low	Low	Medium	Low	Low

NIV=Nutrient index value

SEASONAL VARIATION IN TURFGRASS QUALITY PARAMETERS OF THREE TURF SPECIES

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ABSTRACTS
*Importance of turfgrass in the environment cannot be overemphasized and its essence is in the quality, which can be affected by seasons. Therefore, this study was conducted to determine the effect of seasonal variation on quality parameters (colour, density, texture, and vigour) of some selected turfgrasses (*Axonopus compressus, Cynodon dactylon, *and* Paspalum vaginatum*) in Akure for the 2018/2019 and 2019/2020 season. Data were analyzed using Microsoft Excel and results were presented graphically using bar and line charts. Results indicated variations among the turfgrass species for quality parameters across seasons. Generally, the variations were directly proportional to the rainfall patterns in both seasons. This implies that moisture determines the quality of turfgrasses. Consistently,* P. Vaginatum *performed best in all the quality parameters evaluated in both seasons due to its possession of underground stem (rhizome), and thus recommended as an excellent turfgrass specie.*
Keywords: *rainfall, seasonality, turfgrass, turf quality*

INTRODUCTION

Turfgrasses are the primary vegetative covers for lawns found in airports, athletic fields, cemeteries, commercial buildings, golf courses, home, schools, recreation parks and gardens. Apart from typical usage for recreation and aesthetic facilities, turfgrasses also provide a valuable environmental function by preventing soil erosion from wind and rain, reducing runoff from rainfall, improving soil absorption of and infiltration of water, fire abatement and other beneficial environmental impacts (Chawla *et al*., 2018). In Nigeria, there is a growing increase in the use of turgrasses for its aesthetic value around residential, public, stadia and commercial buildings (Agufugo and Iyi, 2023). Climatic factors are key determinants to turf production processes; solar radiation, rainfall and temperature fluctuations lead to water shortage, altering soil moisture content, pest and disease occurrence that restrict turf growth (Oerke *et al*., 2012; Gommes *et al*., 2010). Rainfall is undoubtedly one of the most important climatic variables. It has far-reaching influences in agricultural production, the crucial role rainfall plays in crop production includes the supply of moisture to the soil to activate crop growth, the replenishment of water in rivers to make irrigation possible through seepage and percolation, and building of underground water resources which are later tapped by wells in drier areas (Tiamiyu *et al*., 2018).
The essence of turf is in its quality. Visual qualities are actually founded on functional qualities and the functional quality of a turfgrass is determined solely by its vegetative plant part and its growth and development (Gobilik *et al*. 2013). Turf respond differently to seasonal variation thereby affecting their qualities. Hence, identifying turf species that can have consistent quality across season is very essential. Important turf qualities include; colour, texture, density, flatness and growth habit of turf.
The objective of the research work is to determine the effect of seasonal variation on turf quality parameters such colour, density, texture and vigour.

MATERIALS AND METHODS

The experiment was conducted at the field of The Federal University of Technology, Akure in southwest Nigeria. Field establishment of the experiment was carried out from May 2018 and repeated the following year 2019. The experiment comprised three species of turfgrass: *Axonopus compressus* (Carpet grass), *Cynodon dactylon* (Bahama grass), and *Paspalum vaginatum* (Portharcourt grass) as test crops replicated three times in a Randomized Complete Block Design and grown for two season. Carefully stripped sprigs of the three turfgrass species, of 10 cm long were planted at spacing of 10 x 10 cm in each experimental plot according to the randomization. Data on Turf quality parameters such as; turf colour, turf density, turf vigour and turf texture were collected every month. Monthly data on precipitation of the two seasons were obtained throughout the duration of the experiments. Turfgrass quality was assessed by a visual score based on a 1 - 9 scale, as used in the National Turfgrass Evaluation Program in the USA. The lowest level (1) defines very poor turf quality while the highest level (9) indicates outstanding turf quality, a rating of 6 is considered minimally acceptable (Morris, 2002). Microsoft Excel was used to analyze the data and the results displayed in bar and line charts.

RESULTS AND DISCUSSION

The quality of a turf is a function of its utility, appearance and favourable characteristic according to its intended use (Turgeon, 2008). Quality of turf is related to function and subjective requirement (Weicko, 2006). Turf quality is a synthetic index evaluated by visual observations and it highlights the quality of turf. The most common way of assessing turfgrass quality is a visual rating system that is based on the turfgrass evaluator's judgement. Turf species respond differently to seasonal variation thereby affecting their quality (density, texture, growth habit, flatness, vigour, color and homogeneity). Hence, identifying turf species that can have consistent quality across season is very essential. In this study variations were observed among the species for quality parameters such as colour, texture, density and vigour across seasons. These variations could be attributed to differences among the turf species. This is in line with the findings of Severmutlu *et al.*, 2012 where variations were observed among different turf species in Turkey across seasons.

Colour is a measure of light reflected by turfgrass (Turgeon, 1980). It is a useful indicator of general condition of plant and influenced by weather, fertilization, disease, nutrient deficiency, cultural practices like mowing quality. In addition, green is a colour of chlorophyll and thus it indicates chlorophyll concentration and grass health (Mangiafico and Guillard, 2005). The colour variation across the turf species for the 2018/2019 and 2019/2020 seasons are presented in Figures 1 and 2. There was high variation among the different species of turfgrass with regard to turf colour scores in different seasons and years. At two months after planting (July) during the course of the two seasons, all species achieved a minimum acceptable turf colour rating of 6, however, declines were observed during the dry season except for the month of November in the 2019/2020 season. This decline in colour can be attributed to low soil moisture due to shortage of rain during the dry season (Figure 1). All species in the 2018/2019 growing season reached their ideal turf colour at 2 MAP (July), with the exception of *A. compressus*, which did so at 3 MAP (August). All species achieved a pretty consistent turf colour in the 2019/2020 growing season between 4 MAP (September) and 6 MAP (November). *P. vaginatum* had the best colour rating in both seasons, this could be seen vividly in the 2018/2019 season.

Turf density is a measure of number of aerial shoots per unit area (Turgeon, 2008). It can vary with genotypic, natural environmental and cultural factors (Bell, 2011). High density (dense) is the requirement for turf density, as the fundamental function of grass is to cover the ground (Janakiram and Namita, 2014). High density contributes to high visual quality of turf stands and help them withstand trampling. Variations observed in turf density of various turf species for the two growing seasons 2018/2019 and 2019/2020 could be attributed to differences in their branching ability. At 2 MAP (July), all turf species across the two growing seasons attained an appropriate turf density rating of 6 (Figures 3 and 4). *A. compressus* reached its optimal density in 3 MAP (August) in the 2018/2019 growth season, while *C. dactylon* and *P. vaginatum* did so at 1 MAP (June). From 6 MAP (November) to 8 MAP (January), a dramatic decrease in density was seen for all species. With the exception of *C. dactylon*, all turf species reached their optimal density during the 2019/2020 growing season at 4 MAP (September). In the 2018/2019 growing season, *P. vaginatum* gave the highest turf density while *C. dactylon* was the best performing in 2019/2020. This variation is attributed to differences in climatic condition in both seasons.

Fine texture is the requirement for texture to permit high speed ball movement and to create a nice feeling for feet, depending on turf field usage and personal preference (Han and Huckabay, 2008). Costea *et al*. (2012) reported that texture of turf is being influenced by the species that are composing the turf. Generally, *A. compressus* had the least texture quality, this can be attributed to the broad leaves of *A. compressus*, and the result is in agreement with the work of Roshni and Shiv (2017). The variation in texture of different turf species for the 2018/2019 and 2019/2020 growing seasons are shown in Figures 5 and 6. Turf species in both growing seasons attained acceptable turf texture rating of 6 at 2 MAP (July). All turf species attained optimum texture at 3 MAP (August) except for *C. dactylon* which does so at 2 MAP (July) in the 2018/2019 growing season. Optimum texture was obtained at 3 MAP (August) for all turf species in the 2019/2020 growing season.

The variation in vigour of different turf species for the 2018/2019 and 2019/2020 growing seasons are presented in Figures 7 and 8 respectively. All turf species attained acceptable vigour at 2 MAP (July). All species in the 2018/2019 growing season attained optimum vigour at 2 MAP (July) with the exception of *A. compressus* which did so at 3 MAP (August). In 2019/2020 growing season, all turf species attained optimum vigour at 3 MAP (August). *A. compressus* had the least vigour in both seasons, this is due to the fact that the turf where planted in open field and *A. compresus* is of shade loving type.

CONCLUSION

The turfgrass species varied for quality parameters throughout seasons. The variations were directly related to the timing of both seasons' rainfall. This suggests that moisture influences turfgrass quality. Among the studied species, *P. vaginatum* performed best in all turf qualities parameters, this can be attributed the possession of rhizome which serves as food reservoir in this species. Therefore, it can be recommended as the best turf quality parameters such colour, density, texture and vigour.

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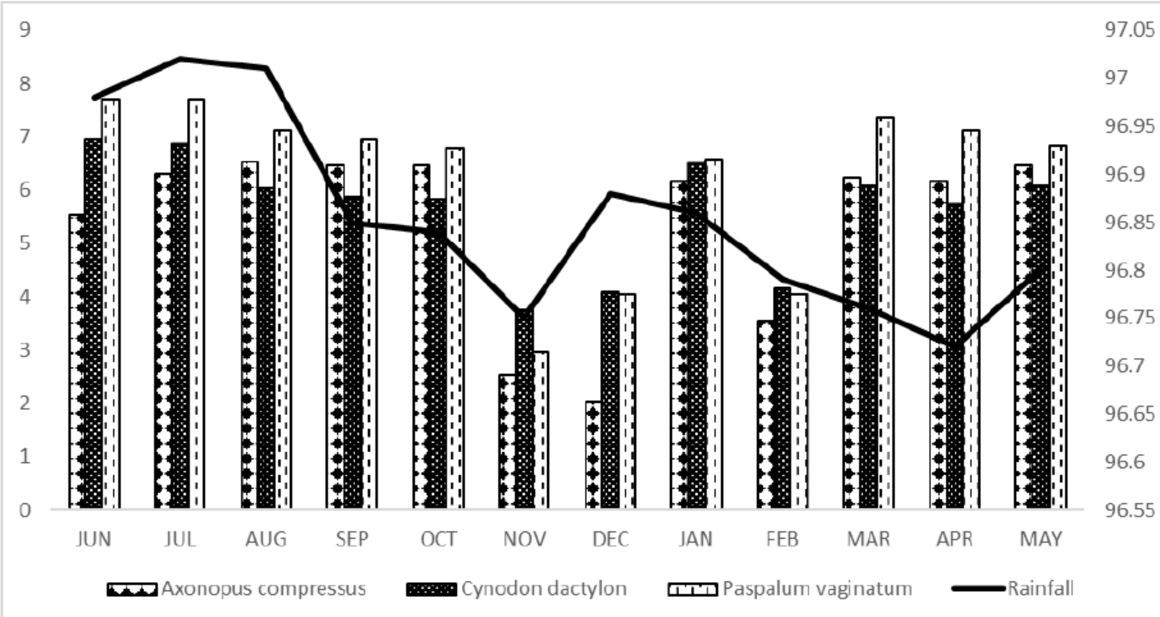

Figure 1: Variation in colour of different turf species in 2018/2019 season as affected by rainfall

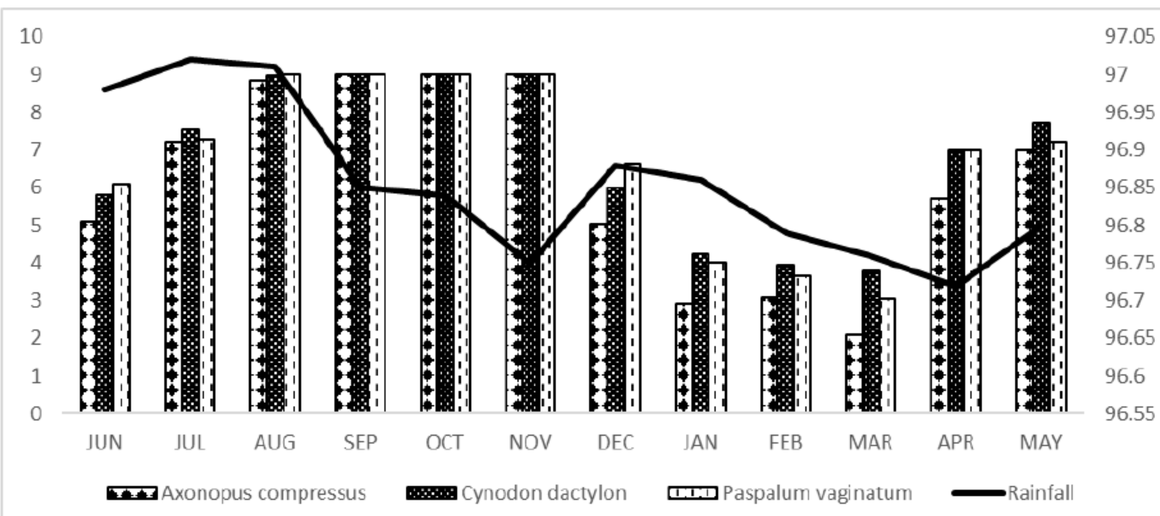

Figure 2: Variation in colour of different turfgrass species in 2019/2020 season as affected by rainfall

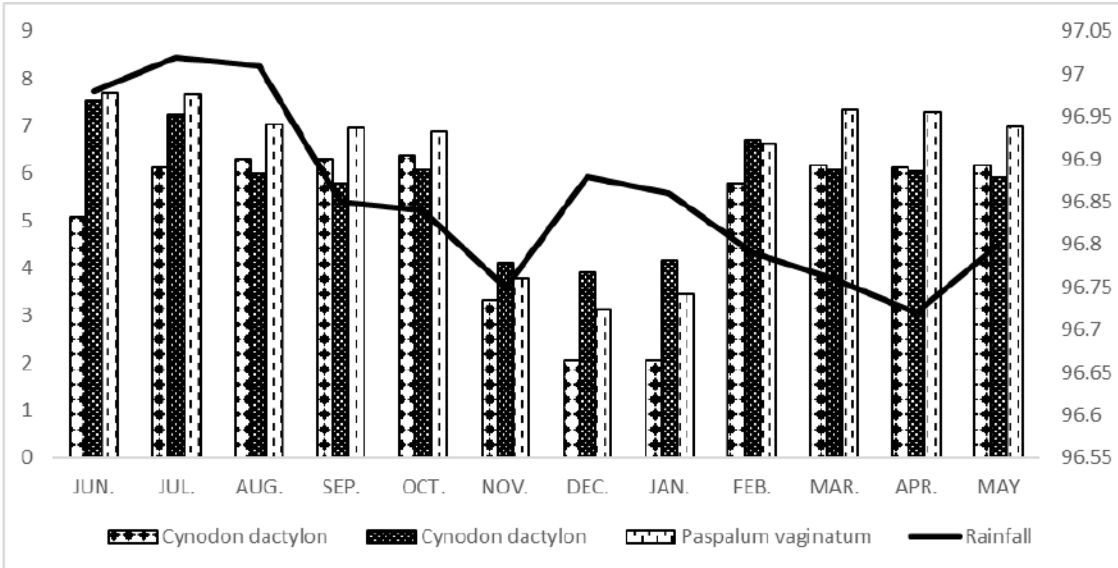

Figure 3: Variation in density of different turfgrass species in 2018/2019 season as affected by rainfall

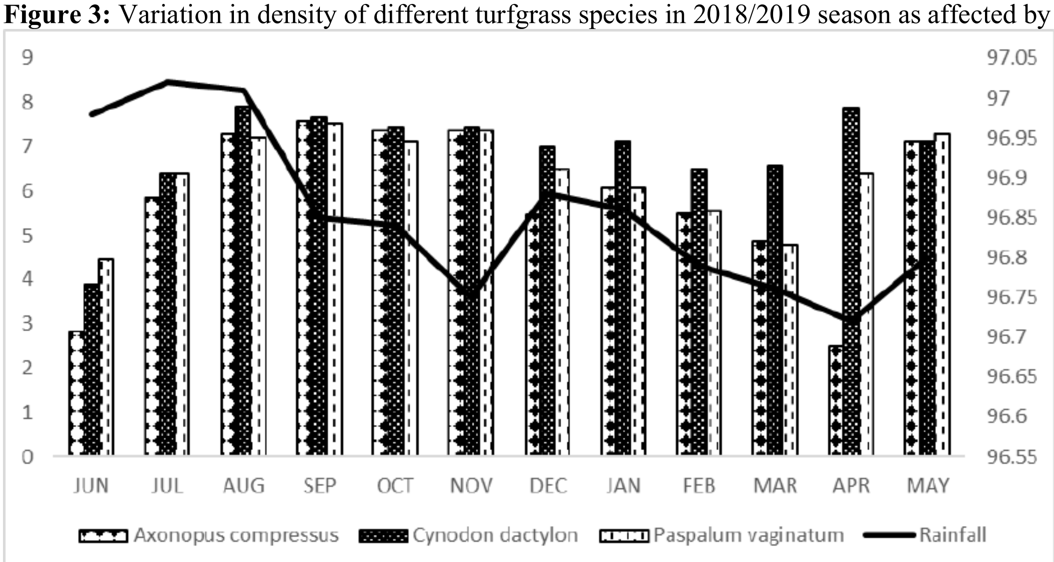

Figure 4: Variation in density of different turfgrass species in 2019/2020 season as affected by rainfall

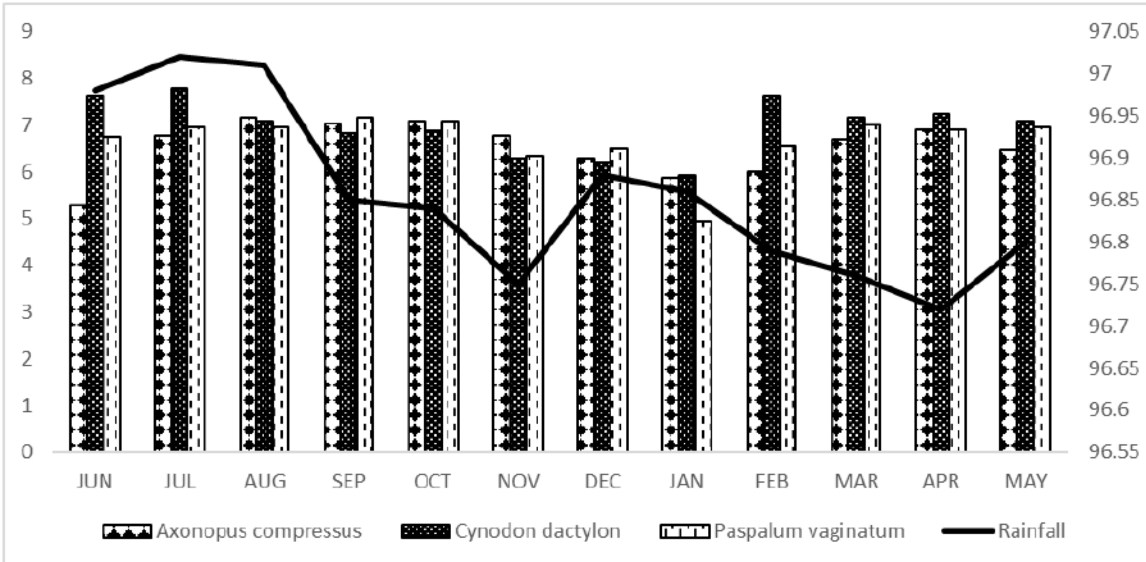

Figure 5: Variation in texture of different turfgrass species in 2018/2019 as affected by rainfall

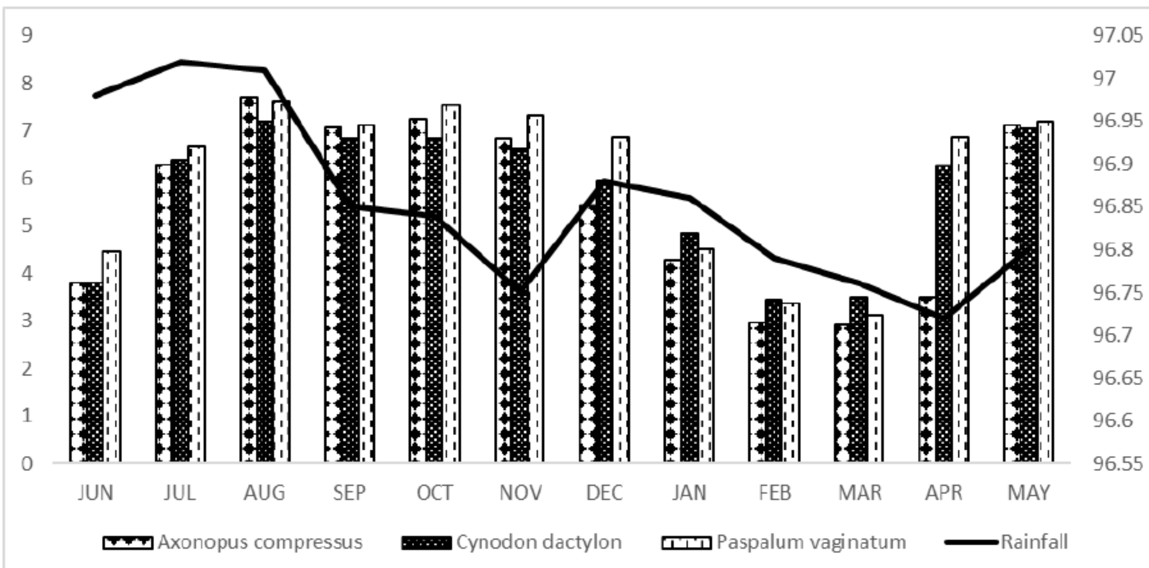

Figure 6: Variation in texture of different turfgrass species in 2019/2020 season as affected by rainfall

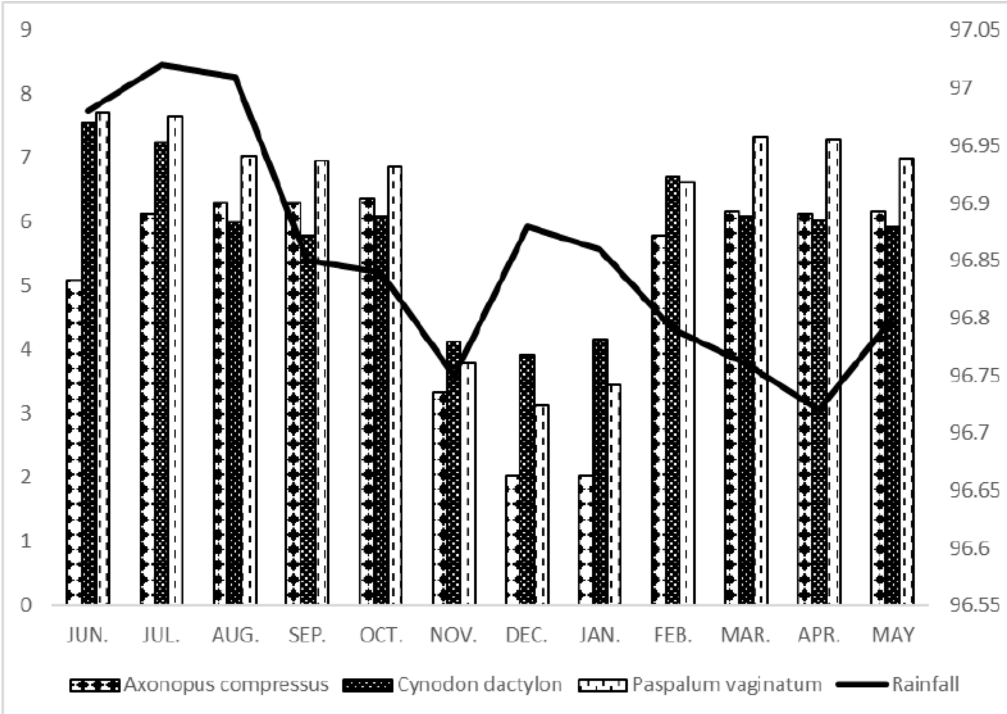

Figure 7: Variation in vigour of different turfgrass species in 2018/2019 season as affected by rainfall

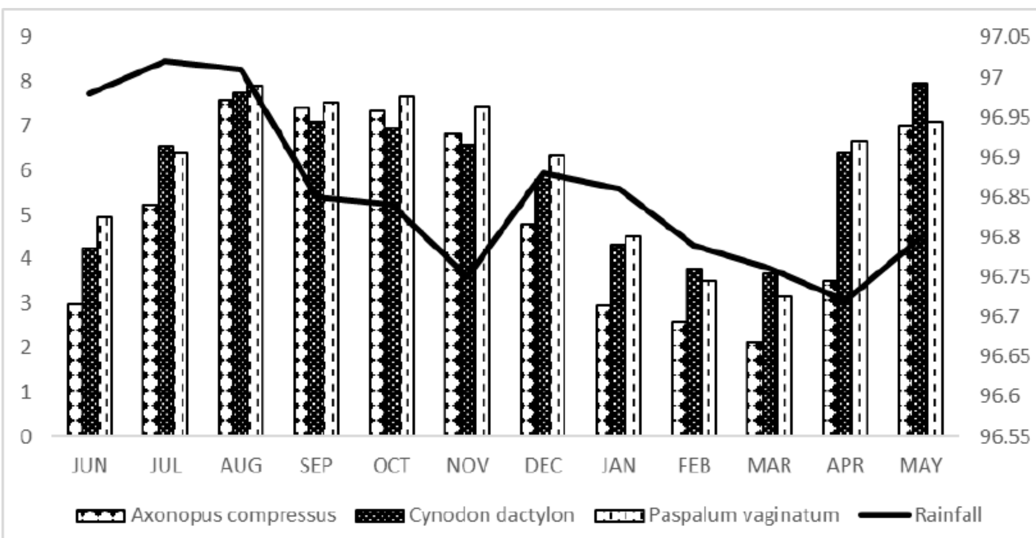

Figure 8: Variation in vigour of different turfgrass species in 2019/2020 season as affected by rainfall

EFFECTS OF WEEDING PERIODS ON THE GROWTH OF CASHEW SEEDLINGS IN THE NURSERY

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ABSTRACT
One of the primary challenges faced by cashew farmers in the nursery is weed control. This study determined the effects of different periods of hand weeding on the growth of cashew seedlings raised in nursery polythene bags. The 3 month experiment was set up in a nursery. The treatments were weed-free (WF), weedy check (WC), weeding once per week (1W), weeding once in 2 weeks (2W), weeding once in 3 weeks (3W) and weeding once in 4 weeks (4W) were replicated three times. Morphological data were collected and emerging weeds were identified. The result showed that WC (2.8) had the least seedling vigour and was also significantly different from WF (4.8), 1W (4.7), 2W (4.8), 3W (4.7) and 4W (4.8). Weed infestation affected cashew seedling growth negatively in the nursery.
***Keywords**: Weeds, Cashew Seedlings, Nursery, Weeding.*

INTRODUCTION

Cashew (*Anacardium occidentale* L) plays a vital role in Nigeria's agriculture sector and significantly contributes to the country's economy (Olukunle, 2022). It is a prominent non-oil export crop, generating substantial revenue and contributing to foreign exchange earnings (Ogunwolu *et al*., 2020). The export of cashew nuts provides income for numerous individuals involved in cultivation, processing, and trading. Cashew trees are primarily propagated through seeds, which are planted in nursery beds, nursery polythene bags, or directly in the field (Essien, *et al*., 2021). Raising cashew seedlings in polythene bags is a common practice among cashew farmers. One of the primary challenges faced in the nursery is weed control (Yu and Marble, 2022). Due to favourable conditions, such as well-drained and moist potting soil, newly potted plants are extremely susceptible to weed infection (Norcini, *et al*., 2010). Weed infestation in nurseries can lead to intense competition for vital resources such as water, nutrients, and light. Weeds compete with cashew seedlings for these resources which adversely affects their growth and development. Weeds have the potential to cause nutrient deficiencies and hinder the growth of cashew plants due to their competition with seedlings. Additionally, weeds can act as hosts for insects or pathogens, increasing the risk of infestation or disease transmission to the cashew plants.

It is crucial to implement timely and appropriate weed management practices to minimize the negative effects of weed infestation on cashew seedlings. Manual weeding, mulching, and regular monitoring are recommended as effective weed control measures in cashew nurseries. By adopting proper weed management practices, cashew farmers can ensure healthier, facilitating their successful establishment and subsequent growth in the field. The objective of this study was to determine the effects of different periods of hand weeding on the growth of cashew seedlings in the nursery.

MATERIALS AND METHOD

The three-month experiment was set up in a nursery at Akinyele Local Government Area, Ibadan, Oyo State, Nigeria. The experimental design was a complete randomized block design (CRD) replicated three times. The treatments were weed-free (WF), weedy check (WC), weeding once per week (1W), once in 2 weeks (2W), once in 3 weeks (3W) and once in 4 weeks (4W). Medium cashew nut biotype sown at 4 cm depth was used in this experiment. The seedlings were raised in a 2 mm sieved topsoil-filled polythene bag size 25 by 12.5 cm. Watering of the seedlings was carried out every two days. The polythene bags were perforated at the base to allow drainage t. Five seedlings were used per treatment making a total number of 30 seedlings per replication and 90 seedlings for the 3 replications. The initial soil sample was taken for the analysis of the physicochemical properties. . From one month after sowing, morphological data such as plant height, stem diameter, number of leaves and leaf area were recorded every two weeks. General seedling vigour was observed at three months after sowing using a vigour scale (5-Excellent, 4-Good, 3-Average, 2-Below average and 1-Poor) (Olasan *et al*., (2018). The weeds observed were also identified and recorded. Data were analyzed using Analysis of Variance (ANOVA) with the aid of GenStat statistical software and treatment means were compared using Least Significant Difference (LSD) at a 5% probability level.

RESULTS AND DISCUSSION

Table 1 highlights some of the weed species identified growing along with the cashew seedlings within the nursery polythene bags. The following weed species were identified, *Talinum triangulare, Tridax procumbens, Laportea aestuans, Spigelia antelmia* and *Chromolaena odorata which are all broad-leaf weeds and Eragrostis tremula* was the only grass weed identified. It is important to note that topsoils used in nurseries carry weed seeds from the source location and germinated with the cashew seedlings. These weeds are tropical weeds (Agyakwa and Akobundu, 1998) and they have been observed to be highly competitive with crop plants. The physical and chemical properties of the soil before planting is shown in Table. . The soil was sandy clay loam and acidic with a pH of 4.36. Egbe *et al* (1989) reported the critical level of some essential plant nutrients that must be available in the soil for raising cashew. The critical level reported for nitrogen (N) was 1g/kg, phosphorus (P) to be 3.7mg/kg, potassium to be 0.12cmol/kg and Organic Carbon (OC) to be 8.7g/kg. In reference to the report of Egbe *et al*. (1989), the N content of the soil used wass low (0.36 g/kg), OC was also low (1.74 g/kg) while available P (5.13 mg/kg) and K (1.01 cmol/kg) were high.

At 3 months after sowing (MAS), the cashew seedlings in the nursery morphologically responded differently to the weeding treatments imposed as shown in Table 3. None of the treatments significantly influenced cashew seedling height. A similar result was also observed by Garau *et al*., (2008) in their study on the effect of weeds on *Eucalyptus globulus* seedlings. However, WC still had the least seedling height of 25.5cm. Seedlings that were weeded monthly (4W) had the tallest height of 29cm followed by 3W (27.6cm), WF (27.4cm), 2W (27.2cm) and 1W (25.9cm). Table 3 further revealed that WC (18.8) developed the highest number of leaves among the treatments and was significantly different from 4W (11.5) and 2W (13.7) but not significantly different from WF (14), 1W (17.2) and 3W (13.7). Trimble, (2021) reported plants can remodify their morphology to gain a competitive advantage by growing more leaves to monopolize the limited resources within their environment. None of the treatments significantly influenced cashew seedling stem diameter (Table 3). WC (5.5 mm) and WF (5.5 mm) had the same stem diameter while 3W (5.1 mm) had the least. As shown in the leaf area column on the table, cashew seedlings were influenced by the treatments. WC (31.39 cm^2) had the least leaf area of all the treatments. This implies that WC produced the smallest leaves of all the treatments despite producing more leaves. Deen, (2003), also observed a reduction in the leaf area of *Triticum aestivum* (Wheat) under a competitive condition with *Lolium rigidum* grass weed. However, only 4W (45.77cm^2) and 3W (43.56 cm^2) produced significantly larger leaf area than WC (31.39 cm^2). Still in Table 3, notable difference in cashew seedling vigour was observed among the treatments. WC (2.8) had the least seeding vigour compared with the other treatments. This implies that weeds growing along with cashew seedlings in the polythene bags negatively impacted the general seedling vigour.

CONCLUSION

In conclusion, weeds generally affected the morphological appearance or vigour of the cashew seedlings negatively. This is at a disadvantage to cashew farmers as poor seedlings command poor market value and also cause poor survival rate of seedlings when transferred to the field. To minimize the additional cost incurred on weeding, a monthly periodic weeding can be maintained in the nursery without adversely affecting the growth of cashew seedlings.

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Table 1: Some of the weeds identified during the experiment

S/N	**WEED SPECIES**	
	Common Name	Scientific Name
1	Water leaf	*Talinum triangulare*
2	Tridax	*Tridax procumbens*
3	Tropical Nettleweed	*Laportea aestuans*
4	Worm Bush	*Spigelia antelmia*
5	Siam Weed	*Chromolaena odorata*
6	Love grass	*Eragrostis tremula*

Table 2: Physicochemical properties of the topsoil.

Parameters	**Values**	**Sufficiency Level**
pH (1:2 H_2O)	4.36	
Organic Carbon (g kg^{-1})	1.74	Low
Total Nitrogen (g kg^{-1})	0.36	Low
Available P (mg kg^{-1})	5.13	High
Exchangeable?? K (cmol kg^{-1})	1.01	High
Textural Class	Sandy Clay Loam	

Table 3: Morphological traits of cashew seedlings as influenced by weeding periods at 3 months after sowing.

Treat	Cashew Seedlings Morphological Parameters				
	Plant Height (cm)	No. of Leaves	Stem Diameter (mm)	Leaf Area (cm^2)	Seedling Vigour
WF	27.4	14	5.5	38.59	4.8
WC	25.5	18.8	5.5	31.39	2.8
1W	25.9	17.2	5.9	37.94	4.7
2W	27.2	13.2	5.6	39.02	4.8
3W	27.6	13.7	5.1	43.56	4.7
4W	29.0	11.5	5.6	45.77	4.8
Std. Er	2.5±5.6	2.4±5.4	0.36±0.8	4.44±9.90	0.2±0.5
LSD @ 5%	not significant				

Key: WF= weed free; WC= weedy check; 1W= once per week; 2W= once in 2 weeks; 3W= once in 3 weeks; 4W= once in 4 weeks. Std.Er= Standard Error.

EFFECTS OF PRETREATMENTS ON CAROTENOID CONTENT OF PUMPKIN VARIETIES (*CUCURBITA PEPO L.)*

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ABSTRACT

The prevalence of micronutrient especially vitamin A deficiency has increased tremendously due to poor dietary intake. Hence, there is need to address this problem with pro-vitamin rich foods. Pumpkin which has high carotenoid content is a good candidate for alleviating vitamin A deficiency. The effects of boiling and steaming on the carotenoid contents in the pulp of two pumpkin varieties (Orangetti and Connecticut field) obtained from National Horticultural Research Institute farm around July 2023 was modeled and optimized. The pumpkin pulp was steamed and boiled for varying time between 0 to 6 minutes, and total carotenoid content was determined on it. The result showed that the carotenoid content decreased for variety 1 (Orangetti) after treatment from 13.79 to 7.94 µg/g while the second variety increased after treatment from 8.79 to 29.40 µg/g. Central composite design of response surface methodology was used as statistical indicator with boiling and steaming time (0-6 minutes) serving as independent variables. As indicated by p-values that of 0.01 and 0.02, both boiling and variety had a significant impact on the carotenoid content of pumpkin pulp. However, steaming had no significant impact on the carotenoid content. The optimization result revealed that Connecticut field was the most desirable with 28.511 % of carotenoid by steaming at 2.6 minutes and boiling for 6 minutes. This study deduced that the application of heat to pumpkin improved the carotenoid content compared to the raw form.

INTRODUCTION

Micronutrient malnutrition, particularly vitamin A deficiency, affects about three billion people worldwide (Pritwani and Mathur, 2017). Vitamin A Deficiency (VAD) has afflicted around 5.2 million preschool-aged children and 9.8 million pregnant women, primarily in sub-Saharan Africa according to the World Health Organization (WHO) (Ohanenye *et al.*, 2021). Vitamin A is required for adequate vision, epithelial tissue integrity, and a wide range of other metabolic processes (Pritwani and Mathur, 2017). According to studies from developing countries, pro-vitamin A-rich foods account for up to 80% of dietary vitamin A intake (Cardoso *et al.* (2009);Van den Berg *et al.* (2000). Vitamin A is available in the form of pro-vitamin A carotenoids, which are pigments generated by many plants and found in green, orange, and yellow plant tissues. Most fruits and vegetables contain carotenoids and encouraging their injection daily can serve as a good potential in tackling VAD. According to the report of Pritwani and Mathur (2017), vegetables that are excellent sources of carotenoids include but not limited to carrots, green pepper, spinach, sweet potato, and pumpkin.

Pumpkin also referred to as squash exist in the family of Cucurbitaceae, genus Cucurbita (Shamsuri and Ahmad, 2019). It is widely grown throughout the tropical and subtropical countries. The most common species of pumpkin are C. maxima, C. pepo, and C. moschata (Lucia Maria Jaeger *et al.*, 2012). The flesh of the fruit is distinguished by its hard outer cover with characteristic yellow to orange colour which indicates the presence of carotenoids, with firm texture and flavour (Chuwa *et al.*, 2022). Rodriguez *et al.* (2018) reported that the fruit is abundant in minerals such as potassium, calcium, phosphorus, ß-carotene (which can be converted to vitamin A), dietary fibre, and lycopene. Vegetables are eaten in either raw or cooked form. Research has shown that most nutrients in fresh vegetables are preserved in the raw condition, however any degree of cooking leads in partial loss of nutrients and significant changes in its sensory properties. Some researchers have conducted studies on the effects of different cooking methods on pumpkin (Shamsuri and Ahmad (2019);Lotfy *et al.* (2017). However, studies focused on modeling and optimization of cooking methods on the total carotenoid content of pumpkin is very hard to come by. Therefore, this study modeled and optimized the effects of boiling and steaming on the total carotenoid content of two varieties of pumpkin using response surface methodology (RSM).

Variety 1 (Orangetti)

Variety 2 (Connecticut field)

MATERIALS AND METHODS

Sample preparation

Two pumpkin varieties (Orangetti and Connecticut field) cultivated and harvested at the same time were obtained from the Research farm of National Horticultural Research Institute, Ibadan, Oyo State. Fresh samples were washed and peeled to remove the outer skin. The seeds were removed and the pulp was cut into smaller sizes and divided into eight portions to increase the surface area and in order to facilitate the treatment process i.e. boiling and steaming. For boiling, 20 g of the sample was randomly selected from the lot and was immersed in boiling water at 100°C for 0 to 6 minutes based on the experimental design while steaming was conducted by placing 20 g of the sample above boiling water in a steamer with lid for varying time between 0 to 6 minutes.

Determination of total carotenoid

The total carotenoid content of the pumpkin was determined according to the method of Lucia Maria Jaeger *et al.* (2012) with little modification. This was done by weighing 0.5 g of the mashed sample into a 20 ml test tube and 5 ml of cold acetone was added and mixed to form a paste, and the mixture was continuously shaken until it became colourless. The extract was then transferred into a 100 ml separating funnel of containing 8 ml of n-hexane, and the acetone was separated by slowly adding water to avoid the development of an emulsion, and the aqueous phase was discarded. The technique was repeated until there was no more remaining solvent. The procedure was repeated until no residual solvent remained. Then the extract was transferred to a 50 ml volumetric flask containing 3 g of anhydrous sodium sulfate and the volume was made up to its full volume by adding n-hexane and read at 450 nm with a UV-visible spectrophotometer (T80 series UV-visible double beam spectrophotometer).

$$\text{Carotenoid content } (\mu g/g) = \frac{A \times V(ml) \times 10^4}{A^{\%}{}_{1cm} \times P}$$

Where A=Absorbance; V=Total extract volume; P=sample weight; $A^{\%}{}_{1cm}$=2560 (ß-carotene Extinction coefficient in n-hexane).

Experimental design and statistical analysis

The experimental design used in this study was the central composite design of response surface methodology; with three independent variables; in which two are numeric (boiling (0-6 minutes) and steaming (0-6 minutes), and one categorical factor (varieties). A total of 18 experimental runs was generated using Windows design expert version 13. Table 1 below give the details of the experimental runs and the treatment combinations considered for each of the run. The data obtained for the corresponding carotenoid content responses for each of the run was then subjected to multiple regression analysis. This was done by fitting the data into polynomial models whose fitness was verified using R^2 (coefficient of determination) and the corresponding p-value.

RESULTS AND DISCUSSION

The carotenoid content of the pumpkin pulp decreased after steaming and boiling for Orangetti from 13.79 % to 7.94 %. While for Connecticut field, the carotenoid content increased upon steaming and boiling from 8.79 % to 29.40 % as shown in table 1 below.

Table 1: Experimental runs, treatment combinations, and carotenoid content of the two varieties of pumpkin pulp.

Runs Variety 1	Factor 1 A: Steaming (minutes)	Factor 2 B: Boiling (minutes)	Carotenoid content (µg/g) Mean ± S.D	Runs Variety 2	Factor 1 A: Steaming (minutes)	Factor 2 B: Boiling (minutes)	Carotenoid content (µg/g) Mean ± S.D
1	0	0	13.79±0.51	**10**	0	0	8.79±0.16
2	6	0	10.38±0.92	**11**	6	0	21.29±0.10
3	0	6	8.92±0.75	**12**	0	6	24.06±0.13
4	6	6	12.86±0.80	**13**	6	6	22.34±0.13
5	0	3	10.00±0.47	**14**	0	3	17.17±0.57
6	6	3	11.46±0.67	**15**	6	3	19.25±0.06
7	3	0	7.94±0.13	**16**	3	0	8.96±0.24
8	3	6	10.60±0.82	**17**	3	6	29.40±0.41
9	3	3	9.40±0.35	**18**	3	3	20.23±0.25

As shown in the table below, the p-value of the model is 0.0215 which is less than 0.005, indicating that the model is significant. Due to the p-values above 0.05, steaming (A) is not a significant factor while boiling (B) and variety (C) is a significant factor. However, the interaction between AB and AC are not significant, while BC and ABC are significant. This implies that both boiling, and variety affects the carotenoid content no matter the treatment time of exposure while steaming does not influence the carotenoid content. The model's F-value of 5.76 obtained implies that the model is significant, and it is a good fit for predicting the responses. An R^2 value of 0.91 indicates that the model is a good predictor for the data.

Table 2: Analysis of variance table for carotenoid responses.

Source	F-value	p-value
Model	5.76	0.0215
A-Steaming	1.79	0.2292
B-Boiling	11.16	0.0156
C-Variety	9.42	0.0220
AB	0.5769	0.4763
AC	0.9630	0.3643
BC	10.83	0.0166
ABC	5.69	0.0544

Model equation for carotenoid content of the pumpkin

$12.85130-1.78426S-0.905741B+0.204259SB+0.213580S^2+0.051358B^2$ …….Equation 1

$7.07889+2.37426S+3.05500B-0.395185SB-0.079074S^2+0.028704B^2$ ……....Equation 2

The model equation above can be used to predict the value of carotenoid content in the pumpkin as steaming and boiling time varies.

The Figure 1 below shows the interaction of steaming (A) and boiling (B) time with the varieties on the carotenoid content of pumpkin respectively. The two undotted lines denotes the first (Orangetti) and second variety (Connecticut field) respectively. It can be observed that for the first variety (Orangetti), between 0-6 minutes the carotenoid content is constant and falls around 10 for both steaming and boiling i.e., the carotenoid content remains constant between that time ranges. While for the second variety (Connecticut field), the carotenoid content shows an increasing trend for steaming and boiling from 0-6 minutes. Though, boiling exhibited a more increasing trend than steaming. It can also be observed that the second variety has better carotenoid content than the first variety. According to Hwang *et al.* (2012), thermal treatment improves carotenoid availability. Similar findings were reported by Shamsuri and Ahmad (2019). Cooking methods degrade food matrices and loosen carotene-binding fibers. This may result in nutritional loss, but it may also improve bioavailability and enhance carotene content (Fernández-García *et al.*, 2012).

A B

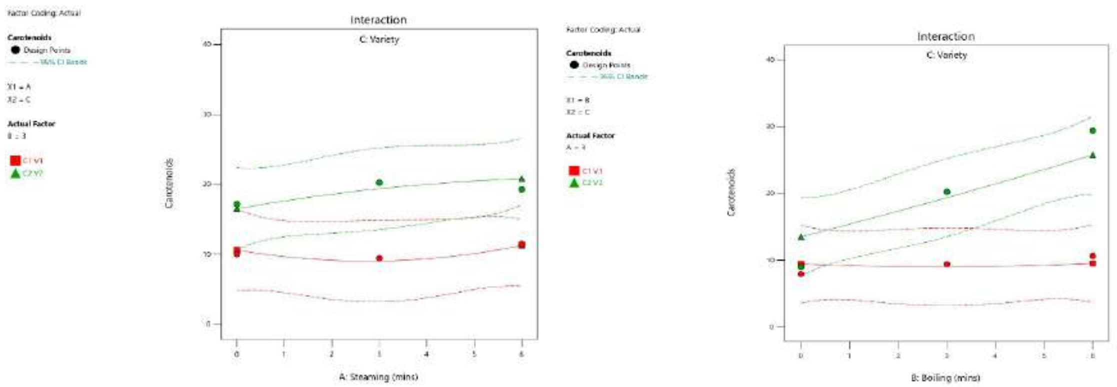

Figure 1: graph illustrating the interaction of steaming (A) and boiling (B) on the carotenoid content of pumpkin.

Optimization of the carotenoid content of pumpkin based on varied treatments

The optimization result generated 19 outputs and only 5 of the optimum desirable output were considered. The most desirable output to obtain 28.511 % of carotenoid was in second variety (Connecticut field) by steaming at 2.6 minutes and boiling for 6 minutes.

CONCLUSION

In conclusion, boiling, and time used has a substantial influence on the carotenoid content of the pumpkin varieties. However, steaming has no significant impact. The second variety (Connecticut field) was the best in terms of availability of carotene, steaming and boiling within 6 minutes can be used to enhance carotenoid bioavailability. Therefore, the inclusion of pumpkin in the diets of both children and elderly ones is recommended.

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CORRELATION ANALYSIS ON GROWTH AND YIELD TRIATS OF PEARL MILLET [*Pennisetum glaucum* (L.) R. Br.] AND COWPEA [*Vigna unguiculata* (L.)]IN MAIDUGURI, NORTH EASTERN, NIGERIA

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ABSTRACT
Understanding interrelationships among various agronomic traits is vital to plan an effective production program in pearl millet/ cowpea intercropping. Field experiments were conducted in 2015 and 2016 rainy seasons at the Teaching and Research Farm of the Department of Crop Production, University of Maiduguri, Maiduguri (11⁰47N; 12⁰16E) to determine the correlation effect on growth and yield traits of pearl millet varieties (Pennisetum glaucum) (L.) R. Br.) intercropped with cowpea (Cowpea Vigna unguiculata (L.) Walp) varieties. The treatments consisted of pearl millet varieties: ZATIP, SOSAT-C-88 and LACRI-9702-IC and cowpea varieties: Borno Brown and SAMPEA 11. The experimental design was Split-Split plot with the pearl millet varieties allocated to the main plots and cowpea varieties assigned to the sub-plots in 1:1 alternate row arrangement, and replicated three times. The parameters collected for pearl millet were plant height, number of leaves/plant, number of tillers/plant, leaf area, number of days to 50% flowering, grain yield/ plant, number of panicles/plant, panicle length, panicle diameter, panicle weight, 1000 grain weight, harvest index and straw yield/plant, while length of branches, number of branches, pod yield/plant, grain yield/hectare, 100 seed weight and fodder yield/hectare were determined for the cowpea component. The results showed that in 2015, 2016 and the combined mean, linear relationships among agronomic parameters of millet revealed that, grain yield/ hectare increased significantly with increase in leaf area, number of leaves/plant, number of tillers/plant, plant height, number of panicles/plant, number of grains/panicle, grain yield/plant, panicle length, panicle diameter and harvest index. Also, in cowpea number of leaf branches at harvest was positively correlated with number of pods per plant, grain yield/ha and fodder yield/ha. Length of branches was positively associated with number of pods per plant, pod per plant, grain yield/ ha and fodder yield/ hectare.
Keywords*: interrelationship, correlation, association, grains, positive*

INTRODUCTION

Cropping systems that carry with them species diversity are seen by agro ecologists and nature conservators, as having the greatest potential of imparting balancing effect on natural ecosystems, since they mimic natural crop communities with in-built processes and mechanisms that exhibit association resistance to withstand ravages of diseases and pests (Trendbath, 2006). Agro ecologist like Micheal and Talbot (2013) opined that investigating such system with a view of improving their biological efficiencies is not only agronomically desirable, but morally sensible. Intercropping is a popular traditional cropping system in the tropical part of the world. It is a practice used by famers for increasing crop yield, crop diversity and stability of crop production. For the fact that the climatic conditions in the tropics are favorable for crop production during much of the year, cropping patterns are numerous in the region. Farmers therefore, choose the one suited to their micro ecological conditions, dietary needs, management level and economic disposition. Under this system, the number of days the land is idle is greatly minimized. According to Trenbath (2001), environmental factors dictate the farming practices, since crop productivity is not only a function of the variety potential of the crops, but also the total environment in which the crops are grown. The total environment has aerial environment (defined in terms of solar radiation, temperature, precipitation, cloudiness, winds etc.) and soil environment as sub-components. The interaction of these components dictates the farming system of a given agro-climatic region by setting broad limits to land patterns and duration. The sahel with annual rainfall of 300 – 600 mm and 60 – 100 days growing season is the main area of production of pearl millet. In the Sudan

Savanna with 600 – 800 mm rainfall and a growing season of 100 – 150 days millet is intercropped with sorghum, maize, cowpea or groundnut (ICRISAT, 2013). In Nigeria 5.2 million hectares are cultivated with a total production of 6.4 million metric tonnes. Mean yield in Nigeria is 1462 kg/ ha (FAO, 2017).

Little was known on the chemistry that intricately govern the competition of same or different varieties of crops raised together before the works of De Wit (1960), Donald (1993), Trenbath (2001). But now several researchers have focused their research lights on the dynamics of this phenomenon. Two types of inter stand or neighbourhood effects influence various mixture performance, namely competition and complimentarity. **Competition**: This is said to occur when component crops compete for light, nutrients, water, CO_2 and other growth factors when they are in limited supply (Gomez and Gomez, 2007). **Complementarity**: The effects of one component on the other which enhance growth and productivity as opposed to competition (Gomez and Gomez, 2007). Thus in complimentarity, crops appear not to compete when they share a habitat (Trenbath, 2001). When each component of the mixture competes equally for growth resources as in pure cultures, the yields that would have been obtained is called the 'expected yield' (De Wit, 1960; Trenbath, 2001). Under this theoretical situation, inter specific competition equals intra-specific competition. Where both crops yields are reduced such that their yield fall short of the mean mixture yield, then we have **inhibitive competition (**De Wit, 1960). He further identified **compensatory competition** as that where increase in yield of one component results in proportional decrease in yield of a second member. The member commanding a large share of growth resources is the **aggressor** or **dominant**, while the lesser competitive is the **subordinate** or **dominated** (De Wit, 1960; Huxley and Miangu, 2009). Of recent, Vandermeer (2010) proposed two useful principles of competition which give insights into the mechanism of mixture advantages. These are **competitive production principle** and **environmental modification principle**. In the former, inter specific competition is sufficiently weak to give the intercrop an advantage, while in the latter, the environment of one or both species is altered through the presence of a second species. Adetiloye (2007) observed that neighbourhood effects are caused by competition for light, water, soil nutrients and alleged allelopathy. While competition between mixture components leads to yield compensation or even mutual inhibition such that mixture yields deviate slightly from mid-pure yield, complimentarity is the desirable situation of appreciable tolerance displayed by both members Bassi and Dugje (2016).

The fact that growing crops in mixtures ensure better land use efficiency is no longer disputable. But the dynamics of the intercrop over-yielding, especially the main source of gains in the mixtures is an aspect that many scientists report contrasting findings. But generally planting early maturing varieties and slow growing crops together seems to be an agreeable arrangement leading to intercrop over-yielding. Also important are the relative statures and size of different crops, growth cycles and seasonal period available for growth (Parish, 2005).

MATERIALS AND METHODS

The experiment was conducted during 2015 and 2016 rain-fed cropping seasons at the Teaching and Research Farm, Department of Crop Production Faculty of Agriculture, University of Maiduguri. The experimental site was located between latitude $11^0 47^1$N and $56\ 00^1$N, and longitude $03^0 12^1$ and 16^0E and altitude of 345 m above sea level, in the northern fringes of the Sudan savanna belt of Nigeria. Seeds of pearl millet and cowpea varieties were obtained from the seed multiplication Unit of Borno State Agricultural Development Programme, Maiduguri and Crop Division of Lake Chad Research Institute, Maiduguri respectively. The treatments consisted of three improved pearl millet varieties: (ZATIP, SOSAT-C-88 and LACRI-9702-IC) intercropped with two cowpea varieties: (Borno Brown and SAMPEA 11). The pearl millet was grown at (3) three plants/stand, while the cowpea were grown at 2 plants/stand (Dugje *et al*.,2009). experimental design was split-split plot with pearl millet varieties assigned to the main-plot and cowpea varieties assigned to the sub-plot, which were replicated three times. The sub-plot size was 3.0 x 5.0 m (15.0 m^2). An alley of 2.0 m was allowed between the replicates, while 1.0 m and 0.50 m alley was allowed between the main plots and sub-plot, respectively.

The land was harrowed with tractor driven disc, after which the plots were laid out and leveled before sowing. Seeds were treated with a pre-planting fungicides Apron Star (42 WS) Anaso *et al* (1998) at the rate of 5 g of chemical per kilogram of seeds. Following land preparation and leveling, the experimental micro individual plots (5m x 3m) were bounded at the edges to minimize run in and run-off. The pearl millet varieties were sown at 90 cm x 50 cm on 5th July each year while each cowpea variety was intercropped into the pearl millet at a distance 45cm from the pearl millet row and 50cm within the row at each sowing dates. The pearl millet and the cowpea intercrops were sown in 1:1 alternate row arrangement.

Fertilizer was applied by band placement at the recommended rate of 60 kg N, 30 kg P_2O_5 and 30 kg K_2O/ha (FPDD, 2002) in 2 split doses. The first dose of 30:30:30 was applied at 2 weeks after sowing (WAS), using NPK (15:15:15). The second dose of 30 kg N/hectare was applied at 6 weeks after sowing using Urea (46%N). For the legumes 50 kg P_2O_5/hectare was applied to the sole plots and the legume componet in the intercrop using single super phosphate (18% P_2O_5) one week after sowing. The same fertilizer rates and methods were applied each year. Insecticide spray for insect pest control in cowpea was done thrice at 30, 45 and 60 days after sowing each year in 2015 and 2016. The insecticide used was Cypermethrin + dimethoate (Sherpar Plus) with active ingredient of 30grams/litre + 250grams/litre. at the rate of 1 litre/hectare The sprayings were conducted using Knapsack sprayer in the evenings during the two years.

Statistical Analysis

Pearson correlation coefficient was used to estimate the relationships between yield and the crops relate traits using Discovery Edition- 3rd software (Genstat, 2007). Differences between treatments means were compared using possible linear correlation coefficients to determine the degree of association among the agronomic trats of pearl millet on one hand and that of cowpea on the other.

RESULTS

The response of pearl millet varieties intercropped with cowpea varieties in 2015 showed that, plant height was positively associated with number of leaves/ plant at harvest (r=0.78*), grain yield/ hectare (r= 0.95*) and straw yield per plant (r= 0.81*) (Table 1). Millet number of leaves/ plant at harvest was positively correlated with harvest index (r=0.92*) and straw yield (r=0.85*). Similarly, number of tillers/plant was positively correlated with number of panicle per plant (r=0.83*), grain yield per plant (r=0.95*), grain yield/ha (r=0.99**), panicle diameter (r=0.93*) and straw yield/plant (r=0.75*). Also, leaf area at harvest was positively associated with number of grains per panicle (r=0.91*), grain yield per plant (r=0.89*), grain yield/ha (r=0.93*), panicle diameter (r=0.69*), panicle weight (r=0.65*) and straw yield/plant (r=0.94*). Number of grains per panicle was positively correlated with grain yield per hectare (r=0.91*), panicle diameter (r=0.97**) and straw yield per plant (r=0.76*), Similarly, number of panicles per plant was positively associated with grain yield per plant (r= 0.88*) and grain yield per hectare (r=0.79*). Harvest index was positively correlated with grain yield per plant (r=0.90*) and grain yield per hectare (r=0.99**) (Table 1). Grain yield per plant was positively associated with panicle diameter (r=0.92*), panicle weight (r=0.85*) and straw yield per plant (r=0.77*). There was no significant linear correlation among the other agronomic traits observed during the 2015 cropping season.

The effect of intercropping pearl millet and cowpea variety on linear relationships among agronomic traits of pearl millet in 2016 are presented in (Table 2). The results showed that, there was significant linear association between millet plant height at harvest with harvest index (r=0.94*) and straw yield (r=0.92*). Number of leaves at harvest was positively associated with grain yield per hectare (0.97**) and straw yield per plant (r=0.75*). The results further revealed that, millet leaf area at harvest was positively associated with number of grains per panicle (r=0.96*), grain yield per plant (r= 0.89*) and grain yield per hectare (r=0.99**) and panicle diameter (r= 0.75*) (Table 2).

The results showed that, there was significant linear association between millet plant height at harvest with harvest index (r=0.94*) and straw yield (r=0.92*). Number of leaves at harvest was positively associated with grain yield per hectare (0.97**) and straw yield per plant (r=0.75*). The results further revealed that, millet leaf area at harvest was positively associated with number of grains per panicle (r=0.96*), grain yield per plant (r= 0.89*) and grain yield per hectare (r=0.99**) and panicle diameter (r= 0.75*). There was significant correlation between number of grains per panicle and grain yield per plant (r=0.78*), grain yield per hectare (r=0.82*) and panicle diameter (r=0.88*) (Table 2). Number of panicles per plant was positively associated with grain yield per plant (r=0.98**) and grain yield per hectare (r=0.96*). Grain yield per hectare was positively associated with millet panicle diameter (r=0.92*), panicle weight (r=0.84*) and straw yield per plant (r=0.87*). Also, panicle diameter was significantly associated with straw yield per plant (r=0.69*) in 2016 cropping season (Table 2). There was no significant correlation among the other agronomic traits observed in 2016 cropping season.

The effect of intercropping pearl millet variety with cowpea variety on interrelationships among agronomic traits of pearl millet for the combined mean of 2015 and 2016 cropping seasons showed that, there was positive linear correlation among agronomic traits of pearl millet intercropped between the plant height at harvest and millet grain yield per plant (r=0.84*), grain yield per hectare (r=0.93*).

and straw yield per plant (r=0.76*)(Table 3). Number of leaves per plant at harvest was positively correlated with number of grains per panicle (r=0.91*), grain yield per plant (r=0.98**), grain yield per hectare (r=0.90*) and straw yield per plant (r= 0.63*). The effect of intercropping on pearl millet variety in combined mean showed that, millet leaf area at harvest was significantly correlated with number of grains per panicle (r=0.79*), grain yield per plant (r=0.87*), grain yield per hectare (r=0.96*), panicle diameter (r=89*) and straw yield (r= 0.70*), while grain yield per hectare was significantly correlated with panicle diameter (r=0.75*) and straw yield (r=0.81*). There was no significant linear correlation among the other agronomic traits determined for the combined mean (Table 3).

Interrelationships among Cowpea Variety Agronomic Traits

The response of cowpea varieties to intercropping with pearl millet varieties in 2015 cropping season showed that, there was significant linear correlation between plant height at harvest and fodder yield/ha (r=0.96*) (Table 4). Similarly, number of leaf branches at harvest was positively associated with number of pod per plant (r=0.99**), pod yield per plant (r=0.86*), grain yield/ ha (r=0.94*) and fodder yield/ ha (r=0.86*). Length of branches at harvest was positively correlated with number of pod per plant (r=0.93*) and pod yield per plant (r=0.80*), grain yield/ ha (r= 0.95*) as well fodder yield / ha (r=0.99**) (Table 4). There was significant linear correlation between number of pods per plant, pod yield per plant (r=0.81*) and grain yield / ha (r=0.90*). Pod yield per plant was positively associated with grain yield / ha (r=0.88*) and fodder yield / ha (r= 0.91*). No significant linear correlation was observed among the other agronomic traits determined for the cowpea component (Table 4).

The effect of intercropping pearl millet varieties on cowpea varieties on cowpea agronomic traits showed that, plant height at harvest was positively associated with pod yield per plant (r= 0.81*) and fodder yield/ ha (r=0.69*) (Table 5). However, number of branches at harvest was positively associated with number of pods per plant (r=0.89*), pod yield per plant (r=0.70*), grain yield/ ha (r=0.92*) and fodder yield/ ha (r=0.97**). Length of branches at harvest was positively associated with number of pods per plant (r=0.79*), grain yield/ ha (r=0.89*) and fodder yield/ ha (r=0.67*). Similarly, number of pods per plant was positively associated with pod yield per plant (r=0.72*) and grain yield/ ha (r=0.86*), while pod yield per plant was positively correlated with grain yield/ ha (r=0.90*) and fodder yield/ ha (r=0.84*). No significant linear correlation was observed among the other agronomic traits determined for the cowpea components during the 2016 cropping season (Table 5).

The effect of intercropping pearl millet + cowpea variety on cowpea traits for the combined mean showed that, there was positive correlation between the plant height at harvest and fodder yield/ ha (r=0.86*) (Table 6). Number of leaf branches at harvest was positively correlated with number of pods per plant (r=0.92 *), pod per plant (r=0.83*), grain yield/ ha (r=0.94*) and fodder yield/ ha (r=0.77*). Length of branches at harvest was positively associated with number of pods per plant (r=0.99**), pod per plant (0.77*), grain yield/ ha (r=0.98**) and also fodder yield/ ha (r=0.91*). Number of pods per plant was significantly associated with grain yield/ ha (r=0.90*) and fodder yield/ ha (r=0.89*). No significant correlation was observed among the other agronomic traits of the cowpea for the combined mean.

Table 1: Matrix correlation coefficients (r) showing association among some growth and yield related components of three millet variety intercropped cowpea varieties in 2015 cropping season

Plant trait		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	PHH														
2	NLSH	0.78*													
3	NTLS9	0.35	0.40												
4	LAH	0.43	0.37	0.42											
5	D50F	0.10	0.22	0.39	0.15										
6	NGPP	0.08	0.07	0.11	0.91*	0.07									
7	NPPH	0.03	0.02	0.83*	0.29	0.06	0.01								
8	HI	0.43	0.92*	0.96*	0.08	0.39	0.21	0.04							
9	GYP	0.45	0.17	0.95*	0.89*	0.35	0.09	0.88*	0.90*						
10	GY/ha	0.95*	0.21	0.99**	0.93*	0.21	0.91*	0.79*	0.99**	0.17					
11	TGW	0.29	0.18	0.17	0.33	0.20	0.11	0.39	0.36	0.42	0.21				
12	PLH	0.31	0.20	0.15	0.27	0.17	0.22	0.31	0.34	0.26	0.20	0.44			
13	PDH	0.46	0.33	0.93*	0.69*	0.25	0.97**	0.28	0.38	0.92*	0.34	0.21	0.11		
14	PWH	0.14	0.40	0.44	0.65*	0.48	0.20	0.16	0.48	0.85*	0.45	0.38	0.44	0.29	
15	SYPP	0.81*	0.85*	0.75*	0.94*	0.19	0.76*	0.24	0.36	0.77*	0.37	0.40	0.10	0.43	0.34

* Correlation is significant at 0.05 level (2- tailed), ** (2- tailed) is significant at 0.01 level (2- tailed).
Values without asterisk (s) have no significant linear correlation DF=22.
1.PHH=Plant height at harvest, 2. NLSH=Number of leaves at harvest, 3. .NTLS =Number of tillers /plant, 4. .LAH=Leaf area, 5. D50F=Days to 50% flowering, 6.NGPP=Number of grains/panicle, 7. NPPH =Number of panicle/plant, 8 HI=Harvest index, 9. GYP =Grain yield /plant, 10. .GY/ha=Grain yield/ hectare, 11.TGW =One thousand grain weight, 12 PLH=Panicle length at harvest, 13.PDH= Panicle diameter at harvest, 14 PWH= Panicle weight harvest, 15 SYPP=Straw yield/ plant

Table 2: Matrix correlation coefficients (r) showing association among some growth and yield related components of three millet variety intercropped cowpea varieties in 2016 cropping season

Plant trait		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	PHH														
2	NLSH	0.26													
3	NTLS9	0.38	0.01												
4	LAH	0.09	0.01	0.37											
5	D50F	0.24	0.28	0.05	0.35										
6	NGPP	0.05	0.06	0.84*	0.96*	0.05									
7	NPPH	0.29	0.21	0.43	0.38	0.11	0.20								
8	HI	0.94*	0.16	0.27	0.45	0.10	0.12	0.49							
9	GYP	0.05	0.01	0.98**	0.89*	0.19	0.78*	0.98**	0.22						
10	GY/ha	0.36	0.97**	0.94*	0.99**	0.12	0.82*	0.96*	0.30	0.45					
11	TGW	0.03	0.11	0.36	0.44	0.22	0.45	0.43	0.49	0.21	0.14				
12	PLH	0.09	0.01	0.28	0.16	0.42	0.36	0.42	0.43	0.13	0.28	0.33			
13	PDH	0.05	0.03	0.30	0.75*	0.18	0.88*	0.37	0.20	0.18	0.92*	0.25	0.20		
14	PWH	0.09	0.02	0.16	0.28	0.30	0.19	0.40	0.15	0.12	0.84*	0.40	0.38	0.17	
15	SYPP	0.92*	0.75*	0.24	0.49	0.43	0.37	0.39	0.27	0.11	0.87	0.17	0.01	0.69*	0.41

* Correlation is significant at 0.05 level (2- tailed), ** (2- tailed) is significant at 0.01 level (2- tailed).

Values without asterisk (s)s have no significant linear correlation, DF=22.

1.PHH=Plant height at harvest, 2. NLSH=Number of leaves at harvest, 3. .NTLS =Number of tillers /plant, 4. .LAH=Leaf area, 5. D50F=Days to 50% flowering, 6.NGPP=Number of grains/panicle, 7. NPPH =Number of panicle/plant, 8 HI=Harvest index, 9. GYP =Grain yield /plant, 10. .GY/ha=Grain yield kg/hectare, 11.TGW =One thousand grain weight, 12 PLH=Panicle length at harvest, 13.PDH= Panicle diameter at harvest, 14 PWH= Panicle weight harvest, 15 SYPP=Straw yield/ plant

Table 3: Matrix correlation coefficients (r) showing association among some growth and yield related components of pearl millet variety intercropped with two cowpea varieties for combined mean

Plant trait		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	PHH														
2	NLSH	0.16													
3	NTLS9	0.26	0.41												
4	LAH	0.43	0.37	0.25											
5	D50F	0.40	0.44	0.41	0.19										
6	NGPP	0.14	0.91*	0.90*	0.79*	0.38									
7	NPPH	0.36	0.44	0.38	0.16	0.25	0.05								
8	HI	0.16	0.13	0.18	0.49	0.09	0.13	0.39							
9	GYP	0.84*	0.98**	0.95**	0.87*	0.41	0.21	0.33	0.47						
10	GY/ha	0.93*	0.90*	0.99**	0.96*	0.12	0.16	0.42	0.45	0.20					
11	TGW	0.16	0.37	0.25	0.12	0.22	0.40	0.19	0.10	0.33	0.12				
12	PLH	0.08	0.13	0.49	0.33	0.17	0.39	0.25	0.10	0.25	0.17	0.16			
13	PDH	0.10	0.36	0.18	0.89*	0.45	0.09	0.33	0.13	0.31	0.75*	0.49	0.49		
14	PWH	0.10	0.44	0.32	0.26	0.48	0.25	0.40	0.28	0.41	0.15	0.48.	0.35	0.45	
15	SYPP	0.76*	0.63*	0.61*	0.70*	0.08	0.37	0.37	0.16	0.43	0.81*	0.05	0.04	0.32	0.16

* Correlation is significant at 0.05 level (2- tailed), ** (2- tailed) is significant at 0.01 level (2- tailed).
Values without asterisk (s)s have no significant linear correlation, DF=22.

1.PHH=Plant height at harvest, 2. NLSH=Number of leaves at harvest, 3. .NTLS9 =Number of tillers /plant, 4. .LAH=Leaf area, 5. D50F=Days to 50% flowering, 6.NGPP=Number of grains/panicle, 7. NPPH =Number of panicle/plant, 8 HI=Harvest index, 9. GYP =Grain yield /plant, 10. .GY/ha=Grain yield kg/hectare, 11.TGW =One thousand grain weight, 12 PLH=Panicle length at harvest, 13.PDH= Panicle diameter at harvest, 14 PWH= Panicle weight harvest, 15 SYPP=Straw yield/ plant

Table 4: Matrix correlation coefficient (r) of cowpea agronomic traits as influenced by cowpea varieties intercropped with pearl millet varieties in 2015 cropping season

Plant trait	1	2	3	4	5	6	7
1 .PPH	-						
2.NLBS.	0.38	-					
3. LBH	0.49	0.14	-				
4.NPYP	0.47	0.99**	0.93*	-			
5.PYP	0.30	0.86*	0.80*	0.81*	-		
6.GYPH	0.28	0.94*	0.95*	0.90*	0.88*	-	
7.HGW	0.38	0.28	0.15	0.22	0.30	0.33	-
8.FYPH	0.96*	0.86*	0.99**	0.26	0.91*	0.22	0.19

*Correlation is significant at (P<0.05) level (2- tailed), ** Correlation is significant (P<0.01) (2- tailed).Values without asterisk (s) have no significant linear correlation. D.F. = 22

1 .PPH= Plant height, 2.NLBS= Number of branches 3. LBH= Length of branches, 4.NPYP= Number of pods per plant, 5 PYP= Pod yield per plant, 6 GYPH= Grain yield (Kg/ha), 7 HGW= Hundred grain weight, 8 FYPH= Fodder yield (kg/ha)

Table 5: Matrix correlation coefficient (r) of cowpea agronomic traits as influenced by cowpea varieties intercropped with pearl millet varieties a in 2016 cropping season

Plant traits	1	2	3	4	5	6	7
1 .PPH	-						
2. NLBS	0.25	-					
3. LBH	0.36	0.27	-				
4.NPYP	0.33	0.89*	0.79*				
5.PYP	0.81*	0.70*	0.45	0.72*			
6.GYPH	0.39	0.92*	0.89*	0.86*	0.90*		
7.HGW	0.29	0.16	0.35	0.24	0.30	0.12	
8.FYPH	0.69*	0.97**	0.67*	0.13	0.84*	0.17	0.05

*Correlation is significant at (P<0.05) level (2- tailed), ** Correlation is significant (P<0.01) (2- tailed). Values without asterisk (s) have no significant linear correlation. D.F = 22 1 .PPH= Plant height, 2.NLBS= Number of branches 3. LBH= Length of branches, 4.NPYP= Number of pods per plant, 5 PYP= Pod yield per plant, 6 GYPH= Grain yield (Kg/ha), 7 HGW= Hundred grain weight, 8 FYPH= Fodder yield (kg/ha)

Table 6: Matrix correlation coefficient (r) of cowpea agronomic traits as influenced by two cowpea varieties intercropped with pearl millet varieties and four cowpea sowing dates for the Combined mean

Plant trait	1	2	3	4	5	6	7
1 .PPH	-						
2.NLBS.	0.27	-					
3. LBH	0.10	0.08	-				
4.NPYP	0.07	0.92*	0.99**	-			
5.PYP	0.47	0.83*	0.77*	0.45	-		
6.GYPH	0.06	0.94*	0.98**	0.90*	0.15	-	
7.HGW	0.13	0.19	0.06	0.04	0.10	0.24	-
8.FYPH	0.86*	0.77*	0.91*	0.89*	0.17	0.11	0.07

*Correlation is significant at (P<0.05) level (2- tailed), ** Correlation is significant (P<0.01) (2- tailed). values without asterisk (s) have no significant linear correlation. D.F. = 22

1 .PPH= Plant height, 2.NLBS= Number of branches 3. LBH= Length of branches, 4.NPYP= Number of pods per plant, 5 PYP= Pod yield per plant, 6 GYPH= Grain yield (Kg/ha), 7 HGW= Hundred grain weight, 8 FYPH= Fodder yield (kg/ha)

DISCUSSION

The linear relationship among agronomic traits of pearl millet varieties intercropped with cowpea indicated that most of the growth characters studied had significant and positive linear correlation with grain yield. Similarly, most of the yield components studied had significant and positive

correlation with grain yield. These suggests that the characters contributed positively towards the yield of pearl millet. The positive linear relationships among grain yield/ hectare, grain yield /plant, harvest index, leaf area, number of grains/panicle, number of leaves/plant and number of panicles /plant were the major determinants of the superior grain yield. Changhani and Odo (2005) reported that higher values of grain yield indicate successful capture of growth resources early during the season. In similar findings by Dugje and Odo (2006a), reported that leaf area index, effective grain filling duration and number of grains are positive contributors towards increase in grain yield of pearl millet.
The linear relationships revealed that all agronomic traits of cowpea contributed positively to both plant and plot yield. There was simultaneous increase in plant height, length and number of branches with increase in grain and fodder yield/hectare. This also suggests that the growth traits contributed positively towards the yield of cowpea in the combined mean. The greater plant height and numbers of branches of cowpea in association with pearl millet is an indication of competition for light. Okigbo and Greenland, (1978), reported enhanced transmission of light to shorter crop for longer period before canopy closure of the main crop. The sparse canopy of these short pearl millet varieties allow more light penetration and subsequent interception by the cowpea understory. These complementary relationships imply minimum competition in the system. Olufajo and Singh (2008) reported enhanced transmission of light to shorter crop for longer period before canopy closure of the main crop enhanced the growth component of the crop system. The significant grain yield of cowpea variety relative to could be associated with its higher number of branches and longer branches, which promoted number of pods per plant.

CONCLUSION AND RECOMMENDATION

The correlation matrix of the varieties in two – cropping season and the combined mean showed that any increase in such character as number of leaf, leaf area, length of branches, number of branches will result to a corresponding increase in total grain yield of the pearl millet and cowpea varieties. Based on the result from the correlation analysis selecting of any pearl millet and cowpea varieties with higher leaf area and number of tillers, panicle diameter, panicle weight, longer length and number of branches, higher pods and grain yield/ hectare is the best for intercropping system.

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UNDER-UTILIZATION OF PINEAPPLE AND ORANGE GENERATED WASTE: BIOACTIVE COMPOSITION, ANTIOXIDANT ACTIVITIES AND REVENUE GENERATING POTENTIALS

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ABSTRACT
Pineapple and orange waste contributes substantially to food loss and waste generated globally at processing and consumption stages, they also constitute 29-40% and 50-55% of fresh fruit weight respectively and are often discarded despite observed nutraceutical and therapeutic values. The objective of this research was to analyze bioactive composition, antioxidant activities and provide recommendations for improving and facilitating orange and pineapple waste processing at domestic and industrial level. Highest free radical scavenging activity was observed in pineapple peel (46.93% and 52.14%) for ABTS and DPPH assays respectively. Higher total phenolic content was observed in orange peel and core as compared to pineapple waste. Concentrations of total phenol, total flavonoid and DPPH for pineapple waste were significantly different. This study faulted slow acceptance and adoption of research findings from researchers by food processing industries as a major factor affecting revenue generation and perspective of populace towards fruit generated waste.
Keywords: *Bioactive composition, food loss and waste, orange waste, pineapple waste, revenue generation*

INTRODUCTION

Pineapple (*Ananas comosus*) and orange (*Citrus sinensis*) are widely grown and consumed fruits the world over with estimated annual production of 25.4 million metric tons (Hikal et al., 2021) and 54.3 million tons (Mahato et al., 2019) respectively. Sub-Saharan Africa accounted for an estimated 21% food loss and waste on farm during harvest, storage, transport, wholesale and processing levels (FAO, 2022). Waste to wealth initiative has driven scientist and enthusiast alike to seek innovative ways of processing food waste into re-usable and marketable goods such as pineapple peel wine (Zhang et al., 2020). However, despite research findings and breakthroughs in areas of value addition for food waste, food processing industries has been particularly slow in accepting and adopting these findings. Horticultural fruits are characterized by relatively short shelf life as compare to cereal and tuber crops, they contribute significantly to global challenge of food loss and waste generated at processing and consumption stages. Pineapple peel constitutes 29-40% (w/w) (Zhang et al., 2020) while orange waste constitutes 50-55% (w/w) of fresh fruit (Suri et al., 2022). This implies that an equivalent 7.37 million metric tons of pineapple and 27.15 million tons of orange is wasted annually. As such the aim of this research is to analyze bioactive composition, antioxidant activities and provide recommendations for improving and facilitating orange and pineapple waste processing at domestic and industrial level.

MATERIALS AND METHODS

Total phenolic content

Total phenolic content was determined using method by (Patil et al., 2015).

Total flavonoid content

This was determined using method adopted by (Kumar et al., 2008).

Antioxidant activity using ABTS+ (2,2-azino-bis-(3-ethylbenzothiazoline-6-sulfonic acid))

ABTS (2,2-azino-bis-(3-ethylbenzothiazoline-6-sulfonic acid)) radical scavenging activity was conducted according to method adopted by (Dudonné et al., 2009).

$$\%\ \mathbf{Scavenging} = ((Ac - As)/Ac)\ X\ 100$$

Ac = Absorbance of control As = Absorbance of sample

Free radical scavenging using DPPH assay

Antioxidant activity using 2,2-diphenyl-1-picryhydrazyl (DPPH) assay was done according to method by (Naveen Kumar et al., 2013).

$$\% \text{ Scavenging} = ((Ac - As)/Ac)\ X\ 100$$

Ac = Absorbance of control As = Absorbance of sample

Statistical analysis

Data was analyzed using statistical package for social science (SPSS) to perform one-way analysis of variance (ANOVA) to identify significant differences at a 95% confidence interval level.

RESULT

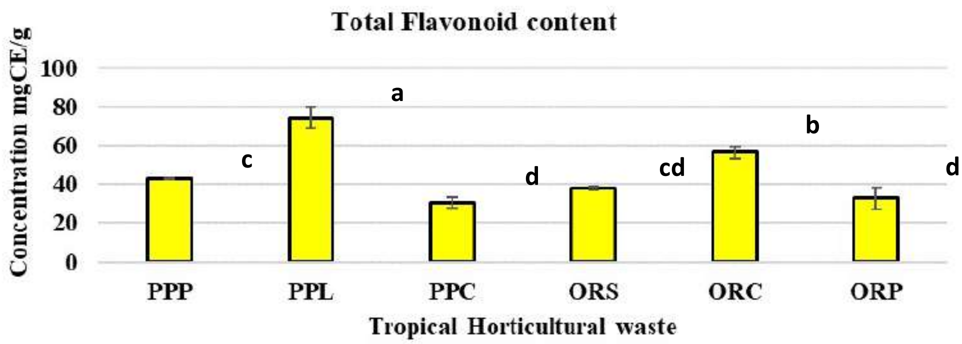

Figure 1: Total flavonoid concentration of pineapple and orange fruit waste.

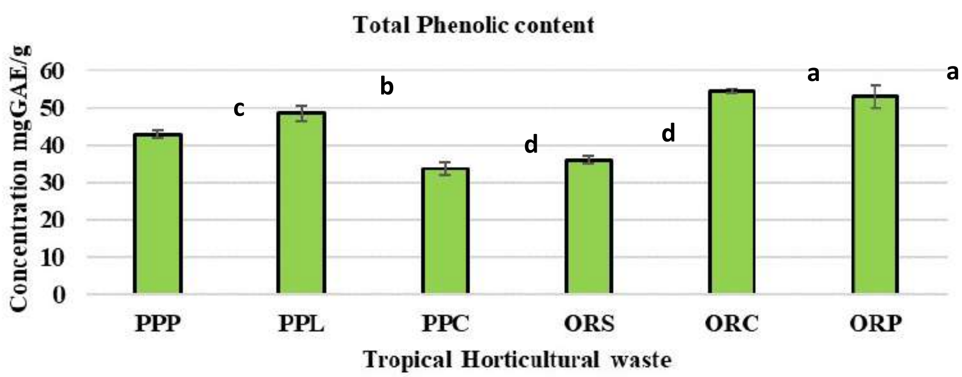

Figure 2: Total phenolic concentration of pineapple and orange fruit waste.

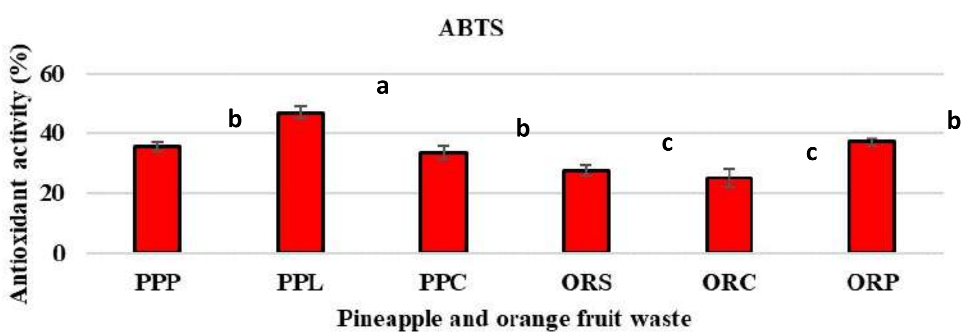

Figure 3: Antioxidant activity of pineapple and orange fruit waste using ABTS+ assay.

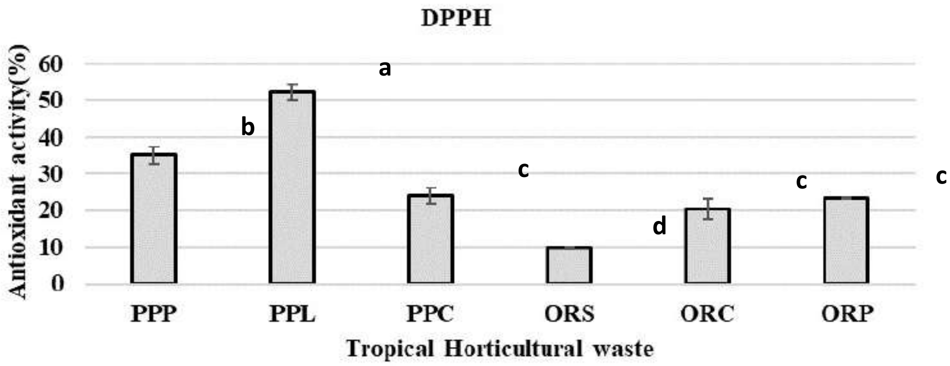

Figure 4: Antioxidant activity of pineapple and orange fruit waste using DPPH Assay.
KEY: TFC= Total flavonoid content, TPC= Total phenolic content, PPP= Pineapple pulp, PPL= Pineapple peel, PPC= Pineapple core, ORS= Orange seed, ORP= Orange peel, ORC= Orange core, DPPH= 2,2-diphenyl-1-picryhydrazyl and ABTS= 2,2-azino-bis-(3-ethylbenzothiazoline-6-sulfonic acid)

DISCUSSION

Highest free radical inhibition 46.93% and 52.14% was observed in Pineapple peel (PPL) for ABTS and DPPH assays respectively as compared to orange generated waste. Higher concentration of total flavonoid, total phenolic content, and antioxidant activities were also observed in pineapple peel as compared to pineapple core and is in accordance with deduction by Lasunon *et al.* (2022). Significant difference was observed in total phenolic and total flavonoid concentrations of pineapple peel, seed and core. Highest concentration of flavonoid were also observed in peels of pineapple as compared to other waste generated from parts of pineapple and orange while orange waste particularly peel and core showed higher phenolic concentration as compared to pineapple generated waste. Findings of this research highlights the bioactive and antioxidant benefits of pineapple and orange waste. As such, incorporation of pineapple and orange waste is encouraged during food processing to maximize their nutraceutical and therapeutic values. Findings by Wu & Shiau (2015) indicates that varying the particle size of pineapple peel fiber can be used to alter the rheology of dough as desired.
These findings are applicable in other fiber rich fruits such as orange (Akubor et al., 2023) towards improving physical condition, overall acceptability, shelf-life and reducing cost of production for cakes, snacks, bread and other areas of food processing where dough is applicable. Incorporating waste from orange and pineapple as supplement, primary or secondary raw material in food processing is highly recommended.

CONCLUSION

Despite increased awareness on nutritional and therapeutic benefits of different fruit waste, its utilization has been particularly low. The path of revenue generation through value addition of horticultural waste is still relatively unchartered as such, there is need for higher adoption of research findings on waste utilization by food processing industries as this would significantly increase the demand for fruit waste leading to increased revenue generation, reduced unit cost of production, and also encourage populace to see and accept parts of fruits such as seeds, peels, pomace and core as fruit parts of immense value and not waste.

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IRON ETHYLENEDIAMINETETRAACETIC ACID AND MYO-INOSITOL ARE ESSENTIAL FOR MICROPROPAGATION OF *Bryophyllum pinnatum*

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ABSTRACT
Bryophyllum pinnatum is very rich in phytochemicals useful for human health as well as serve as ornamental plant. The role of iron ethylenediaminetetraacetic acid and Myo-inositol for rapid micropropagation B. pinnatum was investigated. Leaf explants of B. pinnatum were surfaced sterilized and cultured on Murashige and Skoog basal media with FeEDTA complex (MS) or without FeEDTA complex (MS-FeEDTA), and without Myo-inositol (MS-MI) in a completely randomised design (CRD) in triplicates. The leaf explants were monitored for colour changes until 21 days after culture (DAC). The results showed that leaf explants cultured on MS supplemented with FeEDTA complex had greenish leaves when compared to MS without FeEDTA complex, and MS without Myo-inositol with stunted leaves. All micropropagated B. pinnatum on MS media acclimatized successfully. The addition of micronutrient (FeEDTA complex) and vitamin (Myo-inositol) to micropropagation media is therefore necessary for plant growth and development.
Keywords: *Bryophyllum pinnatum, medicinal plants, micronutrients, plant growth hormones, plant tissue culture, vitamins*

INTRODUCTION

Bryophyllum pinnatum also known as *Kalanchoe pinnatum* belongs to the family Crassulaceae. It is a perennial herb commonly called Air plant in English language but is also known as Divine herb, Wonder of the world and Mexican love plant (Pattewar, 2012). The plant originated from Madagascar and has been found to thrive in temperate regions of the world such as in Asia, Australia and New Zealand (Latif *et al.*, 2019). It is a very useful medicinal and ornamental plant species having all parts from shoot to root utilized globally. Quazi *et al.* (2011) reported the use of the leaf extracts in treatment/management of various diseases such as chicken pox, epilepsy, rheumatoid arthritis, psychiatric disorders and abdominal-related disorders (Sadhana *et al.*, 2017). Pharmacologically, it has been reported to possess antibacterial, antimicrobial, antifungal, anti-inflammatory, analgesic, antihypertensive, anti-cancer, antioxidant and antidiabetic properties (Latif *et al.*, 2019). It is also indicated in prevention of premature labour in pregnant women in Southeast Nigeria (Gupta *et al.*, 2016). Rapid micropropagation allows for quick selection of cultivars showing desirable traits of interest. The nutritional medium can be carefully determined with optimum key elements and composition. Due to its relatively partial solubility, Iron III (Fe^{3+}) is being used in chelated forms as ethylenediaminetetraacetic acid (Fe-EDTA) in micropropagation medium (Nikulina *et al.*, 2020). Iron is introduced into the medium in its hydrated sulphate form ($FeSO_4.7H_2O$) in a mixture with sodium ethylenediaminotetraacetic acid (Na_2EDTA) in the following equation;

$$FeSO_4.7H_2O \quad + \quad C_{10}H_{14}N_2Na_2O_8 \longrightarrow C_{10}H_{12}FeN_2O_8 + Na_2SO_4 + 8H_2O$$

The purpose of the study was therefore to evaluate the importance of Iron ethylenediaminetetraacetic acid (FeEDTA Complex) and myo-inositol in micropropagation of *Bryophyllum pinnatum*.

MATERIALS AND METHODS

Media composition and preparation

Murashige and Skoog (1962) media composition (MS) or without FeEDTA complex i.e. Stock group III (MS-FeEDTA) and Myo-inositol were used for the experiment as shown in Table I following the methods of Esuola and Olusoji (2021). The media also consists of 3% table sugar as carbohydrate and energy source and 10 mg L^{-1} Ascorbic Acid. The pH of the medium was adjusted to 5.8 with few drops of NaOH and HCl. The medium was solidified with 0.7% purified agar tissue culture grade and melted in a microwave oven. The medium (20 ml each) was dispensed into 50 ml baby food jars and autoclaved at 121ºC for 15 min.

Plant Materials

Bryophyllum pinnatum young leaves were collected from fully grown plants at the Floriculture Garden, National Horticultural Research Institute (NIHORT), Ibadan, Nigeria.

Explants surface sterilization

The young leaf pieces were subjected to surface sterilisation steps by first washing under running tap water with few drops of detergent for 1 hour in food jars. Each leaf was sectioned into about 4-6 pieces, each section was about 1 cm long and used as explants. The explants were transferred to the laminar flow chamber and following aseptic conditions they were washed with 70 % Ethanol for 5 min, followed by washing with 3 % of sodium hypochlorite (3.5 v/v) for 10 min with few drops of detergent. Finally, the explants were rinsed thoroughly three times with sterile double distilled water.

Growth culture conditions

The sterilized leaf explants (20 explants per treatment) were dissected to about 1 cm each using sterilised scalpel and blade holder. The explants were each placed into the sterile medium in the baby food jars. The culture tubes were sealed using parafilms and incubated in the growth room at the temperature of 25ºC $\pm$ 2ºC with fluorescent tubes providing light. Morphological changes on the leaf colour changes were observed 21 days after culture (DAC).

RESULTS AND DISCUSSION

B. pinnatum leaf explants regenerates well in the (MS) medium, as well as proliferates well in the plant growth hormone supplemented medium (Fig. 1A and Fig. 2A). The leaves were greenish in this medium. Esuola and Olusoji, 2021 recently observed a similar leaf colour changes in MS media supplemented with iron complex and suggested a possible ability of the plant to photosynthesize in this medium and compared to media with iron complex. It was also observed that media without iron complex did not support a good plant morphology as most of the plants had stunted growth (Fig. 1B and Fig. 1C). Hence, addition of iron complex and Myo-inositol are vital agents to support the plant growth during micropropagation procedures. All the plants acclimatized successfully in the humidity chamber after the micropropagation steps (Fig. 2D).

CONCLUSION

Bryophylum pinnatum could be used as a model crop for plant tissue culture investigations, as the plant can easily grow in test tubes using the leaf explants. This research has paved ways to understand the importance of iron complex and Myo-inositol as well as macro- and micro- nutrients for in vitro micropropagation of horticultural crops.

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Figure 1: *B. pinnatum* whole plant leaf colour changes 21 days after culture (DAC). (A) leaves remained greenish in MS medium with Fe-EDTA complex (MS), (B) leaves turned yellowish in MS medium without Fe-EDTA complex (MS-FeEDTA)_, and (C) leaves turned variegated in MS medium without Myo-inositol (MS-MI). All scale bars = ~ 1 cm.

Figure 2: *B. pinnatum* whole plant supplemented with plant growth hormones at 21 days after culture (DAC) . (A) MS medium with Fe-EDTA complex (MS), (B) MS medium without Fe-EDTA complex (MS-FeEDTA), (C) MS medium without Myo-inositol (MS-MI), and (D) acclimatized *B. pinnatum* plants at the humidity chamber.

Table I: Murashige and Skoog (1962) [MS] Media Composition

Type of Stock	Components	Chemical formula	Amount (mg/L)
MS group I (Macro-elements)	Potassium Nitrate	KNO_3	1900
	Ammonium Nitrate	NH_4NO	1650
	Calcium Chloride	$CaCl_2$	332.02
	Magnesium Sulfate	$MgSO_4$	80.70
	Potassium Phosphate	KH_2PO_4	170
MS group II (Micro-elements)	Manganese Sulfate	$MnSO_4 \cdot H_20$	16.90
	Potassium Iodide	KI	0.83
	Sodium Molybdate	$Na_2MoO_4 \cdot 2H_2O$	0.25
	Zinc Sulfate	$ZnSO_4 \cdot 7H_2O$	8.60
	Boric Acid	H_3BO_3	6.2
	Cobalt Chloride	$CoCl_2 \cdot 6H_2O$	0.025
	Cupric Sulfate	$CuSO_4 \cdot 6H_2O$	0.025
MS group III (FeEDTA complex)	Ferric Sulfate	$FeSO_4 \cdot 7H_2O$	27.80
	Sodium EDTA	Na_2EDTA	37.26
MS group IV (Vitamins)	Glycine (amino acid)		2.00
	Thiamine HCl		0.5
	Pyridoxine HCl		0.5
	Nicotinic Acid		0.5
	Myo-inositol		100

FUMONISIN: DETECTION AND IMPLICATIONS FOR HORTICULTURE AND HEALTH

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ABSTRACT
Fumonisin are mycotoxins recently reported from horticultural crops and pose as serious health threats to humans and animals. Fumonisin was first isolated from Fusarium verticilloides which is responsible for fusarium ear rot in maize and thereafter, it was isolated from other fungi such as Aspergillus niger. Fumonisin can be detected from crop plants by high performance liquid chromatography (HPLC) and mass spectrometry (MS). Fumonisin prevalence is relatively high in humid and hot weather conditions, thus leading to decrease yield and quality of horticultural crops. The implications of fumonisin to human health and horticultural crops are hereby highlighted. This will assist conscious research efforts for the preventive measures of fumonisin producing plant pathogens in horticultural crops.
Keywords: *Fumonisin, Fusarium verticillioides, High performance liquid chromatography (HPLC), mycotoxin, vegetables*

INTRODUCTION

Contamination caused by fumonisin is one of the major mycotoxins found in plant crops which adversely affected human and animal health as well as causes substantial economic losses (Li *et al*., 2023). According to the experts of Food and Agriculture Organisation (FAO) of the United Nations, an estimation of 25% of the world's food crops are lost each year as a result of mycotoxin contamination, with the *Fusarium* species significantly contributing to food contamination (Waskiewicz *et al*., 2012). Fumonisin are a class of toxic secondary metabolites which are synthesized by several *Fusarium* species. Fumonisin are stable to heat and are also water soluble type of mycotoxin (Mostrom, 2016). In 1988, the first isolation and characterization of fumonisin which is a food borne carcinogen that naturally occur in maize was performed in South Africa (Marasas, 1995). The mycotoxin, fumonisin B1 and B2 were isolated from the cultures of *F. verticillioides* MRC 826 at the programme on Mycotoxin and Experimental Carcinogenesis of the Medical Research Council in Tygerberg in South Africa, this isolate was reported to be responsible for the outbreak of equine leukoencephalomalacia (ELEM) in South Africa in 1970, causing porcine pulmonary edema (PPE) syndrome in pig and liver cancer in rats (Marasas, 2001). Fumonisin are insoluble in non-polar solvents but soluble in polar solvents such as water and aqueous solutions of methanol and acetonitrile. Its pure compound is a white, hydroscopic powder that can dissolve in water (in which it is unstable), acetonitrile-water (in which it is stable) or methanol (Waskiewicz, 2012). The importance of fumonisin in horticultural crop, health, as well as its chemical structures are hereby highlighted to insights to its occurrence in major food crops and create awareness for future research.

Microorganisms producing fumonisin

Fumonisin was discovered as a mycotoxin produced mainly by *Fusarium monilifome* and *Fusarium proliferatum*, *Fusarium verticilloides* in maize (Keller *et al*., 1997, Voss *et al*., 2006). Also, the fungus *Gibberella fujikuroi* produces fumonisin B1 (FB1) which are structurally related mycotoxins (Won-Bo Shim, 1999). *Aspergillus nigri* also has been discovered to produce fumonisin but in this case fumonisin B2 [FB2] (Frisvad, 2007). A major producer of fumonisin which is a fungal pathogen *Fusarium verticilloides* of maize produces mycotoxin that negatively affect human and animal health (Brown *et al*., 2007).

Fumonisin in fruits and vegetables

Fumonisin has been seen to affect banana peel as a result of reactive oxygen species of which its imbalance leads to oxidative stress in banana peels leading to increase in fumonisin production in *F. proliferatum* in banana (Xie *et al*., 2023). Fumonisin mycotoxins were found in the African vegetable, morogo; also, different fumonisin producing species such as *Fusarium verticillioides*, *F. proliferatum* and some others were isolated from morogo vegetable (Van der Walt *et al*, 2006), this is so because the vegetable, morogo grows as a weed within the corn farm and so, it could be contaminated by the maize plant with *Fusarium* species producing fumonisin (Bezuidenhout *et al*., 2006). Fumonisin has also been discovered in dates, dried vine fruits, figs when they are infected with *Aspergillus niger* using reversed-plase high performance liquid chromatography/electrospray ionization-ion trap mass spectrometry (RP-HPLC/ESI-ITMS) (Varga *et al*., 2010). Tomato, tobacco, wheat among others have also been discovered to contain B1fumonisin, a secondary metabolite of *Fusarium* species found in these plants (Iqbal *et al*., 2023). *Aspergillus nigri* isolated from onions also produce fumonisin in onions (Massi *et al*., 2021). Interestingly, some horticultural crops have been found to be useful against fumonisin producing pathogens, such as turmeric, which works as an antioxidant for the protection of the liver in chicken (Galli *et al*., 2002). Also, cabbage has been discovered to give protection against fumonisin B1 (Abdual-shahid, 2013). Rosemary (*Rosemarinus officinalis L.*) essential oil (REO) had strong antifungal properties against *Fusarium verticillioides*, it has inhibitory and reducing effect on fumonisin and ergosterol production (Bomfim *et al*., 2015). Clove (*Syzygium aromaticus*) has proven to reduce fungal infections such as that of *Fusarium graminearum* and it is a potential preservative in the postharvest management. Bay leaf essential oil also shows antifungal effects but not as efficient as clove essential oil (Santamarina *et al*., 2016).

Fumonisin in health

The mycotoxin, fumonisin, has affected human and animal health. Initially, the fungus *Aspergillus niger* was discovered to be the producer of the carcinogenic fumonisin B2 (Frisvad *et al*., 2007) in vegetables. Fumonisin has been categorised by International Agency for Research on Cancer (IARC) as group 2B carcinogen and that the consumption of any food that contains this mycotoxin will lead to different sicknesses in both man and animal (Ahangarkani *et al*., 2014). Fumonisin can be detected in urine especially when people or animals are exposed to high concentration of fumonisin (Turner *et al*., 1999). It has also been discovered in breast milk (Mesfin, 2023). It is assumed that high concentration of fumonisin leads to neural tube defect (NTD) which is a birth defect of the brain and spinal cord since it causes equine leukoencephalomalacia (Voss and Riley, 2013). Apart from being a likely carcinogen in human, fumonisin B1 (FB1) has been identified to be toxic to the nervous system, liver and kidney in animals (Stockmann-Juvala and Savolainen, 2008). Fumonisin B1 is a non-genotoxic carcinogen which causes tumours by inducing atrophy, apoptotic necrosis and consequent regeneration (Dragan *et al*., 2001). Prenatal exposure to fumonisin can cause inflammation in strained muscles such as in the heart, and skeletal muscles of wistar rat (Tomaszewska *et al*. 2023). When feed contaminated with fumonisin and aflatoxin are eaten they lead to adversely affected process of growth in nursery pigs (Deng *et al*. 2023). Histological lesions in the liver of chicks have also been discovered as a result of their consumption of feed contaminated with fumonisin (Weibking *et al*., 1993).

Structure and chemical characterization of fumonisin

The fungus *Fusarium verticillioides* which infects maize plants produces mycotoxins formed from polyketide known as fumonisin (Bojja *et al*., 2004). Fumonisin B1 with the molecular formula $C_{34}H_{59}O_{15}$ has two of its polyhydroxy side group esterified with propane tricarboxylic acid (Pitt, 2014). Fumonisin has structure similar to that of spingolipid's sphingoid base backbone (Pitt, 2014). The most common fumonisin forms are the B forms and C forms (which are similar to B forms but only differing in the absence of the terminal methyl group) have been discovered in maize (Pitt, 2014) [Fig. 1]. The A and P forms also have been isolated from pure fungal cultures, but are very rare (Pitt, 2014) [Fig. 1]. Fumonisin B1 (which makes up to 80% of the total fumonisin content in *Fusarium verticillioides* cultures) has the empirical formula of $C_{34}H_{59}NO_{15}$; this mycotoxin happens to be a diester of propane-1,2,3-tricarboxylic acid and 2-amino-12,16-dimethyl-3,5,10,14,15-pentahydroeicosane (WaÅkiewicz, 2012).

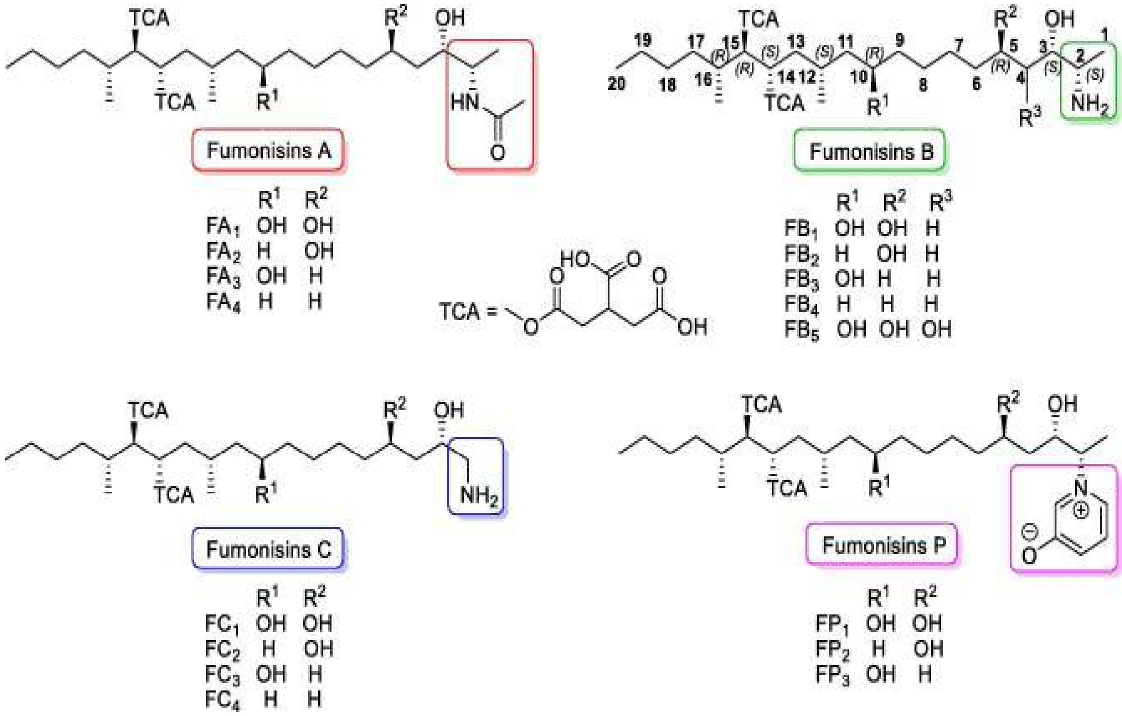

Figure 1: Different structures of fumonisin (Ocampo-Acuna *et al*., 2023).

CONCLUSION

Fumonisin is a mycotoxin have been detected in some important horticultural crops and is a leading cause of human and animal diseases. Therefore, more research work should be done on how to reduce fumonisin producing pathogens of horticultural crops for a healthier world.

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EFFECTS OF SEED SCARIFICATION AND HORMONE SUPPLEMENT IN GROWTH MEDIA ON THE IN-VITRO GERMINATION OF *CITRUS SINENSIS (SWEET ORANGE)*

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ABSTRACT
In vitro germination technique helps in achieving clean, healthy, fast growing, and nutritious plants. Sweet orange (Citrus sinensis) is a major source of vitamin C, sufficient amount of folacin, calcium, potassium, thiamine, niacin and magnesium. The aim of the research was to develop a protocol for in vitro germination of Citrus sinensis seeds using media with and without hormone supplements. The result indicates that citrus seeds that was scarified before inoculation performed better than citrus seeds that were unscarified before inoculation. Control media supported the germination rate than media susplemented with hormones. The number of roots, shoot/height, and leaves when observed in media without hormones performed better than the media with hormone. Contamination rate was low in the control media than the media with hormone. In conclusion, citrus seeds in vitro germination is achievable when the seeds are scarified prior to inoculation in the media without hormone supplements.
Keywords: *Citrus sinensis, plant growth hormones, micro propagation, scarification, germination,*

INTRODUCTION

Citrus species are among the most commercial fruit crops of the world, cultivated in more than 100 countries (Barlass and Skene, 1999). Citrus is widely grown In Nigeria and many other tropical and subtropical regions (Piccinelli *et al*., 2008). Citrus ranks after banana as the world second fruit crop with more than 108 million tons (FAO Statistics 2006). Sweet orange (*Citrus sinensis* L. Osbeck) commonly called orange is a member of this family and a major source of vitamins, especially vitamin C, sufficient amount of folacin, calcium, potassium, thiamine, niacin and magnesium (Angew, 2007). Citrus fruits are also known for their fine flavor, nutritional quality and medicinal value (Ani and Abel 2018). According to UN 2007 data, India is the largest producer of lemons and limes in the world and ranks sixth in the production of citrus fruits. Citrus fruits are mainly produced in coastal areas of numerous countries as well as in the Mediterranean region. *Citrus sinensis* is a member of family Rutaceae, commonly known as navel orange, sweet orange and Malta in Uttarakh and, India (Christman, 2003). *C. sinensis* is a small evergreen tree having 7.5 m height and sometimes reached up to 15 m. Many biologically active, non-nutrient compounds found in citrus fruits such as antioxidants (Tripoli et al., 2007), soluble and insoluble dietary fibres (Ejaz et al., 2006) known to be helpful in reducing the risk for cancers (Elangovan et al., 1994). Many chronic diseases like arthritis; obesity (Walton et Al., 1945) and coronary heart disease (Crowell, 1999). A single orange is said to have about 170 phytonutrients and over 60 flavonoids with anti-tumor, anti-inflammatory, blood clot inhibiting and antioxidant properties (Etebu and Nwauzoma, 2014). Due to high vitamin C content and antioxidant potential of *C. sinensis*, it is consumed worldwide, therefore, considered as one of the major commercial fruit crops of the world (Kiong et al., 2008).
However, the cultivation of *C. sinensis* is difficult due to slow growth, short storage life (Mukhtar *et al*., 2005) Further, citrus stands among difficult to root crops (Usman et al., 2005) and their seeds have a very short life because they are injured by drying during storage and thus, lose their viability (Johnston, 1968; Ali and Mirza, 2006). This study aimed to develop a protocol for in-vitro germination of *C. sinensis*.

MATERIALS AND METHODS

Plant material and explant preparation

Sweet oranges were obtained from the National Horticultural Research Institute, Ibadan, Oyo State. The seeds were extracted by removing the pulp adhering to the seeds. The seeds were washed with running tap water. Seeds were then subjected to floating test as described by Pandey and Tamta (2013), healthy and viable seeds were selected and washed with a few drops of tween 20, a laboratory detergent, for 1 hr; followed by five times rinsing in distilled water. The seeds were dipped in 70% ethanol for 5 min followed by three times rinsing in autoclave distilled water. The seeds were also dipped in 10% hypochlorox for 10 min followed by three times rinsing in autoclave distilled water. Afterwards they were placed in the laminar flowhood for inoculation. Four seeds were scarified to compare the growth rate between the non-scarified.

Culture media

Control Media: The nutrient medium consisted of Murashige and Skoog (MS; Murashige and Skoog, 1962) 2.215 g fortified with 15 g sucrose, myo-inositol is 0.0625 g, having pH adjusted to 5.8 with 1 N NaOH and solidified with 1 g phytagel. The prepared media were autoclaved (in 1.05 Kg cm^{-2}, 121°C for 20 min).

Media with Hormones: The nutrient medium consisted of Murashige and Skoog (MS; Murashige and Skoog, 1962) 2.215 g fortified with 15 g sucrose, myo-inositol 0.0625 g, Ascorbic acid 2.5ml, BAP 2ml, NAA 0.9ml. The pH was adjusted to 5.8 with 1 N NaOH or HCl and solidified with 1 g phytagel. The prepared media were autoclaved (1.05 Kg cm^{-2}, 121°C for 20 min).

RESULTS AND DISCUSSION

From our results in Table 1 and Figure 1 above, 50 citrus seeds each were inoculated into two separate media with different constituents (Control media and Hormone media). 25 of the citrus seeds of each media were scarified and the remaining 25 citrus seeds were not scarified. In the control media, the scarified 25 citrus seeds germinated while the remaining non scarified citrus seeds did not germinate as a result of the thick shell. These indicated that scarification of seeds helps in proper in vitro germination of citrus seeds. In the media containing hormones, 10 citrus seeds out of the 25 scarified citrus seeds germinated while the remaining 40 citrus seeds did not germinate. These indicate that control media supports citrus in vitro germination when compared with media suspended with hormones. The average number of rooting in the control media is 3 while that of the hormone supplemented media is 1. The average number of shooting/height for the control media is 1/3cm while for the hormone supplemented media is 0. The average number of leaves in the control media is 3 while for the hormone supplemented media is 0. The number of contaminated plants for the control media is 5 while for the control media is 8. The control media did much better than the media supplemented with hormones. Our result is the same with in vitro germination of *Telfairia occidentalis* which does not support addition of hormones (Akinyemi and Esuola, 2012).

Table 1: In vitro germinated *Citrus sinensis* at 21 days after treatment in the control and hormone supplemented media

Parameters	Control media	Hormone media
Number of seeds inoculated	50	50
Number of seeds scarified	25	25
Number of seeds non-scarified	25	25
Number of seeds germinated	25	10
Number of seeds not germinated	25	40
Average number of root/seedling	3	1
Average number of shoot/height	1/3cm	0
Average number of leaves	3	0
Number of contaminated plants	5	8

Figure 1: In vitro germinated citrus seeds at 21 days after inoculation in the control media.

CONCLUSION

In conclusion, media without hormones and prior seeds scarification support in vitro citrus seed germination compared to the media with hormones and un-scarified seeds.

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IMPACT OF OIL EXPLORATION ON SOIL, CLIMATE, COCOA BEANS PRODUCTION AND NIGERIA REVENUE: A REVIEW

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ABSTRACT
This paper review negative impact of crude oil exploration on soil, climate, cocoa bean production and Nigeria revenue. Reports showed that oil contributes about 80% foreign exchange earnings and mining causes continuous contamination of soil and climate change through oil spillage and gas flaring. Data on oil contaminated soil of 5, 10, and 20 year physico-chemical properties shows that mean pH value and TOC content were 8.02, 8.07, 8.68 and 2.46%, 3.31%, 4.56% higher than 7.86 and 2.13% of uncontaminated sites respectively while TN and TP contents of 1.17, 0.67, 0.84 g kg−1 and 0.37, 0.32, 0.26 g kg−1 respectively of the sites were significantly lower than 1.26 g kg−1 and 0.36 g kg−1 respectively in control sites. Available land and value of exported crops particularly cocoa bean further reduce through GHG emissions couple with failure of government policies from $611.800 in 2016 to $510, 825 in 2020 while oil revenue remain unstable. This review emphasized the comparative advantage which Nigeria has in cocoa cultivation as well as possible revenue from beans export through establishment of management programme that prevent soil contamination and air pollution.
Keywords: *Cocoa beans, Crude oil, foreign earnings, soil contamination, climate*

INTRODUCTION

The discovery of crude oil in 1956 changed Nigeria from being agrarian economy and oil became major export commodity and main source of foreign earnings. Nigeria has turned to oil revenue dependent nation and overall oil contribution to the economy grew from an insignificant 0.1% to about 80% since 1970 (Ibama and Eyenghe, 2015). The oil exploration has helped Nigeria in terms of infrastructural development but has adversely affected the climate and soil. It was estimated that above 7.0 billion cubic metres per year of natural gas is released into atmosphere through crude oil mining (GGFR, 2021) while soil and water contamination occurred through oil spillage from pipeline leakage, oil tanker accident and waste from refineries. Wang et al., (2010) report on physico-chemical properties of 5, 10 and 20 year-old crude oil contaminated soil increase mean pH and Total Organic Carboncontent (TOC) of oil wells sites were 8.02, 8.07, 8.68 and 2.46%, 3.31%, 4.56%, higher than 7.86 and 2.13% in uncontaminated sites respectively. Total Nitrogen (TN) were 1.17, 0.67, and 0.84 g kg−1 while Total Phosphorus (TP) were 0.37, 0.32 and 0.26 g kg−1) contents in polluted sites significantly ($p<0.05$) lower than (1.26 g kg−1 and 0.36 g kg−1 respectively) control sites. Also, Udoh and Chukwu, 2014 and Onwuka, *et al*., 2021 reports on pH, OC, N and P content of oil contaminated soil in Nigeria showed that these results may be from increase in soil residual hydrocarbon.

The rich soil resources and good climate weather condition in Nigeria before oil exploration made agriculture a source of employment to about 70% of the population, provide raw materials for industries, income for farmers and foreign exchange earnings from crops such as groundnut, cocoa, kola, sorghum, cotton, oil palm and others. Cocoa bean and by product contributed about 90% to Nigeria GDP in the 60s but this has decline gradually to about 0.13% in 2022 (Sekumade 2009; Punchng.com, 9 July 2023). The increase in foreign earning from sales of crude oil shift off focus from agricultural products and cocoa production in particular and reduced market trading as well as income from sales of cocoa (Table 1). Nigeria produced average of about 350 metric tonnes of cocoa beans in the 60s up to 70s but decreased to the range of 250-280 tonnes currently, which place it in the fifth position among Africa countries (Punchng.com, 2022). The reported decrease in cocoa production attributed to crude oil discovery was further linked to continuous depletion of soil nutrient through continuous pod harvest without fertilizer input coupled with failure of government policy among other factors such as inadequate storage facilities and migration of labour needed for harvesting and beans processing to the city (Ogunlade *et al.,* 2012) reduces quantity and quality of cocoa beans produce (Idowu *et al.,* 2007). Also, changes in weather condition through oil exploration has been reported to increase risk of crop pest and diseases which is one of major factors responsible for low quantity and quality of cocoa beans produced (FAO 2021, ICCO, 2015). Report by Orisajo and Dongo (2005) confirmed that pests and diseases are responsible for poor quality beans from the field and during storage. Therefore, government need to play major role in mitigating effect of oil exploration on climate, soil and insect pests infestation which will increase cocoa beans quantity and quality as well as revenue accrue from it sales.

Effects of oil discovery and dangling price on Nigeria revenue

Establishment of new industries and increase in the production of agricultural goods were experienced between 1950s and 60s because of greater attention given to farming. The story changed following the discovery of crude oil which becomes the major export commodity replacing agriculture as the main source of foreign earning (Sylvester Okotie 2018). Consequently, there was sudden decrease in agricultural produce such as rubber, sugar cane, kola and cocoa beans used as raw materials. This manifested in inadequate supply or non-availability of the produce and high market price which resulted to increase importation of the produce as materials to feed our industries. This has gradually brought setback to the operation of some and the total closure of many industries. This has remained irreversible because petroleum exploration continue to gain better backing of the government as their primary source of foreign exchange earnings (Fadipe *et al*., 2012, Adeogun *et al*., 2013). The high price of goods and services produced in Nigeria coupled with continuous and unpredictable fall in oil price per barrel has reduced the standard of living of the citizens. As a major exporter, Nigeria oil revenue (Table 2) remains unstable and tends often to fall as reflected in government budget estimation since the year 2014. Furthermore, the reduction in price and revenue derivable from oil for Nigeria and other countries has continued to decline with increasing advocacy for a shift to renewable energy due to negative effect of fossil fuel emission on climate. The gradual adoption as a means to mitigate effect on climate has reduced though minimal the demand for crude oil. Hence, increase in adoption will make oil price and Nigeria revenue to become more unstable.

Use of renewable energy to mitigate climate change and soil contamination caused by oil exploration

Oil spillage has increased through oil exploration and effects include destruction of farm land, reduction of crop produce, fish and other wildlife, pollution of sources of drinking and irrigation water such as stream, ponds, well, rivers and lakes (Ojimba, 2011). The negative effects of oil on soil chemical composition, structure and texture reduces fertility and available land for cultivation (Anna Klamerus-Iwan *et al*., 2015). Ojimba, (2011) reported increase in poverty level of farmers, especially cocoa farmer in the oil producing state due to soil contamination through oil spillage and air pollution by gas flaring with conclusion that oil exploration reduced income and impoverished farmer. Changes in the average weather condition further increases as a result of emission of greenhouse gases (such as CO_2, CH_4, O_3 etc) when using by-product of crude oil as sources of energy. These gases absorb heat, raise temperature of the ecosystem and reduce the quantity of radiation that is release to the outer space from the earth. The effects of these changes have been observed in rainfall pattern, temperature, relative humidity, sea level and insect pest infestation which affect cocoa production when it stands beyond recommended range (Table 4). There have been several campaigns on need and ways to mitigate climate change with emphasis on reduction of greenhouse gas (GHG) through adoption of alternative energy. Alternative Renewable Energy (ARE) comes from natural sources such as wind, biomass, water, and sun. This has become part of climate change program with focus on improving world economy, human standard of living and welfare (Finance and Development, 2019). The success of ARE in countries such China and Germany (Aparupa Pani, 2022) has placed it at the forefront in the process of mitigating effect of climate change. This has minimal effect on oil consumption and marketing but greatly benefit ecosystem through reduction in the quantity of carbon emission. As knowledge on ARE technology advances, oil price will continue to fall because supply of the commodity will meet gradual decrease in demand and would lead to reduction in exploration, soil contamination, air pollution as well as countries accrue revenue.

Prospect of cocoa production through government policy

It has been revealed that Nigeria has a high comparative advantage in soil and climatic requirement for cocoa production (Table 4). This has been reflected on quantity of cocoa beans and other cocoa product exported yearly compared to other crops (Table 3) and as such become necessary that government step up efforts in ensuring yield increase through rehabilitation of old cocoa plantations, establishment of new ones and clean-up of contaminated soil. Also, activities that encourage farmers to adopt new production, harvesting and processing technique through coordinated programmes of various agency of government to surpass the present export quantity and improve quality that will earn more foreign exchange to reduce dependent on oil revenue are important. Compared to other agricultural produce, cocoa beans have contributed larger percentage of revenue per quarter in 2020 to 2022 (Table 3), supporting economic growth of Nigeria. Cilas and Bastide, (2020), Ogunlade et al., (2012) and Orisajo and Dongo (2005) report among other findings decline in cocoa yield and ascribe this to depletion in soil nutrient, soil contamination, air pollution, insect pest infestation and migration of labour to city which are associated to increase oil exploration. Therefore, programmes that will protect the environment and encourage youth to stay in rural areas to take up farming business especially cocoa cultivation should be adopted through policies and act of government agencies and commissions such as ADP, FADAMA, NCDC etc. Report of Kenfack Essougong *et al.,* (2020) and Attipoe et al., (2020) revealed a positive relationship between cocoa output, soil fertility management, labour and farmer access to finance. Therefore, government institution should work on policy intervention gear towards management of soil in oil and non-oil producing states, provision of credit facility as well as educating farmer on the need for application of research findings on soil-water pollution and contamination remediation as well as adoption of scientific recommendations against insect pest infestation and improve soil fertility so as to increase cocoa production. Finally, guided scientific recommendations that will increase income generation from cocoa export, contribute to grow Nigerian economy and reduce its overdependence on oil export should be worked on.

CONCLUSION

Cocoa as agricultural product contributed significantly to Nigeria revenue and has been identified as major product among commodity of foreign exchange from non-oil export. There is need for policies toward adoption of recommendations on various good agricultural practices, soil contamination and air pollution management to increase cocoa bean production which will reduce effect of crude oil unstable price on Nigeria economy and exploration on air and soil. Therefore, it will be a great achievement, if government could sustain existing and as well make new policies that eliminate constrains in cocoa production to achieve higher yield and revenue.

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Table1: Agricultural contribution, cocoa production and Nigeria revenue from 2013-2021

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021
Agricultural produce Contribution to GDP	20.80	20.00	20.60	21.00	20.80	21.20	21.90	24.10	23.36
Cocoa production Tonnes (000)	248	195	200	245	250	270	250	290	280
Mean cocoa price $/annum	2701.7	2035.2	2241.0	2746.6	2034.1	2172.5	2374.9	2370.7	2348.6
Cocoa beans revenue ($1000)	420.00	512.12	460.00	611.80	598.19	567.75	602.64	510.82	-

Source: *datawolrdbank.org, www.statista.com/statistical/report-content/statistidatadata 2022*

Table 2: Price in world market, Nigeria budget benchmark and accrue oil revenue since 201

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
World market Oil price $/barrel	75.49	88.04	104.7	110.8	93.58	47.00	29.99	49.99	63.25	52.29	57.92	51.36
Nigeria oil price ($) Budget benchmark	57	65	72	75	77.5	53	38	42.5	51	60	28	57
Nigeria oil revenue $billion	59.00	68.44	62.84	58.00	54.55	24.79	17.06	20.98	32.63	34.22	20.43	41.38

Source: *datawolrdbank.org*

Table 3: Top agricultural produce export value from first quarter 2020 to third quarter 2022 (N'billion)

Year /Quarter	Cocoa bean	Cashew nut	Sesame Seed	coconut	Ginger	Frozen sea food	Brasil nut shell	Cocoa butter	Sesame oil	Palm nuts and kernel
2022										
3	30.76	10.43	19.79	-	2.94	5.79	-	2.38	-	-
2	27.73	53.15	25.04	7.28	4.59	2.77	0.57	5.63	0.64	1.35
1	85.79	14.31	56.45	9.30	6.41	3.94	3.28	3.16	1.29	2.36
2021										
4	72.84	5.76	40.71	-	1.19	5.11	-	0.65	0.24	-
3	27.25	10.38	11.13	1.63	15.89	6.85	1.96	0.42		-
2	54.79	37.29	21.63	11.29	2.43	2.55	-	2.44	1.29	-
1	32.21	10.48	41.94	8.66	3.47	1.30	-	1.19	3.42	2.75
2020										
4	9.89	5.27	27.29	1.18	0.62	0.18	-		4.42	1.18
3	11.42	16.66	15.60	0.97	0.56	2.48	0.61	0.96		0.37
2	31.62	18.94	15.75	1.10	1.57	1.71	-	1.34		-
1	52.01	4.46	49.13	0.56	2.76	1.81	-	3.98		0.44

Source: www.nigerianstat.gov.ng

Table 4: Optimal environmental and soil condition required for cocoa production

Factor	Temperature	Annual rainfall	Relative humidity	Altitude	Organic carbon	Soil depths	Acidity and alikanity
Value	18-21^{0}c to 31-32^{0}c	1200mm-3000mm	70%-100%	0-900m	>2% or 20g/kg	>150cm	5.5 – 6.5

Source: *FAO 1976*

EVALUATION OF GROWTH IN COCOA/COCONUT INTERCROP IN SOUTH WEST NIGERIA

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ABSTRACT

A field trial to evaluate the growth of Cocoa intercropped with Coconut was conducted in Cocoa Research Institute of Nigeria (CRIN) Headquarters, Idi-Ayunre, Ibadan, Oyo State between 2019 and 2022. There were four treatments comprising Cocoa sole, Cocoa/plantain, Cocoa/coconut and Cocoa/coconut/plantain intercrop. The experimental design was Randomized Complete Block (RCBD) replicated three times. Data were collected on plant height (cm), stem diameter (cm) and leaf area (cm^2) of cacao. The data were analysed with analysis of variance ($P \leq 0.05$). Result obtained showed that cocoa/plantain was significantly higher than all other treatments in all the growth parameters considered, and closely followed by cocoa/coconut; then cocoa sole, with cocoa/plantain/coconut giving the least performance. Therefore, cocoa/coconut intercrop could be recommended to cocoa farmers in Southwest Nigeria to increase their revenue generation when coconut starts bearing fruit instead of sole planting of cocoa.

Keywords: *cocoa, coconut, intercrop, growth*

INTRODUCTION

The cacao (*Theobroma cacao L*) is a native to the undergrowth of the Amazon forest (Wood and Lass, 1985). Since its introduction in West Africa, farmers have grown cacao under shade trees in order to create light conditions that are similar to those found in native forest (Besse, 1972; Boni, 1985). To obtain these light conditions, several techniques have been developed: under managed natural forest, under natural re-growth or under artificial shade (Besse, 1972; Keli *et al*., 2005). Intercropping is a common agricultural practice in the tropics. It has been reported to increase crop diversity, biological stability of the ecosystem and labour efficiency (Okigbo *et al*., 1975; Osei-Bonsu *et al*., 2002), and that inter-cropping can stabilize socio-economic conditions and alleviate poverty. However, Famaye *et al.* (2014) had reported that small-scale farmers are more concerned with profitability, food security, labour availability and agronomic sustainability than with forest conservation and the loss of biodiversity. Some authors have described the physiological, environmental and economic values of trees in cacao growing systems (Famaye *et al*., 2003; Schroth *et al*., 2004). They quote benefits such as shade for cacao; soil fertility maintenance by recycling nutrients in the soil; biodiversity conservation; protection against drought, bush fire and insect attacks; and additional income through sales of timber species, fuel wood and non-wood forest products.

Cocoa cultivation in Nigeria is currently threatened by the gradual disappearance of the forest. Thus, cocoa growers, which traditionally used forest galleries as a precedent for planting, are now facing difficulties to plant cacao in new lands and need to rejuvenate the current plantations with planting and replanting techniques adapted to this shortage of forest. At the same time, the cocoa farms are getting older as 70% of the plantations age between 11 and 30 years (Aguilar *et al*., 2005). Faced with the deterioration of the plantations, some producers have decided to replant, with considerable difficulties, on previous non-forest land (Assiri, 2008; 2010a). Given these recent cultural practices under light shade, researchers need to assess farmers' innovative intercropping practices (Assiri, 2008; 2010b). Agronomic practices in simplified orchards combining cacao and fruits trees such as coconut have been little documented in the literature. Most studies brought out the concomitant importance of mineral nutrition and way that shade trees filter incident light (Beer, 1998; Somariba and Beer, 2011), but little has yet been reported about the growth of cacao under cacao/coconut intercrop. Although, several species of trees can be used in the same plot of cacao, but the type of associations and planting densities vary greatly (Aguilar *et al*., 2005; Assiri and Koko, 2009).

However, in Nigeria, intercropping in cocoa is usually carried out with arable crops to provide food and income to the farmer before cacao start bearing pod and it is done at juvenile stage between 1-3 years before cacao closes canopy (Famaye, 2013). Similarly, in Nigeria, cacao has been conveniently intercropped with oil palm, kola and citrus (Famaye *et al*., 2003). Should the price of cocoa fall, the income of small holder farmers would still be safe-guided because of the accompanying crops intercropped with it.
Intercropping cocoa with coconut and palm trees is a commons practice in South East Asia (Famaye, 2013). Mature cocoa plantation can also be intercropped with coconut as a way to increase diversity, income, and reduce environmental degradation. However, this has not been practiced in Nigeria. Therefore, the objective of this study was to evaluate the vegetative growth in cocoa intercropping with coconut in Southwest Nigeria.

MATERIALS AND METHODS

This study was carried out in Cocoa Research Institute of Nigeria (CRIN) Headquarters, Idi-Ayunre, Ibadan, Oyo State, Nigeria. Idi-Ayunre (7°25'N, 3°24'E) is an alfisol in the tropical rainforest region of Nigeria. The plantain materials (suckers) were purchased from a plantain farmer. Cocoa seedlings were obtained from CRIN nursery. Coconut seedlings were obtained from coconut nursery farmers in Calabar, Cross River State. The experiment had four treatments; cocoa sole (control), cocoa/plantain (plantain check), cocoa/coconut, and cocoa/plantain/coconut. The experiment was laid out in Randomized Complete Block Design (RCBD) replicated three times. In data collection, parameters considered were physical and chemical properties of the soil at the beginning of the experiment, as well as morphological parameters (plant height, stem diameter and leaf area) of cacao. The data obtained was subjected to statistical analysis of variance and LSD was used to separate the means that were significant.

RESULTS AND DISCUSSION

Result of the physical and chemical properties of the study location at the beginning of the experiment is shown in Table 1. Texturally, the soil was sandy loam belonging to Onigambari series and an Alfisol (Soil Survey Staff, 1999). The site was considered suitable for cocoa production. Tables 2, 3 and 4 show the results of plant height, stem diameter and leaf area, respectively. There were not much significant differences between the treatments on the morphological parameters in the first 3 and 6 months of transplanting. However, from 9 months there were significant ($P<0.05$) differences among the intercrops. The least plant height, stem diameter and leaf area were recorded in cocoa/coconut/plantain. This could have been due to much competition for light at upper surface and nutrient at the root sphere. This agrees with earlier report of Famaye (2000) on effect of shade regimes on growth and nutrient uptake of seedling and matured tree of coffee species in Nigeria. The results equally showed a significant ($P<0.05$) higher increase in growth parameters of cacao in cocoa/plantain, closely followed by cocoa/coconut compared to cocoa/plantain/coconut and the sole cocoa. This agrees with earlier information that intercropping cocoa with coconut and palm trees was a common practice in South East Asia (Famaye, 2013). This result was also in consonance with earlier work of Famaye *et al.* (2014) that reported good growth performance of cocoa seedlings in the nursery at Ibadan, Nigeria.

Table 1: Soil physical and chemical properties of the experimental site at the beginning of the experiment

Soil properties	Idi-Ayunre (Ibadan)
pH($H_2$0)	6.4
% Organic carbon	0.84
% Total Nitrogen	0.08
Available P (mg/kg soil)	7.25
Exchangeable K (mg/kg soil)	0.44
Exchangeable Ca (mg/kg soil)	2.45
Exchangeable Mg (mg/kg soil)	0.03
Exchangeable Na (mg/kg soil)	0.01
% Sand	81.5
% Silt	8.2
% Clay	10.3
Soil classification	Alfisol

Table 2: Plant height (cm) of cocoa intercropped with plantain and coconut

	Months after transplanting							
Treatments	**3**	**6**	**9**	**12**	**15**	**18**	**21**	**24**
Cocoa sole	38.26	38.74	56.60	78.41	82.50	85.47	90.68	100.71
Cocoa/plantain	38.53	39.68	57.07	86.25	88.46	93.02	99.81	112.87
Cocoa/coconut	37.56	38.83	45.91	80.91	84.00	90.91	93.46	103.93
Cocoa/coconut/plantain	36.25	37.14	40.23	72.30	80.13	84.12	87.57	90.48
Mean	35.63	38.60	49.95	79.47	83.77	83.38	92.88	102.00
LSD($P \leq 0.05$)	5.59	1.69	13.17	9.21	5.58	6.78	8.28	14.72

Table 3: Stem diameter (cm) of cocoa intercropped with plantain and coconut

	Months after transplanting							
Treatments	**3**	**6**	**9**	**12**	**15**	**18**	**21**	**24**
Cocoa sole	0.67	0.72	1.57	1.78	1.80	1.93	1.98	2.04
Cocoa/plantain	0.68	0.74	1.78	1.87	1.91	2.00	2.24	2.40
Cocoa/coconut	0.64	0.68	1.56	1.73	1.78	1.90	2.01	2.02
Cocoa/coconut/plantain	0.60	0.63	1.37	1.49	1.51	1.84	1.89	1.93
Mean	0.65	0.69	1.57	1.72	1.75	1.92	2.03	2.10
LSD($P \leq 0.05$)	0.06	0.08	0.27	0.26	0.27	0.11	0.24	0.33

Table 4: Leaf area (cm^2) of cocoa intercropped with plantain and coconut

	Months after transplanting							
Treatments	**3**	**6**	**9**	**12**	**15**	**18**	**21**	**24**
Cocoa sole	136.10	153.60	216.87	268.73	275.40	284.32	301.80	323.30
Cocoa/plantain	138.91	155.29	224.86	284.38	292.12	298.24	320.32	345.41
Cocoa/coconut	133.42	150.07	215.24	253.24	274.86	285.16	298.93	320.80
Cocoa/coconut/plantain	130.52	148.35	201.52	243.35	257.94	280.53	290.36	301.73
Mean	134.74	151.83	214.58	262.43	275.08	287.06	302.85	322.81
LSD($P \leq 0.05$)	5.72	5.05	15.51	28.59	22.19	12.27	20.06	28.43

CONCLUSSION

The morphological growth results show that cocoa/coconut is second to cocoa/plantain in performance and both were superior to cocoa sole and cocoa/plantain/coconut treatments. It was also concluded in the trial that the two crops, cocoa and coconut are compatible when grown on the same piece of land as they did not show any deleterious effect on their respective growth when intercropped together. Therefore, it could be concluded that cocoa/coconut intercrop as well as cocoa/plantain could be recommended to cocoa farmers instead of sole cocoa planting. This would increase the revenue base of the farmers when coconut and plantain would start bearing fruit from the intercrop as against only cocoa beans harvestable from sole cocoa planting.

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EXPLORING THE ADOPTION OF SOLAR DRYERS FOR DRYING BIOMATERIAL IN NIGERIA: ASSESSING AWARENESS, BARRIERS, AND INTEREST

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ABSTRACT
This study investigated the extent of adoption of solar dryers in Nigeria, using farmers and processors in Osun state, as a case study. This study also evaluated the impact of socioeconomic factors on the level of adoption of solar dryers as well as the major drawbacks and interests attributed to its use. The study adopted the convenience sampling approach and selected survey respondents from the major towns in Osun; using a structured questionnaire and analysed data obtained using both descriptive and inferential statistics. The findings indicated that the level of adoption of solar dryers for drying biomaterials is low with 80.6% and 8.5% blaming it on lack of awareness and high initial cost respectively. Age, education, and income level positively correlated ($p < 0.05$) with solar dryer awareness level. Factors mitigating the use of solar dryers in Osun state include the high cost of maintenance, low technological knowledge and the problem of low capacity. The farmers and processors showed a high level of interest (89.9%) in the adoption of solar dryers. This study, therefore, recommends that researchers should pay more attention to awareness of solar dryer use demonstrations to enhance its adoption in Nigeria.
Keywords: *Solar dryer, Osun State, Nigeria, Adoption, Farmers*

INTRODUCTION

In countries like Nigeria, where sunlight is abundant, and the supply of electricity is inconsistent, the use of solar energy has helped farmers reduce post-harvest losses considerably and as well minimise energy costs needed to preserve their products (Olujobi, 2020). Most farmers in the country however rely on the open sun-drying method which has been proven to result in quality losses of processed biomaterials (Udomkun et al., 2020). According to Meléndez-Martínez et al. (2022), exposure to dust, pests, UV photo-bleaching, and fluctuating drying air conditions experienced when the method is used leads to some chemical and biochemical degradation in the quality of products being dried. Additionally, the high level of contamination attributed to the method also renders most food products dried unfit for the export markets, making it challenging for processors to exploit and utilize the full potential of their products for international markets (African Union Commission, 2019).

Solar dryers have emerged as one of the promising and sustainable drying technologies for agricultural products globally (Goel et al., 2023). Solar dryers were designed to minimise most of the drawbacks attributed to the use of conventional open-sun drying methods. They have been designed to utilize the energy from the sun as part of the full heat source for the controlled drying of biomaterials while simultaneously protecting products from rain, insects, birds, and rodents (Chavan et al., 2021; Gorjian et al., 2021). In spite of the many advantages solar dryers have over open-sun drying, the two drying methods are still faced with the problem of reduced efficiency when solar energy is unavailable (Prakash and Kumar, 2017). Hence, researchers and professionals have spent decades developing solar dryers with improved drying efficiency in cases where solar energy is unavailable (Adnouni *et al.*, 2021; Muhumuza *et al.*, 2018).

The evolution of solar-drying technology over the last few decades began with simple designs in the mid-20th century and gradually progressed to passive solar dryers that utilized natural convection (Prakash and Kumar, 2017). In recent times, solar dryers have now been designed with fans, alternative heat sources, integration with other renewable energy systems, and advanced control systems incorporating sensors for enhanced performance, making it a sustainable and efficient solution for agricultural drying needs (Ortiz-Rodríguez *et al*., 2022). However, despite the research efforts to improve the performance of solar dryers, their use among farmers in Nigeria is hard to come by and seldom reported in the literature.

A study conducted by Okala *et al*. in 2011 as well as the study by Ayeni et al. in 2021 established that the practical use of solar dryers is absent in Nigeria. As of the moment, little to nothing has been reported on the subject; making it necessary to conduct a more recent study to track the level of solar dryer adoption in Nigeria; especially in Osun State where the supply of solar energy is readily available and agricultural activities are highly explored (Giwa *et al.*, 2017). This study was therefore aimed at investigating the extent of the adoption of solar dryers in Nigeria, using Osun State farmers and processors as a case study. the objectives of the study revolved around investigating the level of awareness, barriers, and interest of Osun state farmers in the use of solar dryers. The study also explored the impact of socioeconomic factors on the level of awareness of solar dryers among the farmers and processors in the state. Findings from this study will enhance the understanding of how solar dryer designs could be tailored towards addressing the drying needs of farmers and processors in Nigeria.

METHODOLOGY

This study adopted a positivist research philosophy and used the deductive approach of Saunders et al. (2009) to guide the investigation. The study area is located between latitudes 707.5' and 7010'N and longitudes 4032.5' and 4032'E, which lies in the southwestern part of Nigeria and covers several towns, including Osogbo, Ede, Ife, Gbongan, Ilesha, and Ikire in Osun State, Nigeria (Rauf and Fahm, 2022). Following the method of Kungu *et al.* (2017), a cross-sectional survey of farmers was conducted in the study area using a structured questionnaire as the primary data collection tool. This study acquired data utilising the convenience sampling strategy; where farmers and processors, were recruited for the study in a free manner (Atkins, 2014), and a total of 100 respondents were targeted through an online survey approach. This study contacted potential respondents with informed consent and approval to use the information obtained through the study for educational purposes.

The survey tool was administered using the Google form platform and the participants were contacted through administrators of major social media groups created for Osun State farmers and processors. The questionnaires were designed in English and structured into five sections, including respondents' biographic information, their degree of awareness about solar dryers, the extent of usage of solar dryers among farmers, issues impeding the adoption of solar dryers in the state as well as their level of interest in future adoption. To confirm the credibility of the data obtained, the internal consistency of the data was verified using Cronbach's Alpha reliability test of SPSS, with a reliability threshold of 0.7 chosen as the benchmark for validity.

Through the use of SPSS software version 26, the survey results were analysed using descriptive statistics such as frequency, and percentage; as well as inferential statistics like Pearson correlation to determine the relationship between socio-economic factors (which include age, level of education, and monthly income) and some cogent survey parameters indicating the extent of awareness of solar dryers in Osun State

RESULTS AND DISCUSSION

A total of 87 responses were obtained for the study however 20.69% of the responses were considered invalid as the responses were either obtained from respondents who are not farmers or processors or those who do not carry out their farming/processing activities within the study area. Therefore, a total of 69 responses were selected as valid for the research; with 68.12% of the responses obtained from farmers with 31.88% obtained from processors. As presented in Table 2, for all survey responses, the Cronbach's Alpha values ranged from 0.714 to 0.781, with an overall value of 0.785 indicating that the data has good internal consistency and are reliable (Alhayani et al., 2021).

(i) Demographic Information of Osun State Farmers

Table 2 presents the demographic distribution of the survey respondents. Careful examination of the age distribution reveals that most of the farmers and processors in Osun State are between the ages of 31 and 40, indicating that they are youthful and energetic. As further presented in the table, about 60.9% of the responders were males, revealing that males are more active in agricultural activities in Osun State than women. According to the information obtained for the religion, Muslims were more active in farming/processing activities than Christians. A total of 62.3% of the respondents were married indicating that most involved in agricultural practices in the location are not single. Finally, the majority of the farmers have monthly income levels of either between 100 and 150 thousand Naira or less than fifty thousand Naira, which indicates that based on level of income, Osun state farmers and processors can be categorised as either low- or medium-income farmers and processors. At the time the survey was completed the official exchange rate of dollar to Naira is 435. Since 60.9% of the farmers/processors earn below eight Dollars in a day (maximum of 100 thousand monthly) with a family size of not less than four on average as reported by Onya et al. (2019), one can conclude that most of the farmers are living below the poverty line as they have access to less than 2.15 Dollars poverty line per person per day threshold (Jolliffe et al., 2022).

(ii) Solar dryers and the extent of their adoption among farmers/processors in Osun state

The two prominent sources of solar dryers in Nigeria include local fabrication, and importation from overseas (Akinboro *et al.*, 2012) were explored. While 70.22% of the respondents are unaware of the sources of solar dryers used in Osun state, only 29.79% of the respondents have some level of information regarding the sources and 29.79% selected local fabrication as the primary source. As opinionated by Olorunnisola (2021), one may suspect the high cost of importation as a coagent factor responsible for the high adoption of locally fabricated solar dryers. Additionally, despite the majority of the respondents (63.8%) having no idea what solar dryers are, about 17% of respondents identified tent solar dryers as familiar and easier to come by than the other types (direct (10.6%) and mixed-mode together with indirect (8.5%)) in the state. This therefore indicates that while tent solar dryers are the most common in the state direct solar dryers are also common, with indirect and mixed mode types perceived as very rare.

While solar dryers can be used for drying many types of agricultural products, in Osun state, solar dryers are used for some selected agricultural products. While most of the respondents have never seen solar dryers being used in the state, 9.9% of the respondents indicated that cocoa beans are often dried in solar dryers in Osun State. Furthermore, 4.3%, 2.9%, and 2.8% of respondents identified corn, beans, and fish respectively as being commonly dried in solar dryers in the location. Some other products seldomly dried in solar dryers in Osun state as deduced through the survey are cashew, cassava, and melon. okra and grains; whereas, 25.3% of responses show that solar dryers are rarely used for drying ginger and pepper in the state.

Owing to the information obtained through the responses only 15.9% of the respondents have seen solar dryers being used within the state, whereas, only 8.7% have used solar dryers in the state. This result thus establishes that the use of solar dryers in Nigeria is no longer absent as previously reported by Okala et al. (2011) and Ayeni et al. (2021), however, comparing this to the report of Matavel et al. (2022), the level of its adoption among farmers/processors in Nigeria is still low compared to Mozambique, with 65% level of adoption. Furthermore, the information presented in Figure 1 gives the possible reason for the low level of adoption of solar dryers in the location. While 12.8% of the respondents do not know why solar dryers are not adopted by farmers, 76.6% of the respondents blamed the low adoption on a lack of awareness of its use. Nevertheless, 10.6% of the respondents claimed that farmers do not use solar dryers because it is too expensive for them. Based on this deduction, it can be inferred that the level of adoption of solar dryers is still low in Nigeria. This finding is in line with the report of Ayeni et al. (2021) which established that there is poor awareness about solar dryers and this poor awareness is the reason for the low level of its adoption among spice farmers.

(iii) The impact of socioeconomic factors on the level of adoption of solar dryers in Osun state

Table 3 details the outcome of Pearson correlation analysis among some coagent survey parameters. As presented in the table, the Age of Osun state farmers had a negative correlation with hearing about solar dryers, using solar dryers, and seeing solar dryers. This result implies that the higher the age of the Osun state farmers, the lower the likelihood of being aware of solar dryers. The correlation between age and likelihood of hearing about solar dryers and seeing solar dryers are however significant; whereas, a weaker correlation was obtained for the likelihood of using solar dryers. This shows that while age significantly influences the likelihood of seeing or hearing about solar dryers, it does not have any significant effect on the likelihood of using solar dryers. The study conducted by Benard et al. (2018) linked the age of farmers in Tanzania to their level of awareness about solar dryers and the result shows some levels of agreement with the findings made through this study indicating that younger farmers are more enlightened about solar dryer use than the older ones.

Additionally, the level of education of Osun state farmers had a positive correlation with the likelihood of hearing, seeing, and using solar dryers before. This result implies that the higher the number of years of education of Osun state farmers, the higher the possibility that they are aware of what solar dryer is and how it works. The result however shows no significance in the correlation between education and the three variables. Hence, one can say that the level of education of Osun state farmers does not significantly impact their level of awareness about solar dryer use and operation.

Furthermore, the income of Osun state farmers had a positive linear relationship with whether the farmers have heard of, seen, or used solar dryers before. The correlation value of 0.891 recorded for the likelihood of seeing solar dryers indicates that the higher the monthly income of farmers, the higher the likelihood that they might have seen solar dryers before. The result shows that as the income of farmers goes from below 50 thousand to 200 thousand Naira monthly, so also their levels of awareness of solar dryers increase.

(iii) The major drawbacks attributed to the use of solar dryers in Osun state and the level of interest of farmers in solar dryers' adoption.

Based on the responses obtained from the survey participants who are familiar with the use of solar dryers, the factors mitigating the use of solar dryers in Osun state are the high cost of maintenance, high frequency of the need for maintenance, high initial cost, low technological knowledge and the problem of low capacity. These findings are thus in line with the report of Giwa et al. (2017) which highlighted problems such as incentives and financing, research and development, as some of the additional problems confronting the maximal exploration of solar dryers in Nigeria. The level of interest in the adoption of solar dryers among the population considered was as high as 89.9 % of the total responses, which is significantly higher ($p<0.05$) than those who seemed uninterested in its use. This indicates that a very large fraction of farmers and processors are open to the adoption of novel solar drying technology in the study area. His finding is in line with the deduction of Matavel et al. (2022), which indicated that 100% of commercial rural farmers in the population surveyed in Mozambique indicated an interest in the adoption of solar dryers.

CONCLUSION

The aim of this study was to determine how widely solar dryers are adopted in Nigeria; using Osun state's farmers/processors as a case study. All solar dryers found in the state were locally fabricated and they have a low degree of adoption and usage with factors such as lack of awareness and high initial cost identified as the bane for low adoption. Age, education, and income level strongly correlated with solar dryer awareness level. Factors mitigating the usage of solar dryers in Osun state include expensive cost of maintenance, insufficient technological expertise and the problem of low capacity. The farmers and processors exhibited a high degree of interest (89.9%) in the implementation of solar dryers. Therefore, this study suggests that additional time be devoted to raising awareness and holding local demonstrations of the usage of solar dryers.

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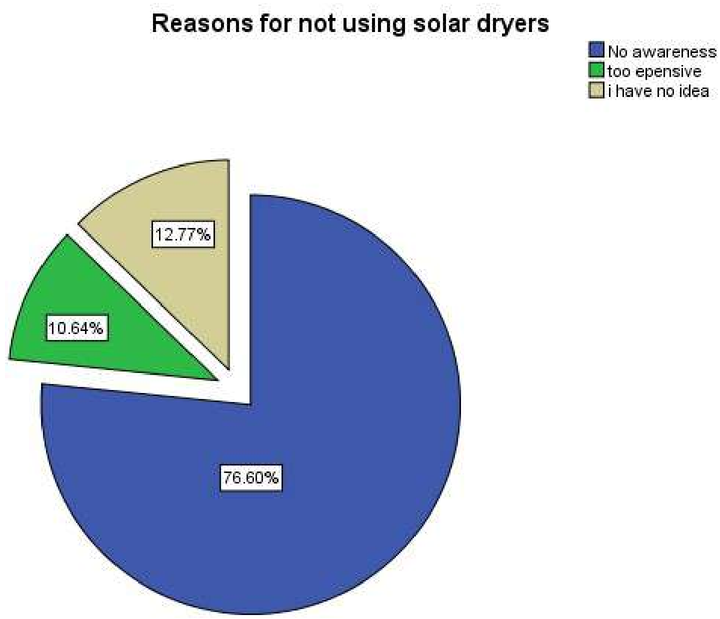

Figure 1: Reason for low level of adoption of solar dryers among spice formers in Osun State

Table 1: Data reliability test of cogent parameters using the Cronbach's Alpha

Items	Parameter	Cronbach's Alpha	Items	Parameter	Cronbach's Alpha
1	Age	0.727	2	Income	0.733
1	Sex	0.732	3	Knowledge _of_ solar dryer (seen used or heard of it)	0.768
1	Marital status	0.714	4	Interest in solar dryer	0.737
6	Solar dryer efficiency	0.746	4	Solar dryer awareness	0.732
1	Religion	0.781	2	Reason for not using solar dryers	0.764
1	Education	0.733	26	Overall	0.785

Table 2: Demographic Information of the Respondents

Variable	Variable distribution	Freq (69).	Percent	Variable	Variable distribution	Freq (69).	Percent
Age	20-30	10	14.5	**Occupation**	Farmers	47	68. 1
	31-40	39	56.5		Processors	22	31.9
	41-50	8	11.6	**Marital Status**	Single	26	37.7
	above 50	12	17.4		Married	43	62.3
Religion	Christianity	22	31.9	**Monthly Income**	< 50,000 Naira	24	34.8
	Islam	47	68.1		> 150,000 Naira	12	17.4
Sex	Female	27	39.1		Between 100,000 and 150,000 Naira	27	39.1
	Male	42	60.9		Between 50,000 and 100,000 Naira	6	8.7

Table 3: Correlation analysis of cogent survey parameters

		Age	Education	Income
Age	Pearson Correlation	1	-0.097	-0.018
	Sig. (2-tailed)		0.517	0.907
Education	Pearson Correlation	-0.097	1	0.139
	Sig. (2-tailed)	0.517		0.352
Income	Pearson Correlation	-0.018	0.139	1
	Sig. (2-tailed)	0.907	0.352	
Heard of solar dryers	Pearson Correlation	-0.516*	0.106	0.699*
	Sig. (2-tailed)	0.009	0.477	0.001
Seen solar dryers	Pearson Correlation	-0.473*	0.084	0.891*
	Sig. (2-tailed)	0.024	0.576	0.000
Used solar dryers	Pearson Correlation	-0.102	0.116	0.650*
	Sig. (2-tailed)	0.495	0.438	0.001

*. Correlation is significant at the 0.05 level (2-tailed).

EFFECTS OF TEMPERATURE VARIATIONS ON KOLANUT PRODUCTION IN NIGERIA

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ABSTRACT
Kola, a tree crop cultivated in Nigeria is faced with low nut yield due to climate change effects. Data of 61 years (1961 – 2021) from FAOSTAT was used to measure area cultivated (ha), yield (kg/ha) and yearly temperature (^{0}C). The data were analysed using least squares regression. Results revealed 895.3kg/ha average yield from157,673.7 ha. Temperature trend showed 18.0 % decrease in 11 years and 82.0 % increase in 50 years. There was 0.0200^{o}C annual temperature increase and 0.0007^{o}C decrease at $R^2$of 0.6380 and 0.0014 respectively. The temperature decrease resulted to increased kola yield by 5.5kg/ha while its increase decreased yield by 7.8kg/ha with R^2 of 0.8302 and 0.3532 respectively. This indicated a direct correlation (0.057) between kola yield and temperature decrease, but an inverse correlation (-0.641) with increase in temperature. Yield in kolanut could be enhanced when ambient temperature is controlled through good agricultural activities that mitigate climate change
Keywords: *Climate change, FAOSTAT, kolanut, temperature variations, yield*

INTRODUCTION

Kola, a tropical African genus of the family Sterculiaceae, comprises about one hundred and twenty five species. Kola species are evergreen, mostly small or moderately sized trees although a few grow to 25 metres. It is mostly produced in Africa and is cultivated to a large degree in Nigeria, but also in Ghana, Ivory Coast, Brazil and the West Indian Islands (Opeke, 1987). Annual production from these countries alone is in excess of 250,000 tons, while the world production is about 300,000 tons (Brickell *et. al*., 2002). A number of species are widely cultivated in tropical countries, especially in Africa. The most commonly used are *Cola. verticillata*, *C. acuminate* (P. Beav) Schott and Endl., and *C. nitida* (vent) schott and Endl, with the latter two having the greatest economic importance. While *C. acuminata* bears seeds containing 3–6 cotyledons, *C. nitida* produces seeds with 2 cotyledons only (Adeleye *et. al*., 2015). The plants are grown purposely for their nuts which are widely consumed in West Africa as stimulants and also used in traditional ceremonies; it is depicted as an object of life that brings peace and progress in African society (Odo *et. al*., 2023).

C. nitida, referred to as “the true kola of commerce” has featured in the internal trade of West Africa for a number of centuries. It is widely cultivated in the tropical rainforest of West and Central Africa and is found as perennial tree in Nigeria, Angola, Liberia, Gambia, Togo, Republic of Benin, Sierra-Leone, Tanzania, Ghana, Mozambique, Gabon and Cote d’Ivoire (Akinola *et. al*., 2020; Aduama-Larbi *et. al*., 2022). Nigeria accounts for 55% of the total world production of kolanuts in 2020 (Wikipedia). It has industrial usage in production of soft drinks as well as flavouring agent in food industry (Asogwa *et. al*., 2006, Nyadanu *et. al*., 2020). It could also be used in jam and jelly production because of its high pectin content. Furthermore, due to the high potassium content of the kola nut testa, it has been suggested as a possible ingredient for making fertilizers (Olubamiwa *et. al,*. 2002). As stated by Asogwa *et. al.,* (2006), other local uses of kola are as follows: (1) it provides some essential materials for cloth dying; (2) the pod bark, when mixed with some ingredients, are used in traditional medicine to reduce labour pains; (3) the bark is used in treating swellings and fresh wounds; (4) the roots provide excellent chewing sticks for cleansing the teeth and the wood is used in local carvings, coach work and boat building. However, About 50% of the existing kola trees especially in Western Nigeria yield insignificant produce (Asogwa *et. al*., 2006) which among other factors has been attributed to climate change (Akinfenwa, 2018). The study is therefore aimed at determining the effects of temperature on kolanut yield and proposing climate mitigation measures towards optimizing its yield.

MATERIALS AND METHODS

Data on area harvested (ha), yield (kg/ha) and temperature (^{O}C) in Nigeria was sourced from the database of Food and Agricultural Organisation Corporate Statistical Database (FAOSTAT); the duration was 61 years (1961 - 2021). The data were analysed using least squares regression.

The least squares line method uses a straight line

$Y = a + bx$

to approximate the given set of data, (x_1,y_1), (x_2,y_2), … , (x_n,y_n), where $n \geq 2$

Where 'a' stands for the intercept and 'b' stands for the slope; x and y are the variables. The slope is equivalent to variation in kolanut yield and temperatures per year (Kadioglu, 1997). Correlation analysis was used to measure the association between the variables.

RESULTS AND DISCUSSION

Temperature variations and kola yield

The surface temperature of Nigeria increased by a range of 0.0004 – 1.4367 ^{0}C with a mean value of 0.7333 ^{0}C while the decrease ranged from 0.0136 - 0.4743 ^{o}C with a mean value of 0.1710 ^{o}C in the 61 years of consideration (Table 1).

Table 1: Kolanut cumulative yield as influenced by temperature variations in 61 years

Variables	Yield as temperature increases		Yield as temperature decreases	
	Temperature (^{0}C)	Yield (kg/ha)	Temperature (^{0}C)	Yield (kg/ha)
Minimum	0.0004	536.6	0.0136	896.8
Maximum	1.4367	1364.6	0.4743	1076.9
Mean	0.7333	881.9	0.1710	956.1
Standard deviation	0.3918	184.7	0.1380	47.6
Correlation analysis	-0.641		0.057	

The maximum kolanut yield per hectare during temperature increase was 1364.6 kg while the minimum yield was 536.6 kg with the mean yield of 881.9 kg. During the decrease in temperature, 1076.9 kg and 896.8 kg were the maximum and minimum yield respectively with the mean yield of 956.1 kg as shown in Table 1. The differential of 77 % between the mean temperature increase and decrease is an indicator of global warming with its attendant effects on mean kolanut yield as reported by Akinnagbe and Ikusika (2016). Kolanut yield was 1.7 % higher during the periods of temperature decrease than at the periods of increase in temperature implying that a decrease in temperature enhanced kolanut yield. This is buttressed by the correlation analysis which showed an inverse relationship (-0.641) between kolanut yield and temperature increase but a direct relationship (0.057) between both variables. In the 61 years under consideration, the yield of kolanut as affected by the rate of temperature increase and decrease is as shown in figures 1 and 2 respectively

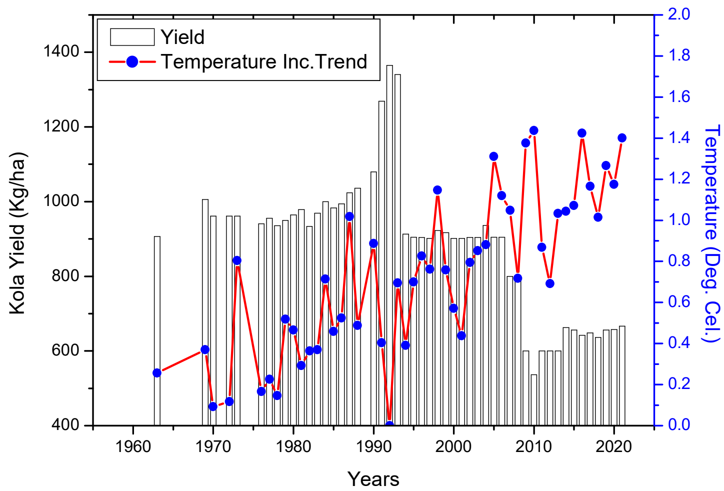

Figure 1: Kolanut yield at the rate of temperature increase

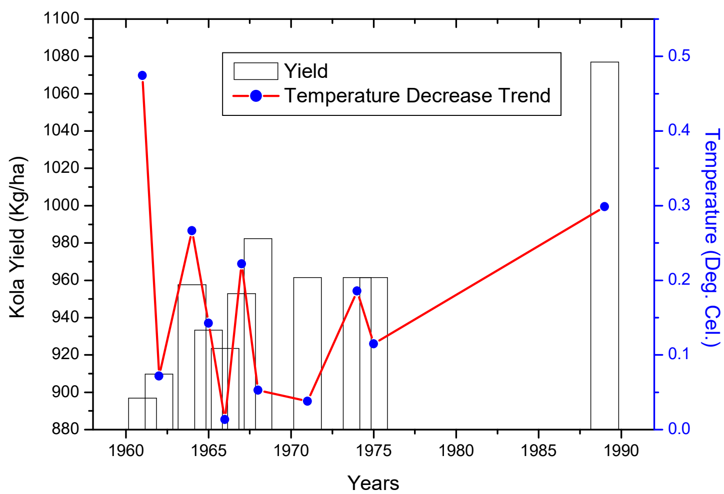

Figure 2: Kolanut yield at the rate of temperature decrease

Regression analysis of kolanut yield trend

The regression analysis showed the trend in kolanut yield during the periods of temperature variations. In 11 years, temperature decreased by 0.0007 ^{0}C per annum with a corresponding annual 5.452 kg/ha kolanut yield increase while in 50 years, temperature increased by 0.02 ^{0}C per annum and the kolanut yield decreased by 7.84 kg/ha per annum (Figures 3 and 4). In 11 years, the overall temperature decrease and corresponding kolanut yields were 0.0077 ^{0}C and 86.24 kg/ha respectively while in 50 years of temperature increase by 1.0 ^{0}C, the kolanut yield decreased by 392.0 kg/ha.

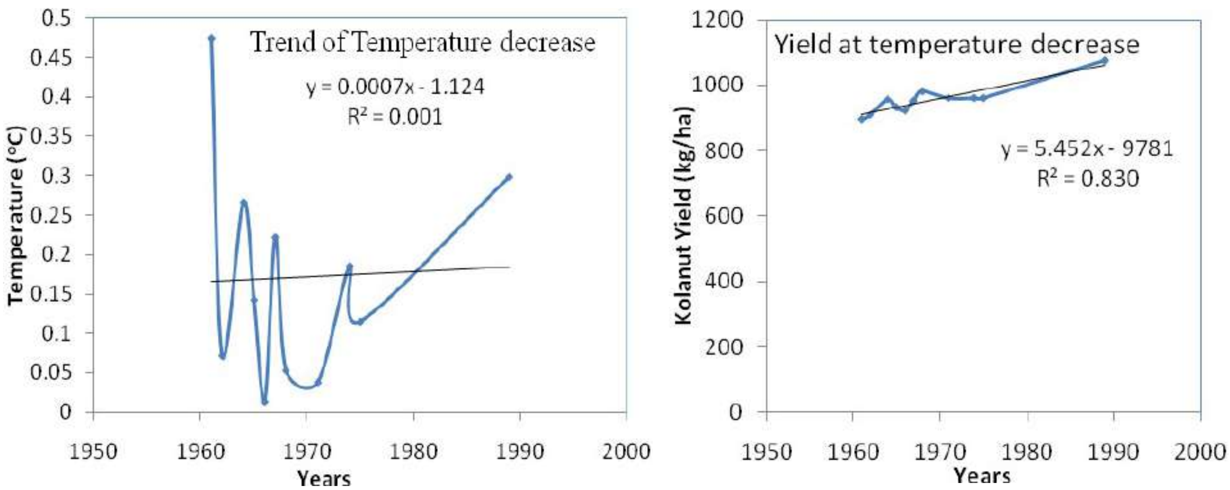

Figure 3: Relationship between annual temperature decrease and kolanut yield

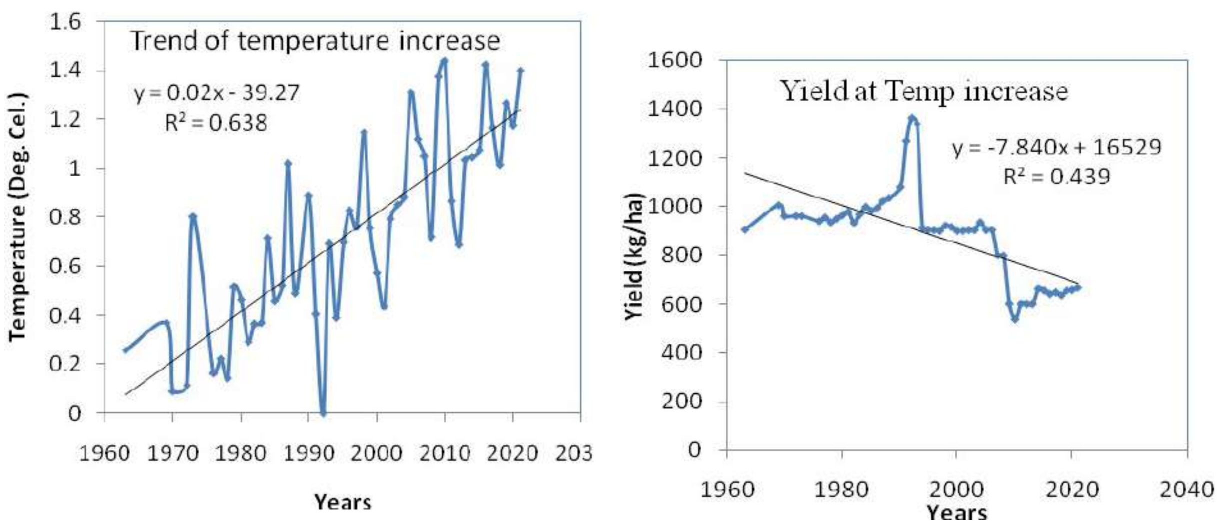

Figure 4: Relationship between annual temperature incr

The corresponding regression coefficients (R^2) in temperature variations were 0.0014 and 0.638 while the values in kolanut yield were 0.830 and 0.439 for temperature decrease and increase respectively. It becomes imperative therefore to control the ambient temperature in Nigeria through mitigation of anthropogenic activities, in order to enhance the yield of kolanut in a sustainable manner. This could be realised by enacting Government policies that encourage aforestation practices such as the planting of economic tree crops like cashew that thrives in various agro-ecologies in Nigeria. Planting of timber trees like teak and mahogany should also be encouraged and sustained. Indiscriminate felling of trees and bush burning should be prohibited.

CONCLUSION

The study has shown that decrease in ambient temperature resulted in increased kolanut yield and vice versa. Consequently, policies and measures that promote green practices which lead to a controlled temperature in Nigeria should be encouraged.

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SOIL FERTILITY EVALUATION FOR CASHEW PRODUCTION AT IYAPO FARM ESTATE, OFFA, KWARA STATE

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ABSTRACT
Cashew (Anacardium occidentale L) is an important commodity crop with great potential as a foreign exchange earner. It is grown principally for it nuts and apple and is a hardy crop which is adapted to a wide range of agro-ecologies. As result of increased in the price of cashew nuts globally, many people developed interest in the cultivation of the crop. The Management of Iyapo farms Limited in its desire to key into this sector requested the technical assistance of Cocoa Research Institute of Nigeria (CRIN) to carry out soil fertility evaluation of the 50 hectares of land proposed for establishment of cashew. The farm was divided into three main sections (A, B and C) based on topography and four land use types (water logged, cassava plot, previously cultivated land and excavated land). section A was parallel to River Oyun followed by section B in the middle of the farm, while the last section C ran parallel to the road from Ijagbo town. The land use types were scattered within the three blocks. The water logged area was however confined only to section A which was close to river Oyun. Soil samples were collected at soil depths of 0-20 cm and 20-40 cm and at a distance of 20 m apart. The soil collected was put in nylon bags and properly labelled. Soil samples collected were air dried, passed through 2 mm sieve and analyzed for some of its physical and chemical properties. In section A, total soil nitrogen at 0-40cm soil depth ranged between 0.07g/kg to 0.18g/kg with a mean value of 0.11 g/kg soil while mean soil available phosphorus at 0-40cm soil depth was 3.16mg/kg. The exchangeable potassium content across 0-40cm soil depth ranged between 0.09cmol/kg to 0.35 cmol/kg with a mean value of 0.25 cmol/kg and 0.19cmol/kg for 0-20 cm and 20-40cm soil depth respectively. In section B, nitrogen across the various soil depths ranged between 0.04 g/kg to 0.12 g/kg with nitrogen content of the soil decreasing with increasing soil depth. This falls below the soil critical level of 1 g/kg required for cashew and was grossly inadequate to meet nitrogen need for cashew. There is need for nutrient supplementation as Nitrogen fertilizer is required to meet the nitrogen needs of the cashew. Similarly, phosphorus was also inadequate across the soil depths with a range of 2.47 mg/kg to 4.51 mg/kg across the various soil depth and a mean value of 3.24 mg/kg and 2.65 mg/kg for 0-20cm and 20-40cm soil depths respectively. This was below the soil critical value of 3.7 mg/kg. There is therefore need to apply phosphorus fertilizer to boost cashew productivity. Soil exchangeable potassium was adequate across the various soil depths with a range of 0.13 to 0.20 cmol/kg and a mean value of 0.18 cmol/kg and 0.16 cmol/kg for 0-20cm and 20-40cm soil depths respectively. There is no need for potassium fertilizer application. The results above indicated that sections A, B and C require 180kg/ha of urea and 31.5 kg of Single Super Phosphate (SSP). The cassava plot and previously cropped bare land requires 189 kg/ha urea and 9.9 kg/ha SSP, while the excavated land requires 194.2 kg urea 25.8 kg SSP and 32.28 kg MOP. Cashew should not be grown on the water-logged section.
Key words: *Cashew, Soil fertility, nutrient management, fertilizer, yield*

INTRODUCTION

Cashew is an important commodity crop with great potentials as foreign earner and source of industrial raw materials with the prospect of becoming a major commercial tree crop in Nigeria. Cashew as a result of its wide adaptation is often grown in very poor soils and this has affected its survival and establishment (Opeke, 2005; Topper, *et al*.2001). Cashew is a commodity crop of international recognition for its numerous importance, food security, foreign exchange earnings, and afforestation with its roles in mitigating the adverse effects of climate change. It is a hardy crop which survives where most tree crops cannot thrive (Ohler, 1979). Hence, it is cultivated in a variety of ecological zones of Nigeria which connotes a wide variety of soil. It is often grown on poor soils and this has affected its survival and adaptability. Cashew nuts production has the potential of increase in Nigeria if available resources are adequate annexed. Particularly important is the financial resources needed to boost cultivation and perform marketing functions that can further facilitate cashew production couple with appropriate record keeping for sustainability. Cashew nuts are among the healthiest and most popular nuts in the world and regular consumption can contribute to the reduction of risks of cardiovascular diseases (MTP 15). The cashew apple is edible fruit rich in vitamin C, sugars and contains considerable amount of tannins (35%, less in the yellow) and minerals, mainly calcium, iron and phosphorous. The fruit can be improved on for consumption and trade by removing the undesirable tannins and processing the apples into value-added products, such as juices, syrups, canned fruits, pickles, jams, chutneys, candy and coffee. The nuts are also processed for other value-added products.

Cashew however grows optimally with corresponding economic returns under ideal soil condition and proper management. Good soil management is a criterion for good quality and high yield of both cashew nuts and apples. This is however lacking in cashew production in Nigeria. Some of the components of good soil management include proper site selection and use of fertilizer. Proper site selection is critical in cashew production because it's a long term investment and this site should have deep soil (1-1.5 m), well drained with steady and continuous supply of nutrients.

Iyapo farm is interested in establishing about 50 hectares of cashew. Soil fertility evaluation is crucial to ensure appropriate recommendation of soil management practice to enhance establishment and yield of cashew. The objective of this work is to carry out soil fertility assessment of Iyapo farm for cashew cultivation.

MATERIALS AND METHODS

Study Site

Kwara State is located between latitude 7°N and longitude 3°E and 7°E. It is geographically located at the Southern border of River Niger and in the Southern guinea savanna. The average annual rainfall in the State is 1202.4mm with two peaks in July and September and a dry spell in August, known as August break. The rainfall starts in late April and ends in October. The Average monthly temperature are fairly constant. However, February, March and April are the hottest months, while June to September has lowest maximum temperature which coincides with the peak of the dry and wet seasons respectively (Ogunwale *et al,* 1999).

Parent materials

Kwara State has two distinct geologies. The soils were formed from basement complex rocks metamorphic and igneous rocks) which is about 95% and sedimentary rock along the Niger River bank which is about 5% of the total area. The metamorphic rocks include biotite gneiss, quartizite, augite gneiss and grantitic gnesis. The intrusive pegmatite and vein quarz (Lawal, 1977).

The farm is located at Ijagbo, Oyun Local Government area near Offa Kwara State. It is on latitude 8° 13.44^1N, longitude 0040 43.501^1 and 36.5 metres above sea level. The 49.547 hectares' farm which is located in the Southern Guinea Zone is bounded by River Oyun, a citrus farm, farm house and a road from Ijagbo at the four boundaries. The farm consisted of scattered locust bean trees, oil palm trees and a few cashew stands. Part of the farm was presently cultivated with cassava, while some had been previously cropped with maize. There was evidence of sand mining in the excavated lands while excavation of the top soil had been carried out.

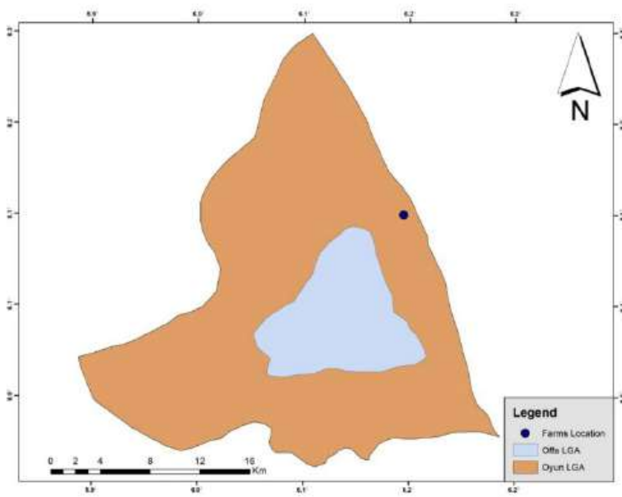

Figure 1: Map of Kwara State showing the location of Iyapo farm

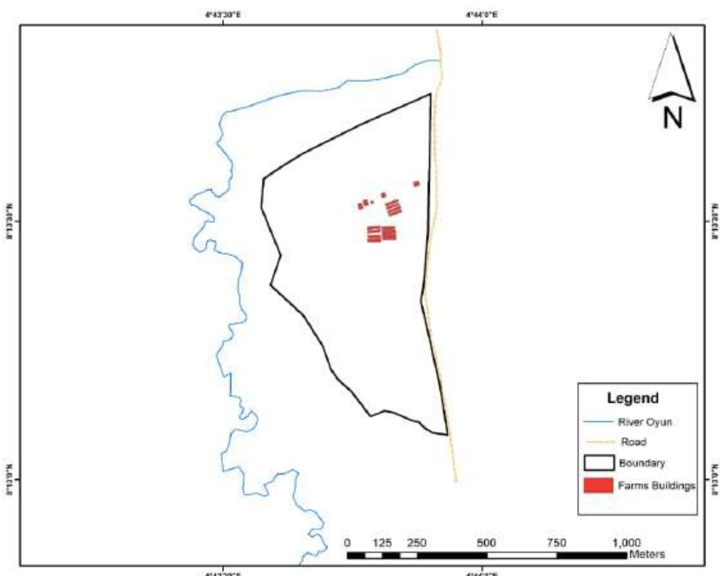

Figure 2: Map of Iyapo farm in Kwara State, Nigeria

METHODOLOGY

Field soil sampling

The farm sampled was divided into three main sections (A, B and C) based on topography and four land use types (water logged, cassava plot, previously cultivated land and excavated land). Section A was parallel to River Oyun followed by section B in the middle of the farm while the last section C ran parallel to the road from Ijagbo. The land use types were scattered within the three blocks. However, the water logged area was confined only to section A which was close to river Oyun. Soil samples were collected at the depth of 0-20cm and 20-40cm and at a distance of 20m apart. The observation spots were selected in such a way that biased points like anthills and rocky spots were avoided. The soil collected were put in nylon bags and properly labelled.

Laboratory analysis

The soil samples collected were bulked to form composite samples, air dried passed through 2mm sieve and analysed for some of its physical and chemical properties. Particle size was determined by Bouyoucos hydrometer methods; soil pH was measured in 1:1 soil - water ratio using the EDT BA350 digital pH meter while organic carbon was determined by the wet digestion dichromate acid-oxidation method. Total N was determined using Kjeldahl digestion method and available P by Bray P1 method. Exchangeable cations (Ca^{2+}, Mg^{2+}, K^+ and Na^+) were extracted with 1 N ammonium acetate (NH_4OAc) buffered at pH 7.0 (Thomas,1982). Exchangeable K and Na in the extracts were read through the Jenway flame photometer (model PFP7) and Ca and Mg were read on Atomic Absorption Spectrophotometer (AAS) Buck Scientific 200A model. Exchangeable acidity was extracted with 1 N KCl and determined by titration with 0.05 N NaOH using phenolphthalein indicator (Mclean, 1965) while the effective cation exchange capacity (ECEC) was by summation method and percent base saturation was calculated as follows:

$$\% \text{ Base saturation} = \frac{\text{Exchangeable bases}}{\text{ECEC}} \times \frac{100}{1}$$

The fertilizer computation was based on the chemical properties of the top soil (0-20cm) taking into consideration that both lateral and creeping roots are housed at this soil depth.

RESULTS AND DISCUSSION

Soil physical and chemical characteristics

Section A

Soil physical and chemical characteristics of block A is shown on (Table 1). Sand content of the 0-20cm and 20-40cm soil depth ranged between 662g/kg to 762.4 g/kg and 602.4g/kg to 742.4g/kg respectively, with a mean value of 682.4g/kg. Sand content decreased with increasing soil depth. Silt content of the top 0-2cm soil depth ranged between 72.8g/kg to 232.8g/kg with a mean value of 160.8g/kg. The silt content of 20-40cm soil depth ranged between 112.8 to 252.8 g/kg, with a mean value of 172.8 g/kg. Silt content increased with increasing soil depth. Clay content of the soil decreased with increasing soil depth. Clay at the top 0-20cm soil depth ranged between 124.8g/kg to 164.8g/kg with a mean value of 151.8g/kg. Clay in 20-40cm soil depth also ranged between 144.8g/kg to 168.8g/kg with mean value of 149.1g/kg. The textural class of the soil is sandy loam. Despite the high sand content of the soil, cashew thrives well on this soil because cashew is hardy and adapt to dry environment (Ohler, 1979). The soil is slightly acidic with soil pH increasing with increasing soil depth. At the top 0-20cm soil depth, soil pH ranged between 6.19-6.66 with a mean value of 6.54. Cashew thrives well in soil of pH of 5-7.7. The soil pH is therefore favourable for cashew production.
Soil organic carbon content in the top 0-20cm soil depth ranged between 16.2g/kg to 28.8g/kg with a mean value of 19.7g/kg. Organic carbon at 20-40cm soil depth also ranged between 10.1g/kg to 22.7g/kg with a mean value of 15.35 g/kg and organic carbon content decreased with increasing soil depth. Soil organic carbon content was medium and was sufficient to sustain cashew production. Total soil nitrogen in the top 0-20cm soil depth ranged between 0.07g/kg to 0.18g/kg with a mean value of 0.1 g/kg soil. While total N in 20-40cm soil depth ranged between 0.07g/kg to 0.16g/kg with a mean value of 0.12g/kg. This is highly inadequate for cashew production, as this value is well below the soil critical value of 1g/kg (Egbe *et al*, 1989) required for cashew production. There is therefore urgent need to apply nitrogen fertilizer. Soil available phosphorus decreased with increasing soil depth. Soil available phosphorus in the top (0-20cm) soil depth ranged between 2.82g/kg to 3.47mg/kg with a mean value of 3.22mg/kg. Similarly, available phosphorus at 20-40cm soil depth ranged between 1.78mg/kg to 4.08mg/kg with a mean value of 2.62mg/kg. Mean soil available phosphorus in the top 0-20cm soil depth was below the soil critical level of 3.7mg/kg, phosphorus level than the critical soil. Phosphorus level all other locations had values. At 20-40cm soil depth, soil available phosphorus also fell below the soil critical phosphorus level with a ranged of 0.09 mg/kg to 0.16mg/kg and a mean value of 2.62 mg/kg. There is need for application of phosphorus fertilizer. Mean exchangeable potassium content across 0-40cm soil depth ranged between 0.09cmol/kg to 0.35 cmol/kg with a mean value of 0.25 cmol/kg and 0.19cmol/kg for 0-20 cm and 20-40cm soil depth respectively. This is above the soil critical potassium level of 0.12 cmol/kg soil required for cashew production. There is therefore no need for potassium fertilizer application. Exchangeable calcium across the various soil depth was high ranging between 4.82 cmol/kg to 7.43 cmol/kg with a mean value of 6.69 cmol/kg and 5.91 cmol/kg for 0-20cm and 20-40cm soil depth respectively. Calcium content of the soil was adequate for cashew production as soil exchangeable calcium content was well above the soil critical calcium value of 0.8 cmol/kg soil. There is therefore no need for calcium

fertilizer application. Similarly, soil exchangeable magnesium across the various soil depth ranged between 0.84 cmol/kg to 1.38 cmol/kg with mean value of 1.12 cmol/kg at 0-20cm and 20-40cm soil depth. Soil exchangeable magnesium was adequate for cashew production as it was well above the 0.08 cmol/kg soil recommended for cashew production. Exchangeable acidity ranged between 0.18cmol/kg to 0.76cmol/kg in the top 0-20cm soil depth with a mean value of 0.28cmol/kg. Exchangeable acidity of 20-40cm soil depth also ranged between 0.40 cmol/kg to 0.68 cmol/kg with a mean value of 0.51 cmol/kg soil.

Table 1: Physical and chemical properties of soils of section A at Iyapo farm Estate Offa, Kwara State

		Soil physical properties						Soil chemical properties				
Location	Soil depth (cm)	Sand (g/kg)	Silt (g/kg)	Clay (g/kg)	pH	Org.C (g/kg)	Total. N (g/kg)	Avail.P (mg/kg)	Exch.K (cmol/kg)	Exch.Ca (cmol/kg)	Exch.Mg (cmol/kg)	Exch.acidity (cmol/kg)
A1	0-20	762.4	72.8	164.8	6.19	20.0	0.027	3.47	0.35	7.43	1.38	0.76
A2	0-20	662.4	172.8	164.0	6.61	28.8	0.183	3.62	0.22	7.58	1.04	0.18
A3	0-20	642.4	232.8	134.6	6.32	16.2	0.128	2.82	0.22	6.20	1.22	0.48
A4	0-20	682.4	164.8	152.8	6.35	13.9	0.053	2.98	0.20	5.53	0.83	0.56
Total	0-20	2749.6	643.2	607.2	25.47	78.9	0.391	12.89	0.99	26.74	4.47	1.12
Mean	0-20	687.4	160.8	151.8	6.37	19.7	0.10	3.22	0.25	6.69	1.12	0.28
A1	20-40	742.4	144.8	112.8	6.38	17.4	0.091	4.08	0.26	6.43	1.32	0.68
A2	20-40	642.6	192.8	164.8	6.62	22.7	0.145	2.76	0.26	6.55	1.21	0.60
A3	20-40	602.4	252.8	144.8	6.65	11.2	0.070	1.84	0.15	5.82	1.10	0.40
A4	20-40	722.4	132.8	144.8	6.50	10.1	0.162	1.78	0.09	4.82	0.84	0.44
Total	20-40	2709.8	691.2	599.2	19.51	61.4	0.468	10.46	0.76	23.62	4.47	2.12
Mean	20-40	677.45	172.8	149.8	4.80	15.35	0.117	2.62	0.19	5.91	1.12	0.51

Table 2: Physical and chemical properties of soils of section B at Iyapo farm Estate Offa, Kwara state

		Soil physical properties						Soil chemical properties				
Location	Soil depth (cm)	Sand (g/kg)	Silt (g/kg)	Clay (g/kg)	pH	Org.C (g/kg)	Total.N (g/kg)	Avail.P (mg/kg)	Exch.K (cmol/kg)	Exch.Ca (cmol/kg)	Exch.Mg (cmol/kg)	Exch. acidity (cmol/kg)
B1	0-20	802.4	32.8	164.8	6.24	18.1	0.119	4.51	0.17	5.53	0.97	0.62
B2	0-20	782.4	92.8	124.8	6.57	38.0	0.075	2.93	0.17	5.03	0.91	0.68
B3	0-20	782.4	92.8	124.8	6.53	7.00	0.067	2.47	0.17	5.53	0.95	0.64
B4	0-20	762.4	112.8	124.8	6.65	11.2	0.091	3.05	0.20	6.05	0.96	0.48
Total	0-20	3129.6	331.2	539.2	26.02	74.3	0.352	12.96	0.71	22.14	3.74	2.42
Mean	0-20	782.4	82.8	134.8	6.51	18.6	0.088	3.24	0.18	5.54	0.95	0.61
B1	20-40	782.4	92.8	124.8	6.63	10.5	0.101	3.05	0.20	5.28	0.97	0.88
B2	20-40	782.4	92.8	124.8	6.31	6.10	0.083	3.10	0.13	5.93	0.94	0.36
B3	20-40	762.4	92.8	144.8	6.66	3.20	0.039	2.82	0.13	5.86	0.80	0.56
B4	20-40	742.4	32.8	224.8	6.68	9.70	0.062	2.47	0.17	5.28	0.97	0.44
Total	20-40	3069.6	311.2	464.4	26.28	633.4	0.285	11.43	0.63	22.32	36.8	2.23
Mean	20-40	767.4	77.8	154.8	6.57	158.4	0.07	2.56	0.16	5.59	0.92	0.56

Section B

The sand in the top 0-20cm soil depth ranged from 762.4 g/kg to 802.4 g/kg with a mean value of 782.4 g/kg. In the 20-40cm soil depth, sand content ranged between 742.4g/kg to 782.4g/kg with a mean value of 767.4 g/kg, with sand content decreasing with increasing soil depth (Table 2). Silt in the 0-20cm soil depth ranged between 32.8-112.8g/kg with a mean value of 82.5 g/kg. Similarly, silt in 20-40cm soil depth ranged between 32.8g/kg to 92.8 g/kg with a mean value of 77.8 g/kg, with silt content increasing with increasing soil depth. Clay content across the 0-40cm soil depth ranged between 124g/kg to 224.8 g/kg with a mean value of 134.8 g/kg and 154.8 g/kg for 0-20cm and 20-40cm soil depth respectively. The textural class of the soil is loamy sand. This is ideal for cashew production. Soil pH content across the various soil depth ranged between 6.24-6.68 with a mean value of 6.51 at 0-20cm soil depth and 6.57 at 20-40cm soil depth. The soil is slightly acidic and okay for cashew production as it falls within the pH range recommended for cashew production. Soil organic carbon at the top 0-20cm soil depth ranged between 7 g/kg with a mean value of 18.6 g/kg. Soil in the 20-40cm soil depth ranged between 3.2 g/kg to 10.5g/kg with a mean value of 7.38 g/kg. Soil organic carbon content decreased with increasing soil depth. Organic carbon in the top 0-20cm was sufficient to sustain cashew production. However, at the lower 20-40cm soil depth soil organic carbon was insufficient. There may be need to apply organic fertilizer in subsequent years to enhance the organic carbon content of the soil. Nitrogen across the various soil depths ranged between 0.04 g/kg to 0.12 g/kg with nitrogen content of the soil decreasing with increasing soil depth. This falls below the soil critical level of 1 g/kg required for cashew and was grossly inadequate to meet nitrogen need for cashew. There is therefore need for nutrient supplementation as fertilizer to meet the nitrogen needs of cashew. Phosphorus was also inadequate across the soil depth with a range of 2.47 mg/kg to 4.51 mg/kg across the various soil depth and a mean value of 3.24 mg/kg and 2.65 mg/kg for 0-20cm and 20-40cm soil depth respectively. This was below the soil critical value of 3.7 mg/kg. There is therefore need to apply phosphorus fertilizer to boost cashew productivity. Soil exchangeable potassium was adequate across the various soil depth with a range of 0.13 to 0.20 cmol/kg and a mean value of 0.18 cmol/kg and 0.16 cmol/kg for 0-20cm and 20-40cm soil depth respectively. There is therefore no need for potassium fertilizer application. Soil exchangeable calcium and magnesium were also adequate. Soil exchangeable calcium had a mean value of 5.54 cmol/kg and 5.59 cmol/kg in 0-20cm and 20-40cm soil depth respectively. This was well above the soil critical level of 0.8 cmol/kg required for cashew. Similarly, exchangeable magnesium content ranged between 0.80 cmol/kg soil and 0.94 cmol/kg soil with mean value of 0.95 cmol/kg and 0.93 cmol/kg for 0-20cm and 20-40cm soil depth respectively. This was also well above the soil critical value of 0.08 cmol/kg soil required for cashew production. Mean exchangeable acidity was 0.61 cmol/kg and 0.56 cmol/kg for 0-20cm and 20-40cm soil depth respectively. This was also adequate for cashew production.

Table 3: Physical and chemical properties of soils of section C at Iyapo farm Estate Offa, Kwara State.

		Soil physical properties								Soil chemical properties		
Location	Soil depth (g/kg)	Sand (g/kg)	Silt (g/kg)	Clay (g/kg)	pH (cmol/ kg)	Org. C (cmol/ kg)	Total N (cmol/ kg)	Avail P (cmol/ kg)	Exch K(cmol /kg)	Exch Ca	Exch Mg	Exch. acidity
C1	0-20	782.4	92.8	124.8	6.48	18.10	0.167	3.74	0.30	5.27	1.16	1.08
C2	0-20	782.4	92.8	124.8	6.51	12.00	0.048	3.97	0.13	5.03	0.72	0.80
C3	0-20	802.4	172.8	24.8	6.47	14.30	0.111	4.90	0.28	9.13	1.04	0.72
C4	0-20	722.4	132.8	144.8	6.34	5.10	0.137	2.75	0.24	7.32	1.22	0.68
Total	0-20	3089.6	391.2	519.2	25.8	49.50	0.463	15.06	0.95	26.75	4.14	2.56
Mean	0-20	772.4	97.8	129.8	6.45	12.38	0.12	3.77	0.24	6.68	1.04	0.64
C1	20-40	762.4	112.8	124.8	6.46	12.40	0.128	4.49	9.29	6.42	1.24	0.44
C2	20-40	782.4	92.8	124.8	6.67	10.50	0.045	4.20	0.11	6.18	0.55	0.76
C3	20-40	702.4	92.8	204.8	6.18	16.20	0.099	4.04	0.24	6.88	1.11	0.84
C4	20-40	742.4	112.8	144.8	6.56	11.20	0.115	4.43	0.24	6.61	1.20	0.60
Total	20-40	2989.6	411.2	599.2	25.87	50.30	0.287	17.16	0.85	26.09	4.10	2.64
Mean	20-40	747.4	102.8	149.8	6.47	12.57	0.10	4.29	0.21	6.52	1.03	0.60

Section C

The mean sand, silt and clay at the top soil (0-20cm) was 772.6, 97.8 and 129.8 g/kg soil respectively while the mean sand, silt and clay at the sub soil was 747.4, 102.8 and 149.8 g/kg soil respectively (Table 3). The soil has a very high sand fraction both at the top and sub- soil. Although the sand fraction at the top soil decreased by 3.2% at the sub-soil while the silt and clay both increased by 5% and 15% respectively. The clay soil content is below 300 g/kg soil which can be considered low and the possibility of water deficit during the dry season is there. However, cashew has ability to adapt to dry environment more than many other tree crops as soon as it survives the first two years of establishment. It is still expected that with good agronomic practices, cashew will still establish despite the level of sand in the farm.

The pH of the soil at both depth was 6.46 and thus falls within the acceptable range of 5.50 to 6.50 for cashew cultivation. Hence, there is no need for any form of adjustment through liming. The average organic carbon and total N at the top soil (0-20cm) was 12.38 and 0.12 g/kg while at the sub soil (20-40cm), the mean was 12.57 and 0.10 g/kg soil respectively. This shows that the organic carbon and the total N at the top soil were higher than the values obtained at the sub soil, the values were however moderate for good cashew cultivation. This gives the possibility of using N- fertilizer particularly of organic origin so that the soil will not be acidified if inorganic N source is used like urea and other acidifying fertilizers. The mean available P at both depth was 4.03mg/kg soil. The value is moderate for cashew production as this could fall below 3.7 mg/kg. There is need for routine management of the P through the use of natural rock phosphate (Sokoto rock phosphate) but if this is not available, single super phosphate could also be used as recommended in the findings of Ibiremo *et.al* (2005).

Similarly, the level of exchangeable K across the depth was 0.22 cmol/kg soils. The mean exchangeable cashew at the top soil was 6.68 cmol/kg soil while at the subsoil was 6.52 cmol/kg soil. The value of exchangeable calcium at the top soil decreased by 2.4% when compared with the value of exchangeable magnesium that was 1.03 cmol/kg soil which is moderate. The Ca/Mg ratio was 6.38. This value maintains the normal relationship provided for productive soil. This indicates that the soil matrix maintains a proper balance and hence there is no likelihood of nutrient imbalance in the soil. It is instructive that there is no need for adjustment in the content of the soil total N, available P and exchangeable potassium. These three major nutrients give the direction for the productivity of soil when pH is within the appropriate range of 5.50 to 7.50.

The mean value of N across the two soil depths was 0.11g/kg. This value is below the soil critical value of 1g/kg. The average value of soil available P of 4 mg/kg soil is higher than the soil critical value of 3.7 mg/kg soil. Similarly, the value of K was above the soil critical value for cashew production. Hence, there is no need for P and K fertilizers as at now. However, nitrogen fertilizer will be required for optimum production.

Table 4: Physical and chemical properties of water logged cassava plots previously cultivated and excavated land at Iyapo farm in Offa, Kwara State.

	Soil physical properties				Soil chemical properties							
	Soil depth (g/kg)	Sand (g/kg)	Silt (g/kg)	Clay (g/kg)	pH (cmol /kg)	Org. C (cmol/ kg)	Total N (cmol /kg)	Avail P (cmol /kg)	Exch K (cmol /kg)	Exch Ca	Exch Mg	Exch. acidity
ged	0-20	642.4	192.8	164.8	6.78	5.40	0.065	3.51	0.09	5.03	0.91	0.40
ged	20-40	582.4	232.8	184.8	6.67	15.40	0.144	3.39	0.17	5.51	0.83	1.36
	0-20	742.4	92.8	124.8	6.56	12.40	0.082	5.12	0.22	8.76	1.02	0.44
	20-40	762.4	92.8	144.8	6.54	1.70	0.056	3.04	0.15	5.87	0.94	0.70
l	0-20	782.4	72.8	144.8	6.52	7.00	0.075	3.10	0.17	5.27	0.92	0.56
l	20-40	762.4	92.8	144.8	6.69	6.60	0.063	5.83	0.22	5.01	0.96	0.64
l	0-20	722.4	112.8	164.8	6.56	5.40	0.050	2.12	0.09	6.61	0.81	0.68
l	20-40	742.4	132.8	124.8	6.75	12.00	0.039	3.34	0.09	5.58	0.77	0.64

Table 5: Fertilizer recommendation for different land use types in Iyapo farm

Land Use Types	N, P and K Required					
Fertilizer Recommendation						
		N kg/ha	P_2O_5 (Kg/ha)	K_2O(Kg/ha)		
Sections A, B and C	82.8	5.6	-	180	31.50	-
Cassava farm and previously cultivated bared land	84.78	1.97	-	189	9.9	-
Excavated land	87.4	5.10	22.97	194.2	25.8	38.28

The sand content of the waterlogged area of the farm which occupied about 1/32 of the farm land (1.56 hectares) was lower than the other land use types - cassava, previously cultivated and excavated land. This might be due to washing away by erosion and the portion of the top soil was higher in sand content. Clay +silt content of the water- logged surface soil (0-20cm) was higher than other land use types. This might be the reason for more water retention which led to water logging because of poor drainage. The water logged portion was situated in the section area of the farm parallel to the major stream at the boundary of the farm. Exchangeable Ca and Mg contents were adequate for cashew in the water - logged area of the farm. The total nitrogen, available phosphorus and exchangeable potassium content were slightly below the amount required by cashew. Fertilizer will be required to supply the deficient N, P and K in that portion of the land.

Cassava plot on the land

The sand content of the top soil of the cassava plot was higher than water-logged and excavated portion of the land. The pH was slightly acidic. All the major nutrients except nitrogen were adequate and slightly above the amount required for cashew. There will be need for supplementation with nitrogen fertilizers.

Cultivated soil

The previously cultivated bare soil portion of the land had lesser amount of available P, exchangeable K and Mg in the top soil compared to the sub soil. This might be due to leaching and or run off. Total nitrogen and phosphorus in the previously cultivated bare land were low and below the critical values required by cashew. This implies that nitrogen and phosphorus fertilizers will be applied.

Excavated land

Total nitrogen, available phosphorus and exchangeable potassium were slightly below the critical nutrient values required by cashew in the excavated land. Exchangeable calcium and magnesium content of the soils were adequate and grossly above the critical values required. N, P and K fertilizer will be required for application on cashew to be planted on excavated land.

CONCLUSION

The soil fertility evaluation of the 49.56 hectares of land proposed for the establishment of cashew by the farm. The farm was divided into three main blocks (A, B and C) based on topography and four land use types (water-logged, cassava plot, previously cultivated land and excavated land). Block A was parallel to River Oyun followed by Block B in the middle of the farm, while the last block C ran parallel to the road from Ijagbo. Soil samples were collected at soil depth of 0-20cm and 20-40cm and at a distance of 20m apart. The soil collected was put in nylon bags and properly labelled. Soil samples collected were air dried, passed through 2 mm sieve and analyzed for some of its physical and chemical properties. In the various land use types, section (A, B and C) requires 180 kg/ha of urea and 31.5 kg of Single Super phosphate (SSP) for optimum productivity. Application of fertilizers improved growth and nut yield of cashew (ComCashew , 2018).The cassava plot and previously cropped bare land require 189 kg/ha urea and 9.9 kg/ha SSP, while the excavated land requires 194.2 kg urea 25.8 kg SSP and 32.28 kg MOP as showed in Table 5 below. Cashew should not be grown on the water-logged section because cashew will not thrive well there.

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ASSESSMENT OF NUTRIENT COMPOSITION OF UGU (*TELFAIRIA OCCIDENTALIS* HOOK. F*)* AS INFLUENCED BY SEX

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ABSTRACT
Telfairia occidentalis (fluted pumpkin) is an important indigenous vegetable in Nigeria. It is mostly grown and consumed in the Southern part of the country because of it is rich in nutrients and minerals which are important in fighting hidden hunger. The study was conducted to assess the differences in the nutrient composition of ugu plant based on different sex type expression in ugu, Seeds of ugu were extracted from the pod and pre-nursed in sawdust, the seedlings were later transferred at four weeks after sowing to well-prepared field using a completely randomized design with three replications. Fresh leaves were harvested at flowering from identified male and female vines for nutrient analysis. Results revealed significant variations (p < 0.05) for the measured nutrient constituents suggesting that the either of the sexes possess useful alleles for recombination. The iron content recorded in female was higher (9.83mg/100g) than in male (9.6mg/100g) both still fall within the recommended dietary allowance (RDA). The result provides evidences that leaves from both sexes can be consumed for improved diet and that both sexes possess useful genes that can further be exploited to develop improved ugu with increased nutrient content.
Keywords*: Hidden hunger, indigenous vegetable, sex type, nutrient, ugu*

INTRODUCTION

The tropical fluted pumpkin is a dioecious and perennial plant belonging to the family of Cucurbitaceae and is characterized by broad lobed greenish leaves commonly referred to as *U*gu. The shrub grows into either a male or female plant; the sex differences are only identifiable after flowering. While the female plant which produces big fruits containing the seeds has broad and succulent leaves; the male plant only produces flowers and smaller leaves. The stems of the female plant are usually big and strong while that of the male plants are tiny. Farmers usually harvest the male plant for leaves while the female plant are left on the field for productions of seeds for the next planting season. However, consumers prefer the female leaves for culinary uses because of its succulent texture and broadness of the leaves (Ajibade et al 2006). Majority of the studies conducted on sex of ugu had been on morphological basis of identification for production and yield ration (Aremu and Adewale 2012, Akoroda and Adejoro1990, Emebri and Nwufo, 1996). Adequate consumption of leafy vegetables has been reported as an important means of fighting hunger and malnutrition, ensuring food security and generating income for farmers. Fluted pumpkin has been associated with several healing properties for treating and alleviating certain diseases and illnesses. It can also be used for making soaps as well as for preparing local spices known as ogiri. Considering that the leaf of *T. occidentals* constitutes a major part of diet and herbal remedies for populations in West Africa, this study seeks to compare the proximate, phytochemical, antioxidant, antinutrients, vitamin and mineral composition of the female and male plant in order to generate useful information for consumers and to generate evidence to support selection for desired sex expression in ugu.

MATERIALS AND METHODS

Plant material

The ugu pod was bought from Ojoo market in Ibadan. The seeds were sown in sawdust in nursery trays in the screen house. The seedlings were transplanted to a well-prepared vegetable research field (N07.40130; E003.84905; 178.06m above sea level) four weeks after sowing in the nursery in the year 2020. The seedlings were planted at a spacing of 1m x 1m using a completely randomized design

(RCBD) with three replications. Vines were tagged separately with regards to the sex type expressed by the flower. Harvested fresh leaf samples were collected from tagged vines and taken to the Product Development Laboratory of the National Horticultural Research Institute for nutrient analysis.

Preparation of leaves

The leaves were first sorted to remove any infested parts; they were then washed under running water to remove dirts and drained off in a perforated plastic basket. The leaves were dried using a hot air food dehydrator at 50^0C. They were ground into powdery form and kept in an airtight container in a refrigerator for further analyses.

Proximate and antioxidant analysis: The Vitamin C content, moisture content and % ash according to standard methods of the Association of Official Analytical Chemists (AOAC, 2005). Moisture content was determined by weighing 50g portion of each sample to constant weight using a vacuum oven at 70^oC for 24 hours. Moisture content was taken as the difference in weight between the initial sample and the dried sample.

Determination of mineral composition

The sample was investigated for elemental composition by using atomic absorption spectrophotometer (AAS- Bulk Scientific model AVG 211) after an acid digestion. Appropriate working standard solution was prepared for each element. The calibration curves were obtained for concentration versus absorbance. The data were statistically analyzed by using fitting of straight line by least square method. Laboratory procedures for the preparation and determination of micronutrients were used as outlined by Shah et al. (2009) for plant samples.

Determination of Proximate Composition

Proximate composition was determined according to the methods described by AOAC (2005). Briefly, protein content was determined using the Kjedahl method. To determine moisture, 5g of samples was placed in a crucible and the crucible in an oven at 100^0C until constant weight was obtained. The moisture content was calculated by finding the percentage loss in weight between the initial and final weight of samples. The fat content was determined using a Soxhlet extractor. The residue left after the extraction of oil using Soxhlet was used for fibre determination. The fat-free material was boiled and washed severally. The resulting residue was ash and the quantity of ash noted. Ash was determined by calculating the percentage loss in weight of 2g of samples in a crucible placed in a muffle furnace at 600^0C for 2 hours. Carbohydrates were determined by difference. Standard procedures were followed for the determination of other measured nutrients.

Data analysis: Data generated were subjected to statistical analysis using SAS version 9.4. Results were expressed as mean of triplicate determinations and statistical significance accepted at 5% probability level.

RESULTS AND DISCUSSION

Result in Table 1 revealed significant variations ($p < 0.05$) in the composition of measured nutrient constituents as differentiated by the sex types. Protein is an important part of human diet as it is responsible for growth and replacement of worn-out tissues. The amount of crude protein in both male and female ranged between 18 – 21% respectively in this study (Table 2). This result is somewhat closer to the findings of Arowosegbe et al. (2015) and Orole et al. (2020) but far from the findings of Mohd et al. (2016) which reported 56% and Adeyeye and Omolayo (2011) which reported 35.4%. The crude fiber content for male and female in this study (1.9 % - 2.0%) was lower to that reported by Orole et al (2020) which reported 8.0 – 9.0% for male and female respectively. Calcium is needed for strong bone formation and skeletal build up. The amount of Calcium is higher in the male ugu (33.2mg/100g) than in the female (32.4mg/100g) which is contrary to the result by Orole et al (2020) which reported higher Calcium in female ugu. Iron is an important constituent of haemoglobin responsible for the transport of oxygen from one part of the body to another while is a trace mineral element meaning that it is needed in small amounts and yet it is a major player in the creation of DNA growth cells, building proteins, healing damaged tissue and supporting a healthy immune system. Iron content was higher in female (9.8mg/100g) while zinc content was higher in the male ugu (0.8mg/100g). Values obtained for iron in this study fall within the recommended dietary allowance (RDA) of 8mg – 18mg/100g.

Male and female ugu contain important phytochemicals. Flavonoids possess a number of medicinal benefits, including anticancer, antioxidant, anti-inflammatory, and antiviral properties. They also have neuroprotective and cardio-protective effects. Flavonoid was higher in the male ugu (210.5mg/100g) which is higher than what was reported by Orole et al. (2020). Antioxidants create protective effects by neutralizing free radicals produced in the course of normal catabolic and anabolic processes within the cells. They act through hindering oxidative damage by bonding free radicals thus inactivating the radicals, antioxidants reduce inflammation and support healthy aging process (Yimer et al., 2023). Total antioxidant activity was higher in the male ugu (823.8mg/100g) than the female ugu. Chlorophyll is a rich source of vitamins including Vitamins A, C, E and K, as well as antioxidants and minerals such as Magnesium, Iron and Calcium. In this study, Chlorophyll A/B in the male ugu (17.50). This may due to the fact that the male ugu does not produce pod like the female where there is high demand for assimilate partitioning for the pod, the male plant thus retains all the trapped chlorophyll in the leaves (Pérez-Llorca and Sanchez, 2019; Sun et al., 2022).

CONCLUSION

The result of this study revealed that both sexes of ugu are reservoirs of healthy minerals and phytochemicals needed for healthy nutrition and well-being. This suggests that the ugu vegetable can be further improved for increased nutrient composition along the sex types. Improved male ugu with increased nutritive value will contribute useful alleles in cross combination to produce better progenies.

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Table 1: Mean square of measured nutrients in ugu leaves as determined by sex

Constituents	Replicate	Sex	Error	CV
	df = 2	df = 1	df=2	%
Vit. C (%)	0.2	12.18**	0.12	2.65
Phenolic (mg/100g)	8.66	308.44*	15.54	10.91
Beta C (mg/100g)	0.02	0.52***	0	0.9
Ch A/B	0.34	31.22***	1.04	6.71
Flavonoid (mg/100g)	32.84	3008.93**	27.77	2.8
FRAP (mg/100g)	8.69*	129.76***	0.18	0.26
Antiox (mg/100g)	266.72	65965.33***	21797547	2.05
Saponin (%)	0	0.52***	0	0.33
Fe (mg/100g)	0.04	0.12	0.03	1.65
Zn (mg/100g)	0	0.05**	0	3.44
Ca (mg/100g)	1.67	1.03	0.37	1.85
Na (mg/100g)	0.02	18.83***	0.03	1.65

*, **, *** Significant at 0.05, 0.01 and 0.001 probability levels, respectively.
CV = Coefficient of variation, Vit. C = Vitamin C, FRAP = Ferric reducing antioxidant power, Antiox = Antioxidant, Beta C = Beta Carotene, Ch A/B = Chlorophyll A/B, Na = Sodium, Fe = Iron, Zn = Zinc, Ca=Calcium

Table 2: Mean performance of quantified proximate composition of ugu as determined by sex

Constituents	Male		Female	
	Mean	Range	Mean	Range
	Quantity (%)			
Crude protein	18.81	0	21.00	18.8 - 23.19
Fat content	18.00	17.00 - 19.00	19.50	19.0 - 20.00
Crude Fiber	1.90	1.80 - 2.00	2.20	2.10 - 2.30
Moisture content	1.25	1.00 - 1.50	0.75	0.50 - 1.00
Ash content	1.75	1.50 - 2.00	2.25	2.00 - 2.50
Carbohydrate	58.29	57.19 - 59.38	54.30	56.89 - 51.71

Table 3: Mean performance of antioxidant, phytochemical and mineral composition of ugu as determined by sex

Constituents	Female	Male	Minimum	Maximum	Difference
	Mean				
Vit. C (%)	11.88±0.06	14.73±0.32	11.81	15.06	2.85**
Beta C (mg/100g)	20.64±0.07	18.96±0.11	18.79	20.78	1.68***
Ch A/B	12.94±0.18	17.50±0.65	12.6	18.75	4.56**
DPPH (%)	82.15±3.11	78.30±0.84	75.94	85.45	3.86
Phenolic (mg/100g)	28.96±0.41	43.30±2.81	28.45	47.32	14.34*
Flavonoid (mg/100g)	165.70±1.05	210.50±4.37	163.8	216.5	44.79**
FRAP (mg/100g)	168.40±1.25	159.10±1.19	156.8	170.2	9.30**
Tannin (mg/100g)	21.28±0.65	30.80±0.74	19.99	31.68	9.52***
Phytate (mg/100g)	57.81±0.70	39.334±2.72	35.08	59.2	18.47**
Total Antioxidant (mg/100g)	614.10±0.64	823.80±12.69	612.8	836.8	209.70***
Saponin (%)	3.96±0.01	4.551±0.01	3.95	4.57	0.59***
Oxalate (%)	0.48±0.02	0.38±0.02	0.36	0.5	0.11**
Fe (mg/100g)	9.83±0.13	9.55±0.06	9.47	9.97	0.29
Zn (mg/100g)	0.65±0.01	0.834±0.01	0.64	0.85	0.19***
Ca (mg/100g)	32.41±0.42	33.24±0.71	31.71	34.16	0.83
Na (mg/100g)	11.76±0.07	8.22±0.11	8.01	11.88	3.54***

Note: *, **, *** Significantly different from Male Ugwu leaf at the 0.05, 0.01 and 0.001 probability levels, respectively, using t test. DPPH = 2,2-Diphenyl-1-picrylhydrazyl, FRAP = Ferric reducing antioxidant power

EVALUATION OF DIFFERENT METHODS OF CULTIVATION ON CROWN SIZE DEVELOPMENT AND PERFORMANCE OF TWO VARIETIES OF LETTUCE (*Lactuca sativa. L.)*

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ABSTRACT
This study aimed to compare the effects of the screen house method of cultivation and open-field cultivation systems on the crown size and performance of two varieties of lettuce. The experiment was a 2x2 factorial scheme arranged in a randomized complete block design (RCBD) involving two methods of cultivation and two lettuce varieties. The results showed that the cultivation system significantly affected crown size and yield of both lettuce varieties. Protected cropping resulted in a higher polar and equatorial crown size and yield compared to the open field cultivation while the leafy lettuce variety had a larger crown size and yield compared to the head variety under both cultivation systems. These findings suggest that protected cropping is the most efficient cultivation system for growing lettuce, with leafy lettuce variety producing higher yield and crown size. It is recommended that farmers and horticulturists use protected cropping for growing lettuce, and should consider the appropriate lettuce variety for the desired yield and crown size.
Keywords: *Cultivation methods, lettuce varieties, Crown size, Yield.*

INTRODUCTION

Lettuce (*Lactuca sativa L.*) is one of the most popular vegetables worldwide and is consumed in large quantities due to its high nutritional value. In addition, it is widely cultivated for its edible leaves that are rich in vitamins and minerals (Kumar *et al*., 2016). In south western Nigeria, lettuce farming provides a source of income for farmers and also satisfies the growing demand for fresh vegetables in the region (Mukaila *et al.,* 2022). The cultivation of lettuce in many tropical and sub-tropical countries. Nigeria inclusive is still largely limited to the wet season, as dry season cultivation requires a lot of irrigation, which is expensive and often unavailable to smallholder farmers (Awazi *et al.,* 2022). The performance of lettuce is influenced by many factors, such as variety, cultivation system, and environmental conditions. One of the key factors affecting lettuce growth and yield is the crown size, which is the diameter of the main stem at the soil level (Islam *et al*., 2021; Fahmy and El-Shahawy, 2018). Crown size is an important growth parameter as it determines the number of leaves that can be harvested, which directly influences the yield of the crop. (Rathore and Singh, 2019). Production practices of different varieties of lettuce is dominated by two groups of varieties, namely the crisp head and the loose-leaf types (Fahmy and El-Shahawy, 2018). The crisp head group includes varieties such as Great Lakes and Grand Rapids, while the loose-leaf group includes varieties such as Salad bowl and Black-seeded Simpson. These two groups of lettuce varieties have different growth habits and are adapted to different climatic conditions. The loose-leaf varieties are easier to cultivate and have a shorter growing period, making them suitable for dry season cultivation.

On the other hand, the crisp head varieties require a longer growing period and are more sensitive to environmental stress, making them more suitable for wet season cultivation (Myers, 2017). Screen house systems of lettuce cultivation involve the use of protective structures to shield the crop from environmental stresses such as extreme temperatures, excessive rain or wind, pests and diseases (Aroune and Haj Sassi, 2019). Studies have shown that screen house systems provide an ideal environment for lettuce cultivation, promoting speedy growth and minimizing yield loss caused by environmental fluctuations (Petropoulou *et al*., 2023). Screen house systems have also been reported to provide better control of pests and diseases, resulting in better yield and quality of lettuce (Wang*et* *al*., 2023). However, the high initial investment in construction and maintenance and increased energy costs for heating, cooling, and ventilation (Barbosa *et al.,* 2015) limits its practices among local farmers in Nigeria. Conventional (open) systems, on the other hand, involve cultivation of lettuce in the open field without any protective structures. This system relies on natural conditions for plant growth, including temperature, rainfall, and sunshine (Alam and Agarwal, 2018). However, open systems have limited control over pests and diseases, leading to significant yield loss (Ashraf *et al.,* 2018).

MATERIAL AND METHODS

Site Description

The experiment was conducted at the screen house in the Department of Agricultural Technology, Federal Polytechnic, Ado-Ekiti (Latitude 7.61^{0}N and 5.23^{0}E) between April and October, 2017. The soil in the area was sandy loam, which is an ideal soil for lettuce.

Establishment of *Lactuca sativa*

Treatments consisted of two methods of cultivation, namely, the Screen House System (SHS) and the Open Field System (OFS) where lettuce seedlings were planted in an open environment. The two varieties of lettuce considered for this study were the crisp head variety (CHV) and the loose-leaf variety (LLV). These two groups of lettuce varieties have different growth habits and are adapted to different climatic conditions. The experiment was a 2x2 factorial scheme arranged in a randomized complete block design (RCBD) involving the following treatments:

i. The Screen House System (SHS) + The loose leafy variety (LLV)
ii. The Screen House system (SHS) + The crisp head variety (CHV)
iii. The Open Field system (OFS) + The loose leafy variety (LLV)
iv. The Open Field system (OFS) + The crisp head variety (CHV)

There were five beds replicated four times to make a total of 20 beds for both trials. Planting was carried out in the screen house between April and June 2017 while the field trial was carried out between August and October, of the same year using the same experimental design. The seedlings were raised in a well prepared seed bed of loose pliable good tilt soil. The dimension of the nursery seed bed was (3mx2m). Watering was done twice a day for a period of three weeks. Transplanting was done when the seedlings were three weeks old at a spacing of 0.3mx0.3m on a raised seed bed. For the screen house trial, a drip irrigation system was installed immediately after transplanting. Drip lines were aligned parallel in every row. Irrigation was usually applied two hours every day from 7:00am to 9:00am every morning while the field trial was subjected to the natural rainfall condition throughout the duration of the experiment. Manual hoe weeding was done every 2 weeks to control weeds and allow for soil aeration until harvesting.

Data Collection

Three plants were randomly selected in each plot for observation on growth parameters (plant height; number of leaves, stem girth) while yield (fruit dry and fresh weight per plant and total fresh fruit yield per hectare) was recorded for the whole plot and converted to yield per hectare by extrapolation. Lettuces were harvested when the head was full and compact at about 30 days after transplanting. In addition, the crown size (polar and equatorial length) was measured.

RESULTS AND DISCUSSION

The effect of different methods of cultivation on crown size development and performance of two varieties of lettuce is presented in Table 3. The result shows that the screen house method (SHS) of cultivation recorded significantly higher values for most of the measured growth and yield characters. The result also shows that the loose leafy head (LLH) variety was significantly better than the Crisp head variety (CHV). Under the screen house method of cultivation, LLH recorded significantly better values for plant height (66.41cm over CSH, 57.03cm), with a lower value being recorded for CHV under the open field condition (OFC). Similar result was recorded for, number of leaves, (40.62 over CSH, 35.91), fruit weight, (228.95g over CSH, 187.43g), and total fresh fruit yield (19.03t/ha, over CSH, 15.65t/ha). In addition, the polar and equatorial crown size was significantly larger under the screen house system (SHS) for LLH than CHV under (OFS).

The results showed that crown size and yield of both lettuce varieties was significantly affected by the cultivation system. Protected cropping resulted in a higher crown size and yield compared to the open field cultivation. The leafy lettuce variety had a larger crown size and yield compared to the crisp head variety under both cultivation systems. Protected structure served as protection of crop from rain, wind and extreme temperatures, (Gerona *et al* 2015, Rogers *et al.,* 2013) which explained the increase in production. Another contributing factor to higher yield efficiency in the protected system is reduced soil borne disease infection and insect pests infestation (Rathore *et al.,* 2019). Foliage diseases could be controlled or eliminated through protected cultivation. The results suggest that protected cropping is the most efficient cultivation system for growing lettuce, and loose leafy lettuce variety is more suitable for higher yield and crown size.

CONCLUSION AND RECOMMENDATIONS

The study shows that the protected cropping system increased crown size and enhanced yield. In addition, the system produced healthier plants with reduced incidence of diseases. It could be a great asset in the enhancement and sustainability of lettuce production in preventing further damage on crops when compared to the open field system which is characterized by excessive rainfall and wind. Leafy-type lettuce when grown inside the protected shelters produced larger crown size compared to plants grown under open field condition.

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Table 1: Meteorological data during the Early and late rainy season of 2017

Month	Temperature (^{0}C)		Average Monthly Sunshine hours	Relative Humidity (%)	Rainfall (mm)
	Maximum	Minimum			
April	33.2	23.7	194.6	55	53.5
May	32.4	22.4	189.3	63	97.9
June	31.7	21.9	161.9	67	205.1
August	29.7	22.5	89.5	81	253.6
September	28.5	21.8	96.3	72	211.9
October	29.8	20.9	147.2	63	179.4

Mean weather data for the period of the experiment

Table 2: Physico-chemical properties of the soil at experimental site

Properties	**Value**
pH	6.95
Total N (%)	0.38
Available P (mg/kg)	16.1
Ca^{2+} (Cmol/kg)	5.4
Mg^{2+} (Cmol/kg)	2.5
K^{+} (mg/kg)	24.9
Na^{2+} (Cmol/kg)	0.34
Organic carbon (%)	2.14
Organic matter (%)	2.15
Particle size distribution	
Sand	62.80
Silt	12.0
Clay	25.20
Texture	Sandy Loam
Bulk density (g/cm^3)	1.32

Table 3: Effect of different methods of cultivation on crown size development and performance of two varieties of lettuce at harvest.

Treatments	Varieties	PCS	ECS	Plant height (cm)	Number of leaves	Stem girth (cm)	Fruit fresh weight (g)	Fruit dry weight/plant (g)	Total fresh fruit yield (t/ha)
SHS	LLV	31.45	17.71	66.41	40.62	1.48	228.95	24.32	19.03
	CHV	11.67	13.45	57.03	35.91	1.45	187.43	20.12	15.65
OFS	LLV	26.86	20.69	45.64	31.85	1.26	174.18	19.63	14.53
	CHV	19.45	12.61	37.98	27.94	0.79	158.59	18.94	13.24
SD		**7.96**	**2.60**	**10.28**	**5.27**	**0.35**	**27.29**	**2.52**	**2.25**
LSD (0.05)		**8.92**	**4.39**	**14.91**	**6.30**	**0.66**	**34.12**	**2.85**	**3.37**
SE±		**3.80**	**1.55**	**6.30**	**2.54**	**0.14**	**14.42**	**1.16**	**1.35**
CV (%)		**0.34**	**0.19**	**0.25**	**0.15**	**0.22**	**0.15**	**0.11**	**0.18**

(SHS)-Screen House System. (OFS) - Open Field System (OFS),(PCS)-Polar Crown Size. (ESC)-Equatorial Crown Size. (CHV)- Crisp Head Variety. (LLV)- Loose-Leaf Variety.

EFFECTS OF DIFFERENT TILLAGE PRACTICES IN COMBINATION WITH POULTRY MANURE RATES ON THE PRODUCTION OF TURMERIC (*Curcuma longa L.)* IN OWERRI

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ABSTRACT

A field experiment was carried out on the effects of different tillage practices in combination with poultry manure rates on the production of Turmeric (Curcuma longa L.) at the Teaching and Research Farm, School of Agriculture and Agricultural Technology, Imo State Polytechnic, Omuma. The experiment was arranged in a spilt plot Design fitted into a Randomized Completely Block Design (RCBD) replicated four (4) times. The treatments include three (3) tillage practices (Bed, Flat and Ridge) and three poultry manure rates (0t, 5t and 10t/ha). Data were collected on plant height, number of leaves/plant at 4,8,12 and 16 weeks after planting while yield values were determined at harvest (thirty six (36) weeks after planting). Analysis of variance (ANOVA) showed that ridge tillage practice + poultry manure at the rate of 10t/ha produced the highest rhizome yield (26.84t/ha). and Dry matter yield (19.29t/ha) which were significantly different from other treatments. Vegetative growth was influenced positively by the ridge tillage practice + poultry manure applied at the rate of 10t/ha throughout the experimental period. However, lowest rhizome and dry matter yields as well as lower vegetative growth were observed at flat tillage practice + 0t/ha (control) treatment. Therefore, ridge tillage practice + poultry manure at 10t/ha is recommended for Turmeric production in the study area.

Keywords: *Curcuma longa, tillage practice, poultry manure, Turmeric.*

INTRODUCTION

Turmeric (*Curcuma longa L*) is a ginger that belongs to the family *Zingiberaceae*. It originated from south East Asia and grows in Bangladesh in about 16.06 thousand hectares with annual production of 41.50t/ha (BBS, 2009). It is an ancient most valuable sacred spices of Bangladesh that contains appreciable quantities of proteins (6.3%), lipids (5.1%) carbohydrates (69.4%), and fibre (2.6%). It is a horticultural root crop that is important not only as a spice, cosmetics but also as a medicinal plant worldwide (Herman and Martin, 1991; Osawa *et al.*, 1995; Hossain *et al.,* 2005; Nakamura *et al*, 1998). In Nigeria, it is mostly cultivated in homestead garden in about 19 states, given different names according to locality (Olojede *et al.*, 2005) (Not included in your reference list). Tropical soils are fragile in nature. In view of this, Integrated Soil Management is necessary for sustaining high crop yield. One of the practices that can moderate the organic matter and sustain productivity is appropriate tillage practice and use of organic manures. Avwundiogba, 2000, Oman, 2007, postulated that water holding capacity in the soil showed that soil was high in the tilled soil. Poultry manure is used as an organic fertilizer for soils low in nitrogen having the highest amount of Nitrogen and Potassium (Adams *et al.,* 2004). Due to the importance of Turmeric in the study area, it was necessary to adopt a strategy that will enhance its sustainable productivity. Therefore, the objective of this study was to evaluate the effects of tillage practices and poultry manure rates on the production of Turmeric (*Curcuma longa L.*) in Owerri, Imo state, Nigeria.

MATERIALS AND METHODS

The experiment was conducted at the Teaching and Research Farm, School of Agriculture and Agricultural Technology, Imo state Polytechnic, Omuma situated between latitude $05^{0}17^{1}$N and longitude $06^{0}54^{1}$ (NIMET, 2015). It has a minimum and maximum temperature of 28 – 32^{0}C, mean annual rainfall of 2500mm and a relative humidity of 89.5%. The area is in the Tropical humid rainforest zone of South East Nigeria. Before and after the experiment, soil sample with 0-25cm was collected at different points at the experimental site which were air dried and bulked for the analysis of physical and chemical properties. The land was cleared manually and marked out in plots. Thereafter, seed bed preparations measuring 3m x 3m were made. 3 tillage practices namely: bed, flat and ridge and 3 rates of poultry manure: 0t, 5t and 10t/ha formed the treatments. The experiment was arranged in a split plot Design replicated 4 times. Each replication is made up of six (6) plots making a total of twenty-four (24) plots in the experiment. Seeds of turmeric variety NCL INVRI obtained from Natural Roots Research Institute (NRCRI), Umudike were planted at a spacing of 50cm x 45cm. Poultry manure was applied at two (2) weeks after planting using band placement method. Data were collected on plant height, number of leaves/plant at 4,8,12 and 16 weeks after planting while yield values (rhizome and dry matter) were determined at harvest thirty six (36) weeks after planting. All data collected were subjected to analysis of variance (ANOVA) for Split Plot Design using SAS package, (1990) while treatment means were separated using Duncan's Multiple Range Test (DMRT).

RESULTS

Soil physico-chemical properties

The results of the pre-planting and post planting soil analysis are presented in Table 1

The effect of different tillage practices and poultry manure rates on plant height

The effect of different tillage practices in combination with poultry manure rates on the plant height of Turmeric (*Curcuma longa L)* is presented in Table 2. At 2 weeks after planting (WAP), Ridge tillage practice + 10t/ha poultry manure gave the highest mean plant height of 3.10cm for Turmeric plant. This was closely followed by a plant height of 2.77cm obtained using Ridge tillage practice + 5t/ha poultry manure during the same period which did not differ significantly ($P<0.05$) from each other. The plant that did not receive any poultry manure in both tillage practices gave the lowest mean plant height of 1.7 and 1.04cm respectively which were statistically ($P<0.05$) the same. The highest plant height (9.42cm) was obtained at Ridge tillage practice + 10t/ha poultry manure at 8 WAP which differed significantly ($P<0.05$) from other treatments. The lowest plant height (3.99cm) was recorded at flat + 0t/ha during the experiment.

The effect of different tillage practices and poultry manure rates on number of leaves/plant

The highest rates of poultry manure in combination with ridge tillage practice produced the greatest number of leaves per plant of Turmeric and this was significantly different from other treatments. At 2 WAP, ridge + 10t/ha poultry manure produced 3.50 leaves, which were statistically the same with the value obtained while using ridge + 5t/ha poultry manure during the experiment. The greatest number of leaves per plant (7.76) of Turmeric was obtained at 8 WAP using ridge + 10t/ha poultry manure which was statistically different ($P<0.55$) from other treatments. This was closely followed by a value of 6.21 leaves obtained using Bed + 10t/ha poultry manure. The least number of leaves per plant (4.63) was recorded for flat + 0t/ha which were statistically similar with the value of 4.69 leaves obtained using Bed + 0t/ha poultry manure throughout the experimental period (Table 3).

The effect of different tillage practices and poultry manure rates on rhizome yield

The rhizome yield of Turmeric (*Curcuma longa* L) at harvest is presented in Table 4. Ridge tillage practice + 10t/ha poultry manure produced the highest rhizome yield of 26.84t/ha. This was closely followed by a rhizome yield of 20.2t/ha obtained using Ridge tillage + 5+/ha poultry manure. The result however indicated a significantly difference ($P< 0.05$) among the treatments. Flat tillage practice + 0t/ha produced the lowest rhizome yield of 12.8t/ha in the experiment. Flat + 0t/ha poultry manure produced a rhizome yield of 14.81t/ha which is statistically similar with the yield of 14.75t/ha obtained using Bed + 0t/ha poultry manure.

The effect of different tillage practices and poultry manure rates on dry matter yield

A similar trend was observed in the dry matter yield of Turmeric. Highest levels of poultry manure in combination with ridge tillage practice produced the highest dry matter yield. Ridge tillage practice + 10t/ha produced the highest dry matter yield of 19.25t/ha which differed significantly ($P<0.05$) from other treatments. Flat tillage practice + 0t/ha poultry manure (control) gave the lowest dry matter yield of 6.4t/ha (Table 5).

DISCUSSION

The yield, dry matter and vegetative growth of Turmeric were significantly influenced with the application of poultry manure at a higher rate in combination with tillage practices. The plants grown on ridge tillage practice and highest rate of poultry manure had the tallest plant height, number of leave per plant, dry matter and rhizome yield. Previous investigation reported the influence of tillage practice on the yield of tuber crops. The experiment further explained that ridge tillage practice performed better when compared to flat and bed tillage practice. Ihenacho *et al.,* (2014) postulated that turmeric crop planted on ridge tillage performed better than those planted on bed and flat tillage practices in terms of plant height, number of leaves, number of days to 50% flowering, rhizome yield and dry matter yield. The greater performance of the plant grown on ridge may be attributed to the ability of the tilled soil to provide better space for the plant root to anchor and establish well which in turn resulted to better root development. Buschiazzo *et al.* (1998) stated that good tillage results to greater shoot development. Bankole and Ojeniyi, (2005), Agbede (2006) had earlier reported higher bulk density for zero tillage compared with tilled soils in south West Nigeria. (Is this report in agreement with or negates your experiment?) This implies that the higher the bulk density, the lower the crop yield as this resulted to the lower yield of the crop planted on the flat tillage practice. The significant improvement as recorded in the application of poultry manure is due to the fact that organic manure improved soil fertility which influenced yield of Turmeric. Manhas and Grill (2010) reported that the application of farm yard manure increased the growth, dry matter and quality of Turmeric. This is in agreement with Agbede and Adekiya (2011) who observed that poultry manure are effective source of nutrient for tuber crops like sweet potato. They further reiterated that poultry manure improved nutrient availability in the soil and improved physical conditions leading to significant improvement in nutrient status, growth and tuber yield of sweet potato.

CONCLUSION

The yield performance of Turmeric *(Curcuma longa L)* grown under different tillage practices and poultry manure rates indicated that ridge tillage + 10t/ha poultry manure produced the highest yield of rhizome and other vegetative growth investigated in the experiment. Lowest yields were constantly observed from the plants grown on flat tillage practices and 0t/ha poultry manure (control).

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Table 1: Physical and chemical properties of soil from the experiment site before the experiment

0.2cm	Sand	Silt	Clay	pH(H_2O)	pH(kcl)	Oc	Om	TN	P	Ca	Mg	H+	Al+	BD
	92.0	8.0	10.0	5.25	5.20	0.60	1.34	0.02	0.20	0.30	0.14	0.48	0.95	1.2
Treatments		After the Experiment												
B+Pm0t	72.7	8.7	19.6	6.44	5.80	0.319	0.550	0.03	26.11	0.35	0.20	1.10	Trace	0.8
B+Pm5t	85.1	3.7	4.2	6.32	65.40	0.359	0.619	0.029	22.4	0.40	0.180	1.20	1.15	1.1
B+Pm10t	76.4	12.0	10.6	6.20	5.47	0.419	0.722	0.03	22.19	0.38	0.117	0.90	Trace	1.2
F+Pm0t	91.8	3.3	4.9	6.25	5.70	0.219	0.378	0.042	21.35	0.50	0.251	1.20	Trace	1.0
F+Pm5t	77.7	5.7	16.6	6.63	5.88	0.279	0.482	0.027	21.56	0.21	0.15	1.00	Trace	1.0
F+Pm10t	82.3	7.4	9.8	6.33	5.80	0.389	0.671	0.018	15.75	0.20	0.167	1.25	1.05	1.1
R+Pm0t	70.2	7.7	13.1	6.50	5.78	0.409	0.705	0.030	19.74	0.65	0.180	1.10	Trace	0.9
R+Pm5t	90	3.6	4.4	6.34	5.55	0.200	0.344	0.02	18.69	0.08	0.036	1.00	Trace	1.2
R+Pm10t	87.2	4.8	8.0	6.35	5.10	0.439	0.757	0.38	26.32	0.600	0.200	0.95	Trace	1.0

Key: B -Bed, F-Flat, R -Ridge, PM -Poultry manure

Table 2: Plant height of turmeric as affected by different tillage practices and poultry manure rates

Treatments	**weeks after planting**			
	4	8	12	16
Bed+Pm0t/ha	1.7^c	3.6^c	3.82^c	4.45^d
Bed+Pm5t/ha	2.02^b	4.42^b	5.08^b	5.28^c
Bed+Pm10t/ha	2.31^b	5.97^b	6.08^b	7.84^b
Flat+Pm0t/ha	1.04^b	3.80^c	3.8^c	3.99^d
Flat+Pm5t/ha	2.30^b	4.27^b	5.35^b	6.20^b
Flat+Pm10t/ha	2.61^b	4.50^b	6.19^b	6.48^b
Ridge+Pm0t/ha	2.51^b	4.82^b	5.44^b	5.54^b
Ridge+Pm5t/ha	2.77^b	6.0^a	6.24^b	8.26^a
Ridge+Pm10t/ha	3.10^a	6.32^a	8.32^a	9.42^a

Means in the same column having the same letters are not significantly (P< 0.05) different using DMRT

Table 3: Number of leaves/plant of turmeric as affected by different tillage practices and manure rates

Treatments	weeks after planting			
	4	8	12	16
Bed+Pm0t/ha	2.55[b]	4.45 [b]	4.52 [b]	4.69[c]
Bed+Pm5t/ha	2.816 [b]	4.76 [b]	4.78 [b]	5.65 [b]
Bed+Pm10t/ha	3.0 [a]	4.87 [b]	4.98 [b]	6.21 [b]
Flat+Pm0t/ha	2.08 [b]	4.33 [b]	4.42 [b]	4.63 [b]
Flat+Pm5t/ha	3.10[a]	4.71 [b]	4.96 [b]	5.21 [b]
Flat+Pm10t/ha	3.25[a]	4.83 [b]	5.21[a]	5.46 [b]
Ridge+Pm0t/ha	3.0[a]	4.98[a]	5.28[a]	5.95 [b]
Ridge+Pm5t/ha	3.50[a]	5.0 [a]	5.35 [a]	5.50[b]
Ridge+Pm10t/ha	3.50 [a]	5.25 [a]	5.59 [a]	7.76 [a]

Means in the same column having the same letters are not significantly ($P< 0.05$) different using DMRT

Table 4: Rhizome yield of Turmeric *(curcuma longa L.)* as affected by different tillage practices and poultry manure rates at harvest.

Treatments	Rhizome yield (t/ha)
Bed+Pm0t/ha	14.75[d]
Bed+Pm5t/ha	17.58[c]
Bed+Pm10t/ha	19.58[b]
Flat+Pm0t/ha	12.81[f]
Flat+Pm5t/ha	13.51[e]
Flat+pm10t/ha	14.81[d]
Ridge+Pm0t/ha	15.52[d]
Ridge+Pm5t/ha	20.26[b]
Ridge+Pm10t/ha	26.84[a]

Means in the same column having the same letters are not significantly ($P< 0.05$) different using DMRT

Table 5: Dry matter yield of Turmeric *(curcuma longa L.)* as affected different tillage practices and poultry manure rates.

Treatments	Dry matters yield t/ha
Bed+Pm0t/ha	7.35[e]
Bed+Pm5t/ha	9.0[d]
Bed+10t/ha	14.47[b]
Flat+Pm0t/ha	6.4[f]
Flat+Pm5t/ha	7.25[e]
Flat+Pm10t/ha	8.4[d]
Ridge+Pm0t/ha	7.85[e]
Ridge+Pm5t/ha	13[c]
Ridge+Pm10t/ha	19.29[a]

Means in the same column having the same letters are not significantly ($P< 0.05$) different using DMR

THE ROLE OF TREES IN COMBATING THE EFFECTS OF CLIMATE CHANGE ON THE ENVIRONMENT

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ABSTRACT
This paper provides an overview of the importance of trees in combating the effects of climate change on the environment. It highlights the role of trees as carbon sinks and emphasizes their ability to absorb carbon dioxide and mitigate global warming. The paper also discusses the significance of forests and agroforestry in climate mitigation strategies, emphasizing their potential to sequester carbon and promote biodiversity. Furthermore, it highlights the role of trees in protecting soil, improving air quality, and providing habitat for wildlife. The paper presents an overview of the benefits of trees in addressing climate change and emphasizes the urgency of tree planting and forest restoration as effective measures for environmental protection.
Keywords: *Trees; Climate Change; Environmental Protection; Carbon Sinks.*

INTRODUCTION

Trees have amassed a great deal of attention recently as one of the most significant nature-based solutions to protect all of humanity from Climate Change (Mukul *et al.,* 2020). Planting trees is a simple and cost-effective solution to combating climate change (Anabaraonye, 2022). As one of the greatest carbon sinks on the planet, trees play a significant role in balancing the rise of atmospheric carbon due to anthropogenic activities (Bastin, 2019). Climate change encompasses more than just the increase in global temperatures; it also contributes to the occurrence of more frequent and severe natural disasters such as droughts, floods, forest fires, and other extreme weather events. These changes in climatic conditions have wide-ranging impacts on ecosystems, human populations, and infrastructure. Trees play a crucial role in mitigating the possibility of such disasters (Keenan, 2015). For example, when there are strong winds from storms, trees can help reduce the force with which they rip through the landscape. The environmental benefits of planting trees are immense and far-reaching, ranging from improved air quality to conserving biodiversity. Trees absorb odours and pollutant gases and filter particulates out of the air by trapping them on their leaves and bark (Makovníková *et al*, 2022).

Zomer *et al*. (2022) suggest a gradual transition from current practices i.e., increasing tree cover by no more than 10% in regions that are currently below the median tree cover for their individual bioclimatic or ecological zone. These restrictions guarantee that change will only occur when planting trees is ecologically and possibly also economically and socially feasible. The objective of this paper is to present a review of the significance of trees in combating the effects of climate change on the environment. The world's total forest area is 4.06 billion hectares (ha), accounting for 31% of the total land area (FAO, 2020). According to the IPCC (2018) increasing the total area of forests, woods, and wooded savannas by 9% by the year 2030 may absorb 25% of the atmospheric carbon needed to comply with 1.5°C pathways on land. In practice, this requires planting 350 million hectares (Mha) of new forest or an area about the size of India. Researchers have discovered that the planet has over 3.5 million square miles (9 million square kilometres) to spare for trees after excluding cities and agricultural areas from the study. Such newly planted trees might reduce atmospheric carbon (a component of the greenhouse gas carbon dioxide) by roughly 25%, bringing it to levels not seen in almost a century (Geggel, 2019).

Climate Change

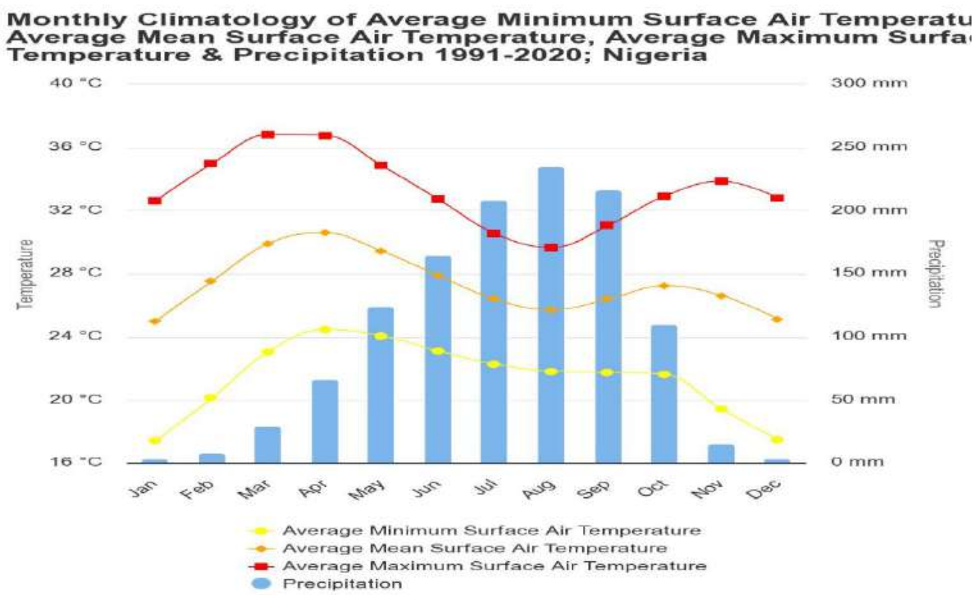
Climate change which tends to be used interchangeably with global warming refers to the rise in the average temperature of the earth over time, as recorded through the years at least 30 years, due to the accumulation of additional carbon dioxide and other greenhouse gases (GHGs) in the atmosphere. According to the Intergovernmental Panel on Climate Change (IPCC) assessment, of 2022, atmospheric concentrations of greenhouse gases, such as Methane (CH_4), carbon dioxide (CO_2), and Nitrous Oxide (N_2O) have risen to unprecedented levels during the previous several centuries (Abbass *et al.* 2022). These gases absorb and confine heat, leading to a gradual increase in temperature (Farmer and Cook, 2013). Climate change classification is based on an analysis of extensive and persistent alterations in temperature and precipitation patterns, along with other factors such as atmospheric pressure and humidity levels.

Because of this, measures to restore forests around the world have been recommended to sequester carbon and combat the impacts of climate change (IPCC, 2018). Scientists investigating climate change have advanced past the basic concept of global warming and are currently working to come up with strategies on how people can adapt to rising temperatures and their repercussions (UCS, 2021). There is an urgent call for understanding the climate and doing everything possible to mitigate its warming (IPCC, 2018).

Figure 1: Monthly Climatology of Average Temperature and Precipitation

Source: World Bank Group, Climate Change Knowledge Portal

CARBON SEQUESTRATION- TREES AS THE ULTIMATE CARBON CAPTURE AND STORAGE



Carbon sequestration is the process of capturing and storing carbon dioxide (CO_2) from the atmosphere, typically through natural or artificial means, to mitigate the effects of climate change. Carbon sequestration aims to reduce the amount of greenhouse gases in the atmosphere, thereby slowing down the rate of global warming (IPCC, 2018). The various methods of carbon sequestration are;

- Geological Carbon Sequestration- injecting carbon dioxide into underground geological formations.
- Carbon Capture and Utilization (CCU)- capturing CO_2 emissions from industrial processes and using them for various purposes.
- Carbon Capture and Storage (CCS)- capturing CO_2 emissions from industrial processes and storing them permanently underground.

Natural Carbon Sequestration: This occurs through the natural processes of photosynthesis and ocean uptake, where plants and trees absorb carbon dioxide during photosynthesis and store it in biomass, and the oceans absorb CO_2 from the atmosphere and store it in the form of dissolved carbon. (Global CSS Institute, 2021). Terrestrial systems, particularly trees and plants, are an important natural carbon store, with a worldwide estimate of 638 Gt, 44% of which is stored in plant biomass. Carbon stock varies according to forest type. While tropical forests retain an average of 303 tons of carbon ha^{-1}, temperate and boreal forests maintain 66 and 44 tons of carbon ha^{-1}, respectively (Aweh *et al*, 2023). According to Schmidt *et al.* (2011), the largest levels of carbon stock are found in young forests, and as forests mature, they become less abundant. Carbon stock refers to the amount of carbon that is absorbed by growing vegetation and stored in wood, other biomass, and soil organic matter (Mukul *et al,* 2020).

Adeyemi and Adeleke (2020) noted that *Pinus caribaea and Gmelina arborea* plantations had more net total biomass and carbon stock of the forest types in Omo Forest Reserve, Ogun State, Nigeria with an estimate of 35.78 ± 2.73 tons/ha and 18.96 ± 1.82 tons/ha. Aweh *et al*. (2023) observed that areas with lower tree cover loss had a higher level of biomass carbon stock than areas with higher tree cover loss in Edo State, Nigeria. These studies further buttress the significance of trees for carbon sequestration to combat Climate Change.

FOREST RESTORATION, AGROFORESTRY AND REFORESTATION: CLIMATE MITIGATION STRATEGY

Forests and trees have a great capacity to mitigate climate change. The approximate potential is influenced by elements including tree kind and location, management techniques, and climatic variables in the area (Safford, 2013; Keenan, 2015 FAO, 2018). According to Aweh *et al.* (2023), forests and other ecosystems account for the majority of land-based mitigation, with a cost-effective potential of about 50%. While natural forests had the highest levels of biodiversity, preliminary findings presented during the workshops revealed that agroforestry landscapes supported higher species richness for trees, birds, mammals, and insects than arable mono-crops, grassland, and other land use categories (Abbass *et al.,* 2022). However, by planting trees in farms and pastures, a network of trees could be built, reducing emissions and at the same time encouraging forest restoration and agroforestry.

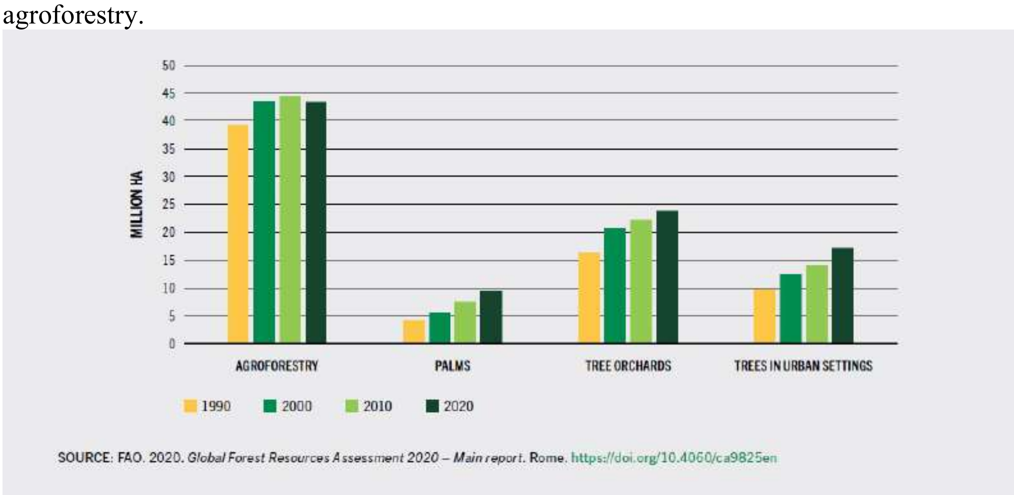


Figure 2: Global Area of other lands with Tree Cover 1990-2020

Simelton *et al.,* 2021 explored concerns pertinent to agroforestry interventions to support livestock keeping in East Africa, where most portions of the region are predicted to become drier due to climate change impacts in the hydrological cycle in the next decades. These interventions included the planting of predominantly exotic fodder trees (Maybeck *et al*, 2021).

Coffee-based agroforestry system (age, planting density)	Ref No	Est ton C/ha	Estimated C (tCO2-eq/ha)
Monoculture Arabica coffee, 10 yr, ~6200 trees/ha	Mulia *et al.* 2020		~18
Coffee 7yo, 750 trees/ha Macadamia 5 yo, 100 trees/ha Jackfruit 4 yo, 30 trees/ha Mix: Peach, longan, plum 2 yo, 170 trees/ha	6	5.5	20
Coffee 7yo, 2000 trees/ha plum 20 yo 75 trees/ha mango 4yo, 50 trees/ha peach 2yo, 40 trees/ha	5 5	12.5 21.2	46 78
Coffee 4yo, 1460 trees/ha *D. indica* 9yo, 50 trees/ha Mix: mango, peach, pear 3 yo, 45 trees/ha	4 4	11.6 22.4	43 82
Coffee 20 yo 85 trees/ha *D. indica 20* yo, 20 trees/ha Peach 10-20yo, 115 tree/ha Mix: pomelo, mango, pear 20 yo 55 trees/ha	8	14.0	51
Coffee 13 yo, 1110 trees/ha Longan 26 yo, 170 trees/ha Plum 22 yo, 135 trees/ha Pomelo 10 yo, 50 trees/ha Mix: mango, jackfruit, guava, starfruit, 3 yo, 140 trees/ha	7	67.5	248
Coffee 10 yo, 3110 trees/ha Longan 30 yo, 330 trees/ha Plum 19 yo, 270 trees/ha Mix: pomelo, mango, litchi, guava, peach 3 yo, 440 trees/ha	9 9	46.3 83.4	170 306

Simelton *et al*.(2021) discovered that among Vietnamese coffee farmers, households adopting coffee agroforestry had more diverse revenue sources and were economically more resilient than those producing coffee monoculture. The findings also show that farmers generally thought about coffee-tree interactions, which are crucial entry points for switching from intensive to organic production. In this case, trees' roles in maximizing shade and legumes' roles in nitrogen fixation are crucial for serving as a climate mitigation strategy (Dobbie *et al.,* 2020).

TREES PROTECT THE SOIL AND PROMOTE HEALTHY SOIL

Soil erosion is one of the impacts of Climate change, causing nutrient weathering and fertility loss as well as altering soil structure and texture, affecting plant nutrition and development and negatively affecting the productivity and sustainability of natural and agricultural ecosystems. Precipitation which has been altered by climate change also is the most important climatic element regulating soil erosion and sediment transport (Cao *et al.,* 2020). Maintaining soil health and productivity is crucial as demands for food production and global population growth increase. The use of trees through agroforestry presents a promising chance to capture and store carbon in the soil that is lost as a result of increased agricultural productivity, intensive tillage, and fertilizer use (Fahad *et al.*, 2022). Integration of trees in cropland can help in maintaining the soil's physio-biochemical properties. Trees litter and pruning biomass improves soil fertility through the release of nutrients into the soil by mineralization. The trees improve soil health through the maintenance or increase of soil organic matter through carbon fixation in photosynthesis and its transfer via litter and root decay. This improves soil biodiversity by providing a specific habitat, refugia for epigenetic species, microclimate variety, buffering action, soil wetness, and humidity which is altered by changing climate (Beliveau *et al.,* 2017).

IMPROVED AIR QUALITY

The World Health Organization (WHO, 2018) has estimated that climate change is responsible for approximately 2% of global deaths each year. This figure is based on a range of different factors, including the direct impact of extreme weather events, as well as the indirect effects of climate change on things like air quality and water availability. The medical journal, The Lancet 2021 published a report that estimated that climate change was responsible for seven million deaths worldwide in 2018, or approximately 12.5% of all deaths. Of these deaths, around 2.4 million were attributable to ambient air pollution, which is exacerbated by climate change. The presence of trees has a noteworthy influence on the quality of air. They can absorb harmful substances like carbon monoxide, sulphur dioxide, and nitrogen oxides from the surroundings, thereby reducing air pollution and enhancing the overall well-being of communities (Nowak *et al.,* 2014; Kardan *et al.*, 2015).

Urban localities are particularly susceptible to elevated levels of air pollution due to heavy traffic and industrial activities. However, by planting trees in cities, it is possible to alleviate the impact of air pollution by trapping harmful particles in the air (Escodedo *et al.,* 2011; Kardan *et al.*, 2015). Zhang *et al.* (2019) stated that trees not only absorb pollutants but also release oxygen, which contributes to improving air quality by producing fresh and breathable air. Additionally, trees can alleviate the heat island effect in urban areas, which is the temperature rise caused by human activities. By providing shade and cooling, trees can decrease the demand for air conditioning, resulting in reduced energy usage and greenhouse gas emissions. Trees contribute significantly to maintaining healthy air quality not only in cities and urban areas but also in rural regions.

BIODIVERSITY AND HABITAT FOR WILDLIFE.

Biodiversity is one of the world's most significant casualties of Climate Change which has led to a rapidly rising species extinction. The rate and degree of Climate are changing the suitable habitat ranges of marine, freshwater, and terrestrial living organisms (Abbass *et al.,* 2022). The majority of Earth's terrestrial biodiversity and its three components - ecosystem, species, and genetic diversity - are found in forests. Trees are the foundations of forest ecosystems, and many of the world's 60,000 tree species also play a vital role in woodlands and agricultural landscapes. Forests are home to around 80% of amphibian species, 75% of bird species, and 68% of mammal species (FAO, 2022). Tropical forests are arguably the most significant biomes on the planet, accounting for one-third of land-surface productivity and evapotranspiration, and are estimated to host over half of all global terrestrial biodiversity (Malhi, 2012; Malhi *et al.*, 2014) and home to around 60% of all vascular plants (FAO, 2022). The sustainability of ecosystems is impacted by changes in general temperature regimes in a variety of ways, including variance in species' relative abundance, range shifts, variations in activity timing, and usage of microhabitats (Abbas *et al,* 2022). Biodiversity is equally susceptible to the other effects of climate change, such as rising temperatures, droughts, and invading pest species.

CONCLUSION

Even when trees are planted quickly, their impacts take time to influence. It may take decades for young forests to reach their full potential in terms of growth and development. To avert the effects of climate change, it is necessary to maintain the existing forests, look into alternate climate solutions, and progressively lessen reliance on fossil fuels. By strategically planting trees, there is a general improvement in quality of life, and increased socioeconomic benefits for the immediate community. Trees offer several additional advantages, including reducing noise pollution, aesthetic benefits, shielding us from harmful ultraviolet radiation, and promoting better health thereby reducing stress levels.

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EFFECT OF GIBBERELLIC ACID AND DIPPING PERIOD ON THE POSTHARVEST QUALITY OF MANGO FRUITS (*Mangifera indica* L.) UNDER AMBIENT TEMPERATURE

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ABSTRACT
The experiment was conducted in the Postharvest Laboratory of Federal College or Horticulture Dadin-kowa. Gombe State to evaluate the effect of three levels of Gibberellic acid (5g, 10g and 15g) and dipping time (5 minutes, 10 minutes and 15 minutes) on the postharvest quality of mango fruits under ambient temperature condition. The experiment was laid out in completely randomized design (CRD) factorially combined and replicated three times. Data collected on fruit weight loss, fruit decay, marketable fruits and skin colour change were analysed using analysis of variance and means separated at 5% level of probability. Results obtained showed that 10g of GA_3 for 5 minutes reduced fruit weight loss (23.3%) after 15 days of storage. Similarly, fruit decay was affected by concentration of 10g of GA_3 dipped for 15 minutes (33.3%). Fruits treated with 15g GA_3 dipped for 5 minutes was more superior in marketable fruits and skin colour change at the end of the storage period. Based on this finding, GA_3 at concentration of 10g/L and 15g/L and dipping period of 5 minutes should be adopted for better mango storage.
***Keywords**: Dipping, Gibberellic acid, Mango, Postharvest, Weight loss*

INRODUCTION

Mango (*Mangfera indica* L.), is a tropical fruit and contains vitamins, mineral and fibre which are essential to human health and export market (Sethi, *et al,* 2011). Mango is classified as climacteric fruit and shows rapid deterioration after harvest due to ripening and senescence. The fruit is considered king of fruits due to its attractive colour, aroma and jelly pulp, but it is highly perishable in nature. Several environmental conditions, higher moisture content, soft textures of fruits and susceptibility to various pathogenic infections are the limiting factors to its shelf life. In this regard, postharvest life of mango is important to consumer's acceptability and marketing (Zhong, *et al.,* 2006; and Chien, *et al.,* 2007).

Application of postharvest treatments which have non-toxic mode of action, with negligible residue, safe on humans, animals and environment has been reported to prolong the storage life of apricots (Fan, *et al.,* 2000), banana (Jansasithorn *et al.,* 2006) and delayed firmness, TSS and TA on sapodilla (Zhong *et al.,* 2006). The use of different plant growth regulators like Gibberellic Acid (GA_3) and BA were seen as highly significant in respect of prolonging the shelf life of bananas (Sultana *et al.,* 2012). Vargas and Lopez (2011) reported the delaying of ripening in Cavendish banana by 3–4 days is achieved through the application of GA_3 at concentrations ranging from 50-250 mg/L Osman and Abu-Goukh (2008) reported that Gibberellic acid treatment (100 ppm) by dipping the fruit whole showed the highest shelf life than by dipping tip only and control where an association of whole fruit dipping with sealed film liners showed superior results.

Although several efforts have been conducted to prolong the shelf life of mango fruits using different levels of gibberellic acid, the result had not been encouraging possibly the dipping period have not been fully explored. The need to employ the use of different concentrations for various dipping periods that are more promising should therefore be experimented. The objective of this study is to determine the appropriate concentration of GA_3 and dipping period for prolonging the quality and shelf life of mango fruits in storage.

MATERIALS AND METHODS

The experiment was conducted in the Postharvest Laboratory of Federal College or Horticulture Dadin-kowa. Gombe State, Nigeria. Freshly harvested mango fruits of uniform size and maturity were purchased from the farmer's field and brought to the laboratory. The fruits were washed in clean running water and allowed to dry before subjecting them to various treatments.

Preparation and Application of the Chemicals

To prepare the treatments, 5g, 10g, and 15g of GA_3 was dissolved in 1000 ml of distilled water. Five mango fruits were submerged into each of the prepared solutions for 5, 10 and 15 minutes respectively and removed, allowed to dry and kept in plastic baskets of 20 cm x 30 cm x 50 cm at room temperatures (35^{o} c) for observation.

Experimental Design

The experiment was laid out in a completely randomized design (CRD), with four levels of GA_3 (0g, 5g, 10g and 15g) and three dipping periods (5 minutes, 10 minutes and 15 minutes) factorially combined. The treatments were replicated three times giving a total of 12 treatment combinations.

Data Collection

Data were collected on fruit weight loss, fruit decay, marketable fruits, skin colour and chemical composition expressed in percentages.

Data Analysis

The data collected was subjected to the analysis of variance (ANOVA) using Gestat statistical package version 10. Mean comparisons was made using least significant difference (LSD) at $P< 0.05$ level of probability.

RESULTS AND DISCUSSION

Effect of Gibberellic Acid and Dipping Period on Percentage Weight Loss of Mango Fruits

The result of the combined effect of GA_3 and dipping period on percentage fruit weight loss of mango is presented in Table 1. The results showed that there were no significant variations among the treatments in all the storage periods of 15 days. There was however gradual increase in weight loss as the storage period increased irrespective of the treatments. The results showed that the highest weight loss (12.1%, 26.6%, 29.3% and 38.1%) at 6, 9, 12 and 15 days respectively was recorded in the control treatment while the least percentage weight loss (10.7%, 16.1%, 20.0% and 23.3%) was in fruits treated with combination of 10g of GA_3, dipped for 5 minutes. Archana and Sivachandiran (2015) found out that a higher concentration of GA_3 results in lower physiological weight loss and vice-versa. Tapas (2016) observed that Gibberellic acid dipping at 150 ppm resulted in the lowest weight loss during storage compared to the other treatments. Similarly, Le (2021) found out that different dipping times would generate different thickness of the film layer resulting in variations of water vapor leakage rate and fruit respiration. This result however, shows that dipping period did not have significant effect on fruit weight loss, hence it is not in agreement with their findings.

Effect of Gibberellic Acid and Dipping Period on Percentage Decay of Mango Fruits

The results of the percentage decay of mango fruits is presented in Table 2. The results obtained showed no significant variations among the treatments, even though they are statistically similar. It also shows that the decay loss increased with the increase in period of storage in all the treatments. The highest fruit decay was observed in the control treatment (55.5% and 73.3%) at 12th and 15th days of storage respectively. Generally, the results showed that 5g GA_3 was not as much effective as other treatments in preventing fruit decay irrespective of the dipping periods. However, fruit dipped in 10g of GA_3 for 15 minutes had the least (0.0%, 0.0%, 6.7%, 20.0% and 33.3%) fruit decay throughout the storage period. The result is in accordance with the findings of Sembok *et al.* (2016), Sahithya *et al.* (2015), Tourky *et al.* (2014) and Archana and Sivachandiran (2015). Archana and Shivachandiran (2015) observed the four different concentrations of GA_3 (250 ppm, 350 ppm, 500 ppm and 750 ppm) to obtain qualitative and quantitative data for analyzing the shelf life in Kathali banana where they observed more shelf life in 500 ppm and 750 ppm treated banana by 4 and 5 days.

Table 1: Combined Effect of GA_3 and Dipping Period on Percentage Fruit Weight Loss of Mango

Treatment	3 DAS	6 DAS	9 DAS	12 DAS	15 DAS
5g + 5m	5.7	10.7	16.3	21.2	27.6
10g + 5m	5.7	10.7	16.1	20.0	23.3
15g + 5m	6.1	12.6	21.4	25.9	29.8
5g + 10m	6.2	11.1	16.1	21.1	27.2
10g + 10m	6.2	11.6	17.4	21.6	26.8
15g + 10m	6.1	11.6	23.2	27.2	32.1
5g + 15m	5.3	14.1	25.0	29.0	32.9
10g + 15m	6.1	11.4	24.5	28.6	33.4
15g + 15m	6.0	11.3	22.8	27.2	32.5
Control	6.1	12.1	26.6	29.3	38.1
P<F	0.502	0.829	0.407	0.469	0.254
L.S	NS	NS	NS	NS	NS
LSD	0.9150	4.170	11.53	10.58	11.09

Key: DAS = Days After Storage, L.S. = Level of Significance, L.S.D. = Least Significant Difference

Table 2: Combined Effect of GA_3 and Dipping Period on Percentage Fruit Decay of Mango

Treatment	3 DAS	6 DAS	9 DAS	12 DAS	15 DAS
5g + 5m	0.00	6.7	20.0	50.0	63.3
10g + 5m	0.00	0.0	6.7	26.7	40.0
15g + 5m	0.00	0.0	6.7	20.0	40.0
5g + 10m	0.00	6.7	20.0	36.7	53.3
10g + 10m	0.00	0.0	6.7	13.3	36.7
15g + 10m	0.00	6.7	13.3	40.0	40.0
5g + 15m	6.67	20.0	36.7	50.0	50.0
10g + 15m	0.00	0.0	6.7	20.0	33.3
15g + 15m	0.00	0.0	20.0	33.3	53.3
Control	8.87	15.5	32.2	55.5	73.3
P<F	0.136	0.252	0.318	0.337	0.649
L.S	NS	NS	NS	NS	NS
LSD	7.327	17.96	28.98	41.88	43.46

Key: DAS = Days After Storage, L.S. = Level of Significance, L.S.D. = Least Significant Difference

Effect of GA_3 and Dipping Period on Percentage Marketable of Mango fruits

The result of the effect of GA_3 and dipping period on marketable mango fruits is presented in Table 3. The results obtained shows that there were no significant differences among the treatment combinations however, there was gradual decrease in the marketable fruits as the storage period increased regardless of the treatment. Highest and significant effect (83.3% and 53.3%) on marketability percentage of fruits was recorded in concentration of 15g GA_3 dipped for 5 minutes, which was at par with 5g GA_3 dipped for 10 minutes (80.0% and 53.3%) treated fruits. Conversely, combination of 5g and 5 minutes had the least (53.3% and 33.3%) percentage marketable fruits at 9 and 12 days respectively, which is however comparable with the control treatment. Similar results were found by Sundaram (2013) lower marketability losses are recorded in GA_3 than uncoated fruits. Kumar and Nath (1993) stated that marketable fruits were noted to be higher in GA_3 coated fruits of banana than fruits dipped in salycilic acid. Plant growth regulator improves the marketability of fruits for a longer period (Pareek *et al.,* 2009).

The effect of GA_3 and dipping period in the skin colour rating of mango fruits is given in Table 3. The result showed that there was no significant variation in all the days of storage except at 9 days. Skin colour score generally progressed during the storage period of mango fruits irrespective of treatments. The result further showed a delay in colour change with GA_3 15 g dipped for 5 minutes (1.33, 2.53 and 3.33) for 3, 6 and 9 days respectively as compared to control and other treatments. The highest colour change was however, observed in 15g + 10 minutes treated mango fruits (3.80 and 4.20) at 9 and 12 days respectively. Similar result was observed by Tapas (2016) where peel color become marketable only after 15 days in 150 ppm GA_3 treated which might be due to control in ethylene level and respiratory activity. Cytokinins inhibit the degradation of chlorophyll and a similar effect can be seen from Gibberellins (Shrestha, 2010). This finding suggests that higher concentration of GA_3 at 15g dipped for 5 minutes might delay colour change in mango fruits stored for 9 days due to the effect of gibberellins.

Table 3: Combined Effect of GA_3 and Dipping Period on Percentage Marketable and Skin Colour of Mango Fruit

Treatment	Marketable		Skin Colour		
	9 DAS	12 DAS	3 DAS	6 DAS	9 DAS
5mg + 5m	53.3	33.3	2.20	3.33	3.93
10g + 5m	76.7	43.3	1.80	3.13	3.87
15g + 5m	83.3	53.3	1.33	2.53	3.33
5g + 10m	80.0	53.3	2.53	3.46	4.00
10g + 10m	83.3	43.3	2.67	3.47	4.07
15g + 10m	76.7	26.7	2.60	3.80	4.20
5g + 15m	53.3	20.0	2.47	3.47	4.20
10g + 15m	80.0	53.3	1.80	3.27	3.73
15g + 15m	73.3	40.0	2.13	3.20	3.93
Control	78.9	33.3	1.87	3.20	4.10
P<F	0.451	0.252	0.120	0.276	0.007
L.S	NS	NS	NS	NS	*
LSD	27.83	33.23	0.943	0.8359	0.3894

Key: DAS = Days After Storage, L.S. = Level of Significance, L.S.D. = Least Significant Difference

CONCLUSION

The study indicates that different concentrations of GA_3 and dipping periods significantly affect the quality of mango fruits stored under room temperature. Also, combination of GA_3 at 10g and 5 minutes' dip significantly reduced fruit weight loss and decay while 15 g + 5 minutes was superior in retaining skin colour and higher marketability of mango fruits. Based on the results obtained, higher concentrations of GA_3 and lower dipping period influenced fruit quality stored under ambient temperature conditions.

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EFFECTS OF PLANTING METHODS AND WEED MANAGEMENT PRACTICES ON THE GROWTH AND YIELD OF RICE (*Oryza sativa* L.) IN LAFIA AND BADEGGI, NIGERIA.

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ABSTRACT
Field experiments were conducted during the cropping seasons of 2022 at the Teaching and Research Farm of the Faculty of Agriculture, Nasarawa State University, Keffi Shabu-Lafia Campus and at the National Cereals Research Institute Baddegi Niger state, Kusotachi experimental site to study the influence of planting method, weed management and timing application on growth and yield on rice. The experiment was a 2 x 6 x 2 factorial combination of two planting methods (pregerminated seeds and transplanting), six methods of weed control (Weedy check, Hoe weeding at 3 and 6 WAS, cyhalofop-butyl + MCPA, quinclorac + pyrazosulfuron-ethyl, MCPA 2 chloro 4 diphenoic acid, pretilachlor + pyribenzoxim) and two timing (Lafia and Badeggi) laid out in a Randomized Complete Block Design (RCBD) with three replications. Planting method was assigned to main plot, location was allocated to the sub plot and weed management was assigned to the sub-sub plot. The results obtained in both locations showed that, the plots with weed management had higher growth and yield of rice than the weedy check. . The highest leave area index was recorded in Lafia location while seed per panicle have the highest record in Lafia location while Badeggi location recorded the highest number of panicles per plant, number of seeds per panicle and highest grain yield.The use of Transplanting method gave the maximum leaf area index, yield and yield attributes of rice. Plots with weed management had higher growth and yield of rice than the weedy check. However the application of MCPA performed better than the other weed management.Therefore, it is recommended that farmers should adopt the integration of transplanting method of planting rice with early and late applications of MCPA in both locations for improved growth; yield and yield of rice.
Keywords: *Yield, rice, planting methods, weed management*

INTRODUCTION

Rice (*Oryza sativa L)* constitutes major staple foods in many parts of the world. It supply more of carbohydrates, proteins, fats and also minerals vital needed for survival and healthy life (Ejebe, 2013). In Nigeria, the demand for rice assumed a regular increase for the past decades compared to sorghum and millet which fluctuate annually. Rice demand annually in Nigeria was estimated to about 5 million metric tons while local production around 2.21 million metric tons and about 2.79 million metric tons imported to bridge the gaps (NRDS, 2009). The time required for harvesting, transplanting, weeding and other management practices is much higher during rice cultivation. Thus, to reduce the cost of cultivation, shifting from traditionally practiced of transplanting to dibbling method of rice cultivation could easy planting method of rice (Dendup *et al.,* 2018). Transplanting is the most common method of planting rice, while dibbling and broadcasting are reported to be picking-up gradually (Gill *et al*., 2014). Akhgari *et al*. (2011) defined dibbling (direct seeding) of rice as the process of establishing a rice crop from seeds sown in the field rather than by transplanting rice seedlings from the nursery, it assist rice farmers to have a reduced production cost.

Weed being one of major pests in agriculture, having ability to compete with crops for nutrients through rapid growth and development. Hence, good weed management program is essential throughout the growing period of crops to overcome various types of weeds challenges (Neog *et al.,* 2015). Manual control of weeds is not a quick method thus, requires lot of time and labour. Cates, A.H. (1969), the period required for weeds to be hand pull thus, have the ability to compete with the growing crop and reduced yields. Although, hoe weeding and hand weeding have similar disadvantages. It is, however a faster means of weed management. It can be carried out at an earlier stage in the growth cycle of rice crop, and is more effective when weeds within the row are removed by hand at the same time. In addition it has proved more effective to other mechanical methods of weed control. Both hand and hoe weeding are suitable only for use on small farms. Other methods of weed control must be used on larger areas (De Datta *et ai.,* 1973). Herbicides offer easy, economical and quick control of weeds if applied in proper dose and at proper stage of crop growth (Bhullar *et al.,* 2018). Among all measures taking in rice weed control, chemical weed control is commonly used to overcome weeds infestation and it is reliable, easy, quick, time saving, and cost effective.

There is no or little attention given by the rice growers in Nigeria on the use of metsulforun methyl, cyhalofop-butyl + MCPA, quinclorac pyrazosulfuron-ethyl, MCPA 2 chloro 4 diphenoic acid, pretilachlor + pyribenzoxim herbicides in controlling of weed in rice production due to paucity of information about the herbicides. However, this study is aiming at evaluating the effects of these herbicides application under various timing (early and late) and planting methods (pre-germinated seed and transplanting) on rice production. The objective of this study therefore is to determine the effect of location, planting methods and weed management on weed control, growth and yield of lowland rice.

MATERIALS AND METHODS

The field experiment was conducted at two locations during 2023 cropping seasons at the Teaching and Research Farm (Latitude 08.33^{0}N, Longitude 08.33^{0}E) of the Faculty of Agriculture, Shabu-Lafia Campus, Nasarawa State University Keffi, Nasarawa State, Jayeoba, 2013. And at National Cereals Research Institute (NCRI) Baddeji, Niger State at experimental site Kusotachi latitude 9°3'24.58"N, Longitude 6°8'36.31"E) Ojohomon *et al*., 2006. The experiment is a 2 x 6 x 2 factorial combination of two planting methods (Dibbling and transplanting), six methods of weed control (Weedy check, Hoe weeding at 3 and 6 WAS, cyhalofop-butyl + MCPA, quinclorac + pyrazosulfuron-ethyl, MCPA 2 chloro 4 diphenoic acid, pretilachlor + pyribenzoxim) and two location (Lafia and Badeggi) arranged in a randomized complete block design (RCBD) replicated three times. The gross plot size was 3 m x 4 m (12 m^2) while the net plot size was 1.5 m x 4m (6 m^2).

The field was cleared using a land preparation herbicide (Glyphosate a.i 360g/L) at 3 L/ha. The soil was ploughed and the site was marked into plots and replications. One meter unplanted boarder were maintained between plots, while 0.5 m unplanted boarder was maintained between each replication. The nursery was prepared in dry soil conditions on 3 by 4 m wide seed bed, was filled with top most soil to a height of 10 cm level. A layer of half burned paddy husk was distributed on the nursery bed to facilitate uprooting. 80 kg/ha of seed was used for the sowing covered with mulch, watering the beds at regular basis (morning and evening). Transplanting of vigorous healthy seedlings where done after 14-21days of germination. Five pre-germinated seeds were sown (direct seeding) and thinned to two plants per stand. For transplanting method, 14-21 days old seedlings were transplanted from nursery bed to permanent field. One seedling per hole at a space of 20 cm by 20cm between and within the plant where maintained. Same plant spacing for transplanting was maintained for pre-germinated seed planting methods. Seed rate of 80 kg/ha where used for pre-germinated seeds while 40 kg/ha for transplanting. Fertilizer application wasdone using side placement in all the plots at the rate of 46 kg P_2O_5/ha and 64 kg N /ha. Phosphorus in the form of single super phosphate (SSP) was applied at the time of sowing and transplanting. Whereas, N in the form of UREA was applied in three splits (one third during sowing and transplanting and the remaining two third was apply in two splits at 4 and 8 WAS

The following data was collected at appropriate crop phenology. Data was taken from the five randomly selected tagged plants during growth period at 4, 6, 8, 10 and 12 WAS. The leave area index was calculated as sum of the leaf area divided by unit area as described by Yoshida (1981). Numbers of panicle per plants from the five tagged plants was counted and the mean recorded. The Numbers of seeds per panicle taken from the main tiller of each tagged plant was counted at maturity stage separately after harvesting. The net plot where harvested manually, grain collected, dried to 13.5% moisture content, and weight recorded. This was determined by weighing grains from the net plot, divided by net area and multiply by 10,000.

$$\text{Grain yield} = \frac{\text{Seed yield per net plot}}{\text{Net plot area}} \times 10{,}000$$

The data collected where subjected to analysis of variances (ANOVA) using Statistics software while Least Significant Difference (LSD) was used to separate treatment means at 5 % level of probability.

RESULTS AND DISCUSSION

The effect of location, planting method and weed control on leaf area index of rice at 4-12 WAS as presented in (Table 1) below show location had a significant effect on leaf area index at 6 and 12 WAS respectively. The Lafia location consistently produced the highest leaf area index than Badeggi location which consistently produced the lowest leaf area index. Planting method also had a significant effect on leaf area index throughout the sampling periods of the study. The use of Transplanting method consistently recorded the highest leaf area index than dibbling method which consistently produced the lowest leaf area index. Weed control affected leaf area index significantly at each sampling times of the study. At 4 WAS, the use of 2 HW at (3 + 6 WAS) produced significantly highest leaf area index than all the other weed controls compared with late application of Pretilachlor + Pyribenzoxium which recorded the lowest leaf area index. At 6 WAS, early application of Pretilachlor + Pyribenzoxium significantly produced the highest leaf area index than all the other weed controls compared with the weedy check which recorded the lowest leaf area. But that was not the case at 8 WAS, were early application of Metsulforun methyl produced significantly highest leaf area index than all the other weed controls compared with the weedy check which had the lowest leaf area index. At 10 WAS, early and late applications of MCPA significantly produced statistically similar highest leaf area index than all the weed controls compared with the weedy check which recorded the lowest leaf area index. At 12 WAS, early application of Metsulforun methyl; early and late application of MCPA significantly produced similar highest leaf area index than all the other weed controls compared with the weedy check which recorded the lowest leaf area index in this study.

Table 1: Effect of location, planting methods and weed management on leaf area index at 4 – 12 WAS of rice

	Leaf area index				
Treatment	4 WAS	6 WAS	8 WAS	10 WAS	12 WAS
Location (L)					
Lafia	0.0172a	0.0400a	0.0476a	0.0733a	0.0851a
Badeggi	0.0182a	0.0341a	0.0445b	0.0704b	0.0808b
LSD (0.05)	0.0025	0.0009	0.0003	0.0008	0.0014
Planting method (PM)					
Dibbling	0.0169b	0.0322b	0.0445b	0.0647b	0.0771
Transplanting	0.0185a	0.0419a	0.0175a	0.0079a	0.0888a
LSD (0.05)	0.0006	0.0008	0.0004	0.0007	0.0015
Weed management (WM)					
Weedy check	0.0152fg	0.0308g	0.0393f	0.0552g	0.0744f
2 HW (3 + 6 WAS)	0.0203a	0.0370c	0.0468c	0.0613f	0.0770e
Metsulforun Methyl (E)	0.0191b	0.0330f	0.0543a	0.0784b	0.0921a
Metsulforun Methyl (L)	0.0171dc	0.0350de	0.0442d	0.0763c	0.0874b
Cyhalofop buthyl + MCPA (E)	0.0152fg	0.0366cd	0.0469c	0.0747d	0.0810d
Cyhalofop buthyl + MCPA (L)	0.0189bc	0.0374c	0.0433d	0.0736d	0.0801d
MCPA (E)	0.0190bc	0.0381c	0.0484c	0.0840a	0.0935a
MCPA (L)	0.0194ab	0.0398b	0.0505b	0.0845a	0.0932a
Pretilachlor + Pyribenzoxium (E)	0.0162ef	0.0513a	0.0481c	0.0783b	0.0839c
Pretilachlor + Pyribenzoxium (E)	0.0143g	0.0347e	0.0484c	0.0763c	0.0828c
LSD (0.05)	0.0011	0.0016	0.0018	0.0015	0.0015
Interaction					
L × PM	NS	NS	NS	NS	NS
L × WM	NS	NS	NS	NS	NS
PM × WM	NS	NS	NS	NS	NS
L × PM × WM	NS	NS	NS	*	NS

The interaction between location, planting method and weed control on leaf area index of rice at 10 WAS was significant on (Table 2) below. The combinations of Lafia location, transplanting method with early and late applications of MCPA produced statistically similar highest leaf area index than all the other combinations compared with the combination of Badeggi location, dibbling method and weedy check which produced the lowest leaf area index in this study. The effect of location, planting method and weed management on number of panicles per plant and number of seeds per panicle as presented below on (Table 3). Lafia location significantly produced highest number of seeds per panicle than Badeggi location which recorded the lowest number of panicles per plant and lowest number of seeds per panicle. Planting method affected number of panicles per plant and number of seeds per panicle. The use of transplanting method significantly produced highest number of panicles per plant and highest number of seeds per panicle than dibbling method which produced the lowest values of the parameters.

Weed control had a significant effect on number of panicles per plant and number of seeds per panicle. Application of early Metsulforun methyl; early Cyhalofop butyl + MCPA and late application of MCPA significantly produced similar highest number of panicles per plant than all the other weed controls compared with the weedy check which produced the lowest number of panicles per plant statistically similar with early application of MCPA. The use of 2 HW at (3 + 6 WAS) and late application of Cyhalofop butyl + MCPA significantly produced similar highest number of seeds per panicle than all the other weed controls compared with early and late applications of Pretilachlor + Pyribenzoxium which recorded statistically similar number of seeds per panicle. The effect of location, planting method and weed control on grain yield, indicate that, location affected grain yield significantly. Badeggi location significantly recorded the highest grain yield than Lafia location which recorded the lowest grain yield. Planting method also had a significant effect on grain yield. The use of transplanting method significantly produced the highest grain yield than the use of dibbling method which recorded the lowest grain yield in both locations. Weed control significantly affected grain yield. Early and late applications of MCPA significantly produced similar highest grain yield than all the other weed controls compared with the weedy check which recorded the lowest grain yield.

DISCUSSION

The constantly leave area index observed during sampling period with lafia location having the highest leave area index and badeggi location recording the highest grain yield. This is in line with Andrew (2014) and Yosida *et al.,* 2010, who observed an efficient photosynthetic process in crop, good soil fertility and better utilization of fertilizer applied to crop, could be attributed to widest leave area thus contributed to crop growth and yield in the different location of this study. A significantly increase that produce the highest number of panicle, highest number of seed per panicle and highest grain yield in transplanting method in badeggi location. Is in line with Berhanu (2015). who reported an increase in spikelet number of panicle which was attributed to adequate nutrient availability and ease of light penetration even to the older leave which was due to a better spacing. Mobasser *et al.,* 2010 also reported an increase in grain yield due to higher number of panicles produce by 120 plants as compared to 20 plants.

The lowest growth, yield and yield attributes of rice recorded in the weedy check plot could be attributed to poor interception of light as well as lesser nutrient availability to rice plant that resulted in poor photosynthesis and photochemical energy supply which negatively affected the translocation of photosynthesis to the developing grains. This finding is in conformity with the work of Manisankar et al. (2021) who reported that unweeded control obtained significantly lower number of yield attributes and yield of rice due to poor interception of light as well as lesser nutrient availability to rice plant that resulted in poor photosynthesis and photochemical energy supply which ultimately affected the translocation of photosynthesis to the developing grains. Parthipan and Subramanian (2013) reported that unweeded control registered lower yield and straw yield of rice due to severe crop weed competition during throughout crop growth period.

CONCLUSION

It is concluded from the results of this study that, Lafia location recorded the highest leaf area index while Badeggi location recorded the highest number of panicles per plant, number of seeds per panicle and highest grain yield. The use of Transplanting method gave the highest leaf area index, yield and yield attributes of rice. Plots with weed management had higher growth and yield of rice than the weedy check. However, the application of MCPA performed better than the other herbicides tested in this study.

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Table 2: Interaction between location, planting method and weed management on leaf area index at 10 WAS of rice

		Weedy check	2 HW	Metsulforun Methyl (E)	Metsulforun Methyl (L)	Cyhalofop buthyl + MCPA (E)	Cyhalofop buthyl + MCPA (L)	MCPA (E)	MCPA (L)	Pretilachlor + Pyribenzoxium (E)	Pretilachlor + Pyribenzoxium (L)
Location	**Planting method**										
Lafia	Dibbling	0.0520p	0.0612mn	0.0744f	0.0647i-l	0.0651ijk	0.0635j-m	0.0817de	0.0838cd	0.0788e	0.0756f
Lafia	Transplanting	0.0599n	0.0641i-m	0.0863bc	0.0884b	0.0860bc	0.0842cd	0.0921a	0.0919a	0.0838cd	0.0817de
Badeggi	Dibbling	0.0492p	0.0558o	0.0665hij	0.0638i-m	0.0617lmn	0.0623k-n	0.0705g	0.0701g	0.0668hi	0.0663hij
Badeggi	Transplanting	0.0599n	0.0641i-m	0.0863bc	0.0884b	0.0860bc	0.0842cd	0.0921a	0.0919a	0.0838cd	0.0817de
LSD $_{(0.05)}$	LSD $_{(0.05)}$					0.0031					

Table 3: Effect of location, planting methods and weed management on number of panicles per plant, number of seeds per panicle and grain yield per hectare

Treatment	Number of panicle per plant	Number of seeds per panicle	Grain yield per hectare
Location (L)			
Lafia	5.70b	70.17b	4164.6b
Badeggi	12.74a	135.49a	4313.8a
LSD (0.05)	1.38	1.78	124.34
Planting method (PM)			
Dibbling	8.95b	102.78a	3891.5b
Transplanting	9.48a	102.88a	4586.8a
LSD (0.05)	0.23	0.67	22.08
Weed management (WM)			
Weedy check	7.86e	103.13cd	1533.7j
2 HW (3 + 6 WAS)	10.00b	108.58a	3519.6h
Metsulforun Methyl (E)	10.78a	104.51c	5457.9b
Metsulforun Methyl (L)	8.91c	102.32d	5268.7c
Cyhalofop buthyl + MCPA (E)	11.32a	101.70de	4519.6e
Cyhalofop buthyl + MCPA (L)	8.81cd	108.46a	4615.0d
MCPA (E)	8.25de	99.00gh	6089.6a
MCPA (L)	10.78a	106.42b	6056.3a
Pretilachlor + Pyribenzoxium (E)	8.13e	100.74ef	3868.8f
Pretilachlor + Pyribenzoxium (E)	9.08c	100.49ef	4577.1d
LSD (0.05)	0.61	1.47	54.47
Interaction			
L × PM	NS	NS	NS
L × WM	NS	NS	NS
PM × WM	NS	NS	NS
L × PM × WM	NS	NS	NS

EFFECTS OF SPENT ENGINE OIL ON THE GROWTH AND HERBAGE YIELD OF AMARANTH (*Amaranthus hybridus* L.) BIOREMEDIATED WITH LIQUID ORGANIC FERTILIZERS

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ABSTRACT
This trial is focused on the potential of liquid organic fertilizer as bioremediant for spent engine oil polluted soils conducted in the Screen House, Department of Crop Science, Faculty of Agriculture, University of Benin, Nigeria. This study involved three concentrations of spent engine oil pollution (0, 5 and 10 % w/w, spent engine oil in 10 kg soil) and four liquid organic fertilizers types (water (control), cattle dung, poultry manure and rabbit manure) laid out in a 3 x 4 factorial arrangement and fitted into completely randomized design (CRD) with three replications. Data were collected on plant height, stem girth, number of leaves and leaf area at two, four, six and eight weeks after sowing, both fresh and dry yield were estimated at six weeks after sowing. Soil analysis showed that Soil pH was significantly ($p<0.05$) reduced with increase in spent engine oil pollution. However, organic carbon and Heavy metals (Cr. Cd and Pb) concentration increased with increasing concentration of spent engine oil pollution. Soil pollution adversely affected plant height, number of leaves, leaf area, stem girth and herbage yield. Growth and herbage yield were significantly ($p<0.05$) higher in liquid organic fertilizer amended spent engine oil polluted soil than with soils without amendment. The highest herbage yield (13.30 t ha^{-1}) was obtained from unpolluted soil. Rabbit manure amended plants had the highest fresh herbage (12.49 t ha^{-1}) which was similar with liquid poultry manure treated plant yield (12.21 t ha^{-1}). Spent engine oil unpolluted soil supplied with rabbit manure had the herbage yield of 20.49 t ha^{-1}. However, poultry and rabbit manures had similar dry weight values. Hence poultry and rabbit manures are thereby suggested for the bioremediation of spent engine oil polluted soils.
***Keywords**: Bioremediation, growth, herbage yield, liquid organic fertilizers, spent engine oil.*

INTRODUCTION
Spent engine oil is used motor oil collected from mechanical automobile workshops and industrial source like hydraulics oil, turbine oil, process oil and metal working fluids (Oluaboji and Ogunwale, 2008). It is usually obtained after servicing and subsequent drawing out from automobile and generator engines (Sharifi *et al,* 2007). Spent engine oil is a mixture of different chemical including petroleum hydrocarbons, lubricant additives, decomposition products and heavy metal that come from engine parts as they wear away (Wang *et al.,* 2000). The physical, chemical and microbiological properties of soil polluted with petroleum hydrocarbons, undergo various changes, the changes in soil due to contamination with petroleum derived substances can lead to water and oxygen deficit (Odjegba and Sadiq, 2002). Soil contamination with spent engine oil lead to significant reduction of soil moisture content which subsequently increase retardation in plant growth considerably. It causes damage to different parts of the plant that are vital for its well-being and survival and hence obstructs development and growth (Appiah-Adjei *et al.*, 2016). Leaves of plants affected by the pollution tend to dehydrate and show a general sign of chlorosis, indicating water deficiency (Udo and Fayemi, 2004).
The reduction in photosynthetic rate results in the decreased rate of growth, which leads to the reduction of leaf sizes (Boyd and Murray, 1982). Spent Engine oil delay germination by inducing stress, inhibiting

water and nutrients uptake by the root of the plant, hence causing deficiency to other parts of the plant (Appiah-Adjei *et al*., 2016). Bioremediation is a collective, phenomenon involving processes that use biological systems to either restore or clean-up contaminated sites. It aims to reduce or bring down pollutant levels up to understandable, nontoxic, or acceptable levels (Kumar *et al,* 2015). Organic fertilizers act as means of bioremediation by degrading the oil and improving the physical properties of soils which leads to increased agronomic parameters of such soil (Mbah *et al*., 2009). More so, the use of Organic fertilizers like cattle dung and poultry droppings for bioremediation is cost effective because it also serve as source of manure thus reducing the cost of using inorganic fertilizer (Essien *et al.,* 2015). This study is thus aimed to determine the effect of spent engine oil on the growth and yield of *Amaranthus hvdridus* bioremediated with liquid organic fertilizers.

MATERIALS AND METHOD

This experiment was conducted between April and June 2021 and 2022 in the screen house 1 of the Department of Crop Science, Faculty of Agriculture, University of Benin, Nigeria (Lat 6" 20' 1.32" N Long. 5° 36' 0.53" E). Benin-City lies in the forest zone of South Western Nigeria with an altitude of 86m above sea level. Top soil was obtained from Capitol in the University of Benin, Seeds of *Amaranthus hybridus* used for this study were purchased from a local farmer in Benin City. Spent engine oil was obtained from a motor mechanic workshop at Uwelu, Benin City, Poultry and rabbit droppings were obtained from the University of Benin Farm project and Cattle dung from the cattle market at Uselu, Benin City.

General procedure and experimental design

Ten (10) kg samples of top soil was weighed and contaminated with 0, 5 (64ml) and 10 % (128ml) levels of spent engine oil with each of the contamination levels watered with ordinary water, liquid cattle dung fertilizer, liquid poultry manure and liquid rabbit manure in a 3 x 4 factorial layout making it a total of twelve treatments combinations and replicated three times in a completely randomizes design (CRD). An analysis was conducted to determine the physical and chemical properties of the soil and liquid organic manure using standard laboratory procedures. The liquid manure was prepared by immersing 5 g of already cured manure tied inside a jute bag inclusion of stone into 15 litres of water and left for three days. On the third day, the liquid manure was sieved and diluted with three times it's volume of fresh water. *Amaranthus hybridus* seeds were sown directly in the soil and thinned to three plants per bucket at two weeks after sowing (WAS). The buckets used for the experiment were perforated on the sides to prevent water logging and nutrient run off, the liquid fertilizer used for watering was intermitted weekly with fresh water.

The data collection started two weeks after sowing and continued at two weeks interval until the six weeks after sowing. The parameters recorded were plant height, number of leaves per plant, stem girth and leaf area. Number of leaves was counted manually, the Stem girth, leaf length, leaf width and plant height was measured with a calibrated tape rule. The leaf area was calculated by multiplying the leaf length, leaf width and a correction factor of 0.65 for *Amaranth* (Marshal, 1968). At 6 WAS, the plants were harvested, the fresh weight was measured with a mechanical scale and dry weight with an electrical sensitive scale after oven drying at 60° C to a constant to a weight. Data collected were subjected to analysis of variance (ANOVA) after finding the mean of the data collected between the two cropping seasons using GENSTAT statistical package. Differences among treatment means were separated using the Least Significance Difference (LSD) test at 0.05 level of probability.

RESULTS

Effect of spent engine oil on soil chemical and physical properties

The soil analysis conducted on the onset of the experiment showed that porosity decreased with increase in spent engine oil contamination while bulk density increased with increase in the application of spent engine oil (Table 1). Soil pH was decreasing with increase in the concentration of spent engine oil. The organic carbon increase with addition of spent engine oil (SEO). Total nitrogen and available phosphorus content of soil decreased with application of engine oil. Available P decreased with increase in SEO concentration. Exchangeable cation decreased while exchangeable acidity and heavy metals increased with increase in SEO concentration.

Growth and yield of Amaranth

The results of the growth and herbage yield *of A. hybridus* grown on spent engine oil bioremediated with liquid organic manure are presented in Table 2. Plant height decreased with increase in spent engine oil contamination. This trend was repeated for stem girth, number of leaves, leaf area, herbage yield and dry weight. There was increase in heights of the plants bioremediated with liquid organic fertilizers over control except rabbit manure. However, *A. hybridus* planted on soil fortified with cattle dung has the tallest plants. While those treated with poultry and rabbit manures had plants with similar girth values but significantly thicker than those produced in the control plots. This observation was mirrored for number of leaves per plant, herbage yield and dry weight of Amaranth. Poly bags treated with poultry manure produced plants with the largest leaf area. There was significant interaction of spent engine oil and liquid organic fertilizer on herbage yield. Unpolluted soil treated with liquid rabbit manure had the highest herbage yield (Table 3).

DISCUSSION

Soil polluted with spent engine soil exhibited poor physical and chemical properties. The presence of spent engine oil in soil probably brought about increased bulk density and decreased porosity, an evidence of low water holding capacity and poor aeration. This was earlier reported by Kayode *et al*. (2009) who reported the presence of spent engine oil in increasing bulk density, decreasing water holding capacity and aeration propensity. The lower pH observed in spent engine oil polluted soil could have been responsible for the lower available P since it availability is pH determinant.

The observation connoted the report of Uchedu and Ogwo (2014) who reported the pH values of polluted soil around a mechanic village were predominantly acidic. The strongly acidic nature observed on spent engine oil polluted soil could have depressed microbiotic acidity leading to reduced total N content. The observed reduced exchangeable cations content and higher level of heavy metal in the contaminated polluted is in agreement with Uchendu and Ogwo (2014) report. The higher organic carbon content observed on spent engine oil polluted soil could be due to its enrichment from the oil which has been found to have high carbon content. However, its higher carbon content could neither depressed the strong acidity nor the higher exchangeable acidity of polluted soils. These unfavourable conditions associated with soil contaminated with spent engine oil could have caused unfavourable growth and herbage yield of amaranth. This observation is in agreement with Odjegba and Sadiq (2002) who report low yield and decreased growth of plant grown in spent lubricant oil contaminated soil.

The retarded growth observed in spent engine oil contaminated soil through evidenced with shorter fewer number of leaves, thinner stems and decreased leaf area. This further decreased with increase in contamination concentration. This observation connoted Udo and Chukwu (2014) who reported the effect of spent lubricant oil pollution on soil properties and growth of plant is dependent on their concentration in a given soil as it is increasingly detrimental to the functional ability of the soil and plant growth. The leaf area decreased in polluted soils, an indication of lower photosynthetic activity, leading lower growth evidenced with shorter plants, thinner stems and fewer number of leaves (Boyd and Murray, 1982). The reduced photosynthetic activity in plants grown in spent engine oil polluted soil occasioned by decreased leaf area led to lower herbage yield due to the production of reduced amount of assimilate. This necessitated the need for bioremediation of the soil through the application of liquid organic fertilizer. The tested liquid organic fertilizers were moderately to slightly acidic with high content of organic carbon and appreciable amount of total N, available P and exchangeable cations. The appreciable total N content could be of enourmous advantages of the fertilizers as Walworth *et al.* (2007) claimed the additional of organic nitrogen rich nutrient is an effective approach to enhance the bioremediation process. The position effects of nitrogen amendment on microbial activity and/or petroleum hydrocarbon degradation have been widely demonstrated by Riffaldi *et al*. (2006).

The application of liquid organic fertilizer to spent engine oil pollution witnessed higher growth and herbage yield of Amaranth compared to untreated soil. This is an evidenced that justified these

amendments reducing the adverse effect of spent engine oil on the soil. The high organic carbon of these amendment activated the activities of microbes to breakdown the organic pollutant through nourishment which was further enhanced through nitrogen.
In this study, higher plant heights thicker stems, higher number of leaves, larger leaf area, herbage yield and greater dry weight, were accrued to soils treated with poultry and rabbit manures than to those with cattle dung. This variation could have arisen as a result of total N content and organic carbon of these amendments. Spent engine oil contaminates the soil and adversely affect the growth and yield of *Amaranth hybridus* but liquid organic fertilizers bioremediated the soil and improved the growth and yield of *Amranth.* Based on these findings, poultry and rabbit manures due to their better performance are suggested as a liquid organic fertilizer to bioremediate soils polluted with spent engine oil.

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Table 1: Physical and chemical properties of polluted soil with spent engine oil and chemical composition of organic fertilizer

Parameters	0	5	10	LSD (0.05)	Cattle dung	Rabbit manure	Poultry manure
Particle size (g kg^{-1})							
Sand	886	887	889	na	na	na	na
Salt	64	62	60	na	na	na	na
Clay	50	51	51	na	na	na	na
Porosity (%)	58.6	56.4	56.2	2.001	na	na	na
Bulk density (g cm^{-3})	1.18	1.2	1.31	0.112	na	na	na
pH (H_2O)	5.4	5	4.8	0.498	6.5	6.7	6.25
Organic C (g kg^{-1})	17	17.6	18.2	0.979	25.8	30.3	28.6
Total N (g kg^{-1})	0.77	0.74	0.72	0.045	1.54	1.24	1.87
Available P (mg kg^{-1})	12.3	10.8	10.3	1.415	16	17	18
Exchangeable cation (cmol kg^{-1})							
Ca	0.85	0.8	0.66	0.16	1	1.08	1.22
Mg	0.34	0.34	0.32	0.096	0.5	0.44	0.35
K	0.31	0.31	0.18	0.129	2.12	2.04	0.34
S	na	Na	na	na	0	0	3.88
H	0.01	0.04	0.35	0.308	0	0	0
Al	0	0.05	0.14	0.116	0	0	0
Heavy metal (mg kg^{-1})							
Pb	0	0.01	0.02	0.017	0.01	0.01	0.02
Cr	0	0.02	0.03	0.027	0.01	0.01	0.01
Cd	0	0.02	0.03	0.027	0.01	0.01	0.01

na = not applicable

Table 2: Herbage yield (t ha^{-1}) of Amaranth as influenced by spent engine oil pollution bioremediated with liquid organic fertilizer

Spent engine oil (% v/w)	Liquid organic fertilizer				
	Control	Cattle dung	Poultry manure	Rabbit manure	Mean
0	8.41	11.55	13.21	20.04	13.3
5	7.56	10.88	12.81	9.88	10.28
10	5.96	5.05	10.62	7.54	7.29
Mean	7.31	9.16	12.21	12.49	
LSD (0.05) SEO	2.859				
LSD (0.05) LOR	3.301				
LSD (0.05) SEO x LOR	5.717				

SEO-spent engine oil, LOR-Liquid organic fertilizer

Table 3: Effect of spent engine oil pollution bioremediated with liquid organic fertilizer on the growth and herbage yield of Amaranth

	Plant height (cm)			Stem girth (cm)			No. of leaves			Leaf area (cm^2)			Herbage yield ($t\ ha^{-1}$)			Dry weight ($g\ plant^{-1}$)		
Treatment	2021	2022	C	2021	2022	C	2021	2022	C	2021	2022	C	2021	2022	C	2021	2022	C
Spent engine oil concentration (%)																		
0	65.3	14.7	38.2	4.38	0.35	2.31	42.0	10.9	26.2	2625	141	1370	23.54	2.87	13.20	25.74	14.74	20.02
5	61.7	14.1	39.9	3.27	0.25	1.81	35.3	10.4	23.1	2064	115	1102	15.27	3.40	9.33	26.84	9.63	17.72
10	61.6	7.1	34.4	3.18	0.18	1.68	30.9	5.3	18.1	1921	20	970	15.32	1.36	8.34	16.33	8.94	12.64
LSD $_{(0.05)}$	ns	2.84	2.82	0.648	0.080	0.318	6.5	1.3	6.6	469.8	76.0	235.3	5.480	1.165	2.859	3.733	1.090	4.587
Liquid organic fertilizer																		
Control	64.0	4.4	34.2	3.03	0.14	1.59	27.0	5.2	16.1	1897	32	964	14.29	0.32	7.30	14.59	8.56	11.58
Cattle dung	70.0	12.7	41.5	3.39	0.28	1.83	28.6	10.0	19.3	1717	147	932	16.74	1.58	9.16	21.05	9.63	15.34
Poultry manure	60.3	14.8	37.6	4.32	0.26	2.29	52.2	10.2	31.3	3031	81	1556	20.62	3.80	12.21	26.71	12.46	20.58
Rabbit manure	58.8	16.6	36.7	3.68	0.34	2.01	36.6	9.8	23.2	2169	106	1138	20.51	4.46	12.48	27.61	11.72	19.67
LSD $_{(0.05)}$	ns	3.35	3.26	0.748	0.092	0.367	9.3	1.46	7.57	542.5	30.1	271.7	6.330	1.287	3.301	2.089	0.950	5.296
Interaction	ns	ns	ns	ns	0.742	ns	ns	2.52	ns	ns	ns	ns	ns	ns	5.717	ns	1.886	ns

Note: ns - Not significant at 0.05 level of probability, C - combined

ASSESING FERTILIZER POTENTIAL OF SOME PLANT EXTRACTS IN OKRA (*Abelmoschus esculentus* (L.) Moench) CULTIVATION

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ABSTRACT

An experiment was conducted to evaluate growth and yield response of okra to NPK and organic fertilizer. It was carried out at the screen house of the Institute of Agricultural Research and Training, Ibadan between April and August 2021. The experimental design was Completely Randomized Design with six treatments, namely; NPK (100%), Neem Extract (100%), Jatropha Extract (100%), Neem extract+NPK (50:50), Jatropha extract+NPK (50:50) in four replicates. Data collected were number of leaves/plants, plant height, leaf area, number of fruits per plant, and fruit yield (g/pot). Data collected were subjected to analysis of variance while the significant means were separated by Duncan Multiple Range Test at 5% probability level. Result obtained showed that plant extract of neem and jatropha improved the growth and yield of okra, as sole application or in combination with NPK than NPK. Neem (100%) gave the highest fruit yield of 377.7 g/pot, followed by neem+NPK (50:50) with 252.9 g/pot and jatropha (233.0 g/pot) which are all comparable but significantly higher than other fertilizer sources. Therefore, use of organic fertilizer sources for growing okra can be an alternative to inorganic sources which are not readily available to peasant farmer.

Keywords: *Extract; Fertilizer; Jatropha; Neem; Okra; Yield*

INTRODUCTION

Okra (*Abelmoschus esculentus* (L.) Moench) is an annual, herbaceous flowering plant in the Mallow family that originated from tropical and subtropical Africa and is natural to the West Africa (Aladele *et al.,* 2008). Okra is mainly cultivated for its young immature fruits and consumed as a vegetable, raw, cooked or fried in countries like Sudan, Egypt and Nigeria; it is also important in other tropical areas including Asia central and South America often used as ingredient of soups and sauces. The fruits can be conserved by drying or pickling, the roasted seed is considered as coffee substitute; the leaves, flower buds, flowers and calyces can be eaten cooked as greens. In Nigeria, okra is grown in both wet and dry season but attract a larger profit in the dry season when the demand is often in excess with limited supplies. Okra is a good source of vitamins, minerals, calories and amino acid found in seeds and compares favorably with those in poultry, eggs and soybean. Growth of vegetables can be greatly improved through regular care. Fertilizer application is one of the most important factors which affect plant growth. Lack of certain nutrients lead to some symptoms such as small leaves, light green or off-color foliage and less elongation of branches and general lack of thriftiness or vigor (Melvin and James, 2001). Nitrogen is one of the basic plant nutrients that is built into the body of simple and conjugated proteins and many of organic substances of plant cell. Phosphorus is considered one of the important macro element nutrients.

Among the various factors affecting successful cultivation of okra, the judicious fertilizer application is one of those. Nitrogen is an essential element and important determinant in growth and development of crop plants. It plays an important role in chlorophyll, protein, nucleic acid, hormone and vitamin synthesis and also helps in cell division, cell elongation. Phosphorus fertilization can influence fruiting and development of okra. Phosphorus is called the "key to life" because it is directly involved in most living processes (Firoz, 2009). The requirements of fertilizers in okra are important for the early growth and total yield of fruit. Okra cultivation requires nutrients such as nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), sodium (Na) and Sulphur (S) for fertility maintenance and crop production. These nutrients are specific in function and must be supplied to plants at the right time and at the right quantity. Lack of sufficient amounts of these nutrients result in poor performance of the okra with growth been affected resulting to low yield (Chauhan, 2012). In developing countries like Nigeria, the population growth rate is so high that improved technologies including rational use of fertilizers must be employed to meet the food requirement of the people (Hedrick, 2012). Improving soil fertility through the application of fertilizers is an essential factor enabling the world to feed the billions of people that are added to its population (Hera, 1996). Declining soil fertility is a major production constraint in Africa, especially in Nigeria, and it is becoming increasingly critical to secure sustainable soil productivity (Oladotun, 2002). Organic manure helps to improve the physical condition of soil and provide adequate amount of necessary nutrients for the soil productivity.

Organic fertilizers application resulted in improvement of growth and yield of different vegetable crops. This effect may minimize the amounts of chemical fertilizers and improve their application efficiency and subsequently avoiding environmental pollution. Use of inorganic fertilizers can improve crop yields and soil pH, total nutrient content, and nutrient availability, but its use is limited due to scarcity, high cost, nutrient imbalance, and soil acidity. Use of organic manures as a means of maintaining and increasing soil fertility has been advocated (Smil, 2000). Despite increasing relevance of okra in Nigeria where it is widely consumed, low yields are obtained in farmers' field because of declining soil fertility due to continuous cropping and disregard for soil amendments, which has led to several nutrients' loss in the soil (Akanbi *et al.* 2010). The application of inorganic fertilizers results in increase of okra yield. Unfortunately, inorganic fertilizers reduce the quality of arable lands. The Economic Commission for Africa (2001) reported that tropical soils are adversely affected by suboptimal soil fertility and erosion, causing a deterioration of the nutrient status and changes in soil organism populations. Akanbi *et al.* (2010) asserted that inorganic fertilizers can improve crop yields and soil pH, total nutrient content, and nutrient availability, but their usage is limited due to scarcity, high cost, nutrient imbalance and soil acidity. Hence, the objective of this study is to determine the growth and yield response of okra (NH47-4) to NPK and organic fertilizer sources.

MATERIALS AND METHODS

The field experiment was carried out at the screen house of the Institute of Agricultural Research and Training (I.A.R&T) Ibadan located on latitude of 7°22N and Longitude 3°05 E. Okra, *Abelmoschus esculentus* (L.) (NH47-4) variety seeds were obtained from IAR&T Seed stores. Five seeds were sown in each of the 5 kg capacity polythene bags, watered and later thinned to two seeds per pot. While the various plant extract was applied two weeks before planting in the appropriate pots, the inorganic fertilizer was applied two weeks after planting at the application rate of 80 kgN/ha. The experimental design was Completely Randomized Design (CRD) with six treatments of NPK, Neem leaf extract, Jatropha leaf extract, Neem+NPK (50:50) and Jatropha leaf + NPK (50:50) and control each replicated four times. Extract from neem and jatropha were obtained by soaking plucked leaves in distilled water, followed by blending and sieving of the extracts before use.

Data collection commenced at two weeks after sowing (WAS) on number of leaves/plant and plant height (cm). Leaf area was estimated by the non-destructive method of Olasantan and Salau (2008). The estimated regression equation between leaf area (Y) and leaf length (X) is: $Y= -386.93 +40.56X$ ($r= 0.91$). Two fully expanded leaves from five sample plants were used whose mean length represent X. This data was taken 8 WAS, at the commencement of flowering to ensure that the peak of vegetative growth was reached. Yield parameter taken are the number of fruit/plant and fruit yield (kg). The data collected were analyzed using analysis of variance to test the significant difference of treatments and mean differences were compared and separated using Duncan Multiple Range Test (DMRT) at 5% level of significance.

Table 1: Nutrient analysis of Jatropha leaf and Neem leaf

Properties	Neem extract	Jatropha extract
Total Nitrogen (%)	0.078	0.081
Total Phosphorus (%)	0.07	0.10
Total Potassium (g / kg)	0.21	0.31

RESULTS AND DISCUSSION

Physical and chemical characteristics of the experimental soil.

The result of the physical and chemical characteristics of soil showed that the soil is moderately acidic with a pH of 5.67, available phosphorus and total nitrogen were moderate with values of 18.97mg/kg and 0.30g/kg respectively (Table 2). The organic carbon was very high with value of 2.59% and the exchangeable cations were high. The textural class of the soil was loamy sand.

Table 2: Physical and chemical properties of soil

Parameters	Soil Test Value
pH	5.67
Organic C (g/kg)	2.59
Total N (g/kg)	0.30
Avail. P (mg/kg)	18.97
Exchangeable cations (cmol/kg)	
Ca	1.63
Mg	2.00
K	0.35
Na	1.02
Particle size (g/kg)	
Sand	816
Silt	116
Clay	68
Textural class	Loamy sand

Effect of fertilizer source on the growth parameters of okra at 8 WAS

The result showed that organic fertilizer sources had significant effect on the number of leaves of okra at 8 weeks after sowing (WAS) than inorganic fertilizer source (Table 3). Meanwhile, neem extract produced the highest number of leaves (7) which is similar with other fertilizer sources except NPK and control plants which had the lowest value of 5. Similarly, the tallest plant of 92.8 cm was from Neem extract, it was comparable with other fertilizer sources and the control plant. However, Jatropha extract significantly produced the highest number of leaf area of 60.9 cm^2 which at par with other organic sources but higher than NPK (25.2 cm^2) and control plant (16.5 cm^2). This result was in line with the works of Akanni *et al,* (2011) and Olowoake & Ojo (2014) who reported that the combinations or sole application of organic fertilizers perform better on leaf area expansion, higher number of leaves/plant (Ojo *et al.,* 2014) and taller plants according to the findings of Singh *et al.* (2007) who posited that neem extract increased the plant height of okra compared to the control.

Table 3: Effect of fertilizer source on the growth of okra at 8 WAS

Treatments	Leaf area (cm^2)	Plant height (cm)	No of leaves/plant
Control	16.5b	75.2	5.3b
NPK	25.2b	72.6	5.3b
Neem (100%)	56.4a	92.8	7.7a
Jatropha (100%)	60.9a	77.9	7.4a
Neem+NPK (50:50)	54.4a	71.7	6.9a

Jatropha+NPK (50:50)	51.5a	79.2	7.3a
		Ns	

ns - not significant. Means with same letter (s) in a column are not significantly different at 5 % level of probability by Duncan Multiple Range Test (DMRT) WAS – weeks after sowing

Effect of fertilizer source on the yield of okra

The result showed that all the fertilizer source produced similar number of fruit/pot with the highest value from neem (Table 4). In the same vein, neem-based fertilizers gave the highest fruit yield while neem gave the highest value of 377.7 g/pot, followed by neem+NPK (50:50) with 252.9 g/pot and jatropha (233.0 g/pot) which are all comparable but significantly higher than other fertilizer sources. The lowest yield of 88.7 g/pot was from Jatropha extract + NPK. The resultant improvement in the yield of okra may be due to growth enhancement in terms of leaf production and taller plants than other fertilizer sources, which aid photosynthetic ability of the plant. In addition, neem extract is quick acting, provides a slow and steady nourishment and improves yield and quality of crops (Meena et al., 2009). Olaniyi et al. (2005) reported significant increase in the number of fruits and fruit yield of okra raised from organic fertilizer sources.

Table 4: Effect of fertilizer source on the number of fruits and cumulative yield of okra

Treatments	Cumulative yield (g/pot)	Cumulative no of Fruits
Control	120.6b	39.0
NPK	103.3b	22.4
Neem (100%)	377.7a	44.4
Jatropha (100%)	233.0ab	29.3
Neem+NPK (50:50)	252.9ab	35.7
Jatropha+NPK (50:50)	88.7b	22.5
		ns

ns - not significant. Means with same letter(s) in a column are not significantly different at 5 % level of probability by Duncan Multiple Range Test (DMRT)

CONCLUSION

The plant extract of neem and jatropha improved the growth and yield of okra, be it singly or in combination with inorganic fertilizer. Since, similar yield result was obtained using conventional NPK fertilizer which are usually inaccessible to peasant farmer, when compared with organic fertilizer sources investigated, it can be concluded that neem extract and jatropha extract may be considered by farmers and researchers to provide safer and cheaper fertilizer alternatives to the Nigeria populace. Therefore, neem fertilizer applied at 80 kgN/ha is recommended to maximize yield of okra.

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EVALUATION OF PLANT PARTS HARVESTING TECHNIQUES FROM SOME INDIGENOUS WOODY PLANT SPECIES IN THREE ECOLOGICAL ZONES OF TARABA STATE NIGERIA

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ABSTRACT
This research focused on plant parts harvesting techniques from some indigenous woody plant species in different ecological zones of Taraba State. It investigates the different techniques, reasons and impacts of harvesting these species. Two stage sampling design was used to obtain data in the study. In the first stage, the study was stratified into three study ecological zones. The second stage involved the use of purposive sampling technique and e and Yamane's adaptation of Solvin's formula to select a sample size of 399 respondents (133 respondents in each ecological zone). A total of six (6) species (2 species per ecological zone) were selected using purposive and Snowball sampling methods. Data obtained were analyzed using quantitative indices (Fidelity level, plant part value, harvesting impact) and qualitative parameters (Frequencies, Percentages, Tables and Bar charts). The results showed that the stem of Prosopis africana and Pterocarpus erinaceus received the highest harvesting risk. The most preferred plant parts harvested were Vetellaria paradoxa stems and Pterocarpus erinaceus leaves as evidence by fidelity levels. Vitellaria paradoxa stems (37.43%) had the highest plant part value. The rate of reproduction of these species is being slowed down by the rising rates of unsustainable harvest caused by preference choice and the high value esteem of the plant parts. As evidenced by high harvesting impacts scores of 77.50 and 64.00 for Vittellaria paradoxa and Pterocarpus erinaceus stems, decreased rates of reproduction have negatively damaged the species.This calls for the promotion of effective conservation strategies and sustainable harvest of the priority indigenous woody plant species.
Keywords: *Ecological zone, Harvesting impact, Sustainable, Plant part, and Unsustainable*

INTRODUCTION

Indigenous woody plant species (IWPS) are generally harvested for timber and Non-Timber Forest Products (NTFPs) (Gaoue *et al*., 2017). The harvesting and consumption of IWPS parts from natural forests is known to account for a large proportion of livelihood (Ndangalasi *et al*., 2007). These plant parts are used by human beings over time for various reasons like food, fodder, fiber, traditional medicine, agricultural amenities, domestic materials, construction materials and many of these reasons are associated with cultures (Talukdar e*t al*., 2020). In sub-Saharan Africa, extraction for daily livelihood needs often results in uncontrolled exploitation of leaves, bark, and seeds of valuable indigenous woody species. However, overharvesting can threaten reproduction (Nacoulma *et al*., 2017). Majority of IWPS parts harvested are Non-Timber Forest Products (NTFPs) while others are timber forest products.

Various techniques used in harvesting different parts of IWPS have not been investigated and some of these species are poorly harvested. Unsustainable harvest of IWPS parts in Taraba State is widespread and common. The current unsustainable harvesting techniques being practiced and lack of sustainable harvesting knowledge have resulted to severe damage of many species in the state. Most IWPS are harvested for more than one reason (Delvaux *et al*., 2009) and the harvesting techniques focus on the economic reasons thereby, adopting methods of extraction such as lopping of branches, premature harvesting and cutting of trees. The removal of IWPS parts have variable impacts on the plants themselves, depending on the parts harvested. For example, harvesting flowers and fruits has a significant impact on regeneration and on the population viability (Gaoue and Ticktin, 2008; Delvaux *et al*., 2009). However, harvesting bark or roots is more damaging in terms of tree survival (Delvaux *et al*., 2009). The actual impact of harvesting depends on the method and type of resource that is removed. Intensive and uncontrolled harvesting can reduce the abundance of solitary plants (Ndangalasi *et al*., 2007).

Taraba State is blessed with considerable vegetation resources, which is one of the factors that contributed to the development of timber and non-timber forest products markets in the area. The natural ecosystems of the State constitute a main source of IWPS, these species play important role in the survival of man (Meer, 2018). The importance of these species in daily lives cannot be over emphasized. IWPS are making a positive impact on rural economic development of the State but the negative impacts out run the positive impacts as it negatively affects species functions, growth and production. The populations of many IWPS harvested for their foliage, bark and roots have reduced reproductive performance and age at first reproduction which ultimately translated into reduced population growth rate (Gaoue *et al*., 2013). The high rate of different harvesting techniques been practiced in Taraba State needs scientific attention. Therefore, the main objective of this study is to investigate the different harvesting techniques, reasons and impacts of harvesting IWPS in Taraba State. This evaluation will therefore provide adequate information for sustainable use and management of IWPS.

METHODOLOGY

The study area

Taraba State in Nigeria lies between latitudes 7° 00’ 00” N and 9° 30’ 00” N and longitudes 10° 00’ 00” E and 12° 30’ 00” E. It occupies a total land mass of approximately 54, 473 km^2 (Figure 1). The State is bordered on the northwest by Gombe State, west by Plateau and Nassarawa States and by Adamawa State in the northeast. It also shares its southwest boundary with Benue State. An international boundary on the east separates Taraba State from the republic of Cameroon (GIS MAU, Yola, 2023). The state is made up of three (3) major ecological zones which include Southern guinea savanna located in the south western part of the State, Northern guinea savanna in the northeast and Montane Forest in the southeast (Meer *et al*., 2019).

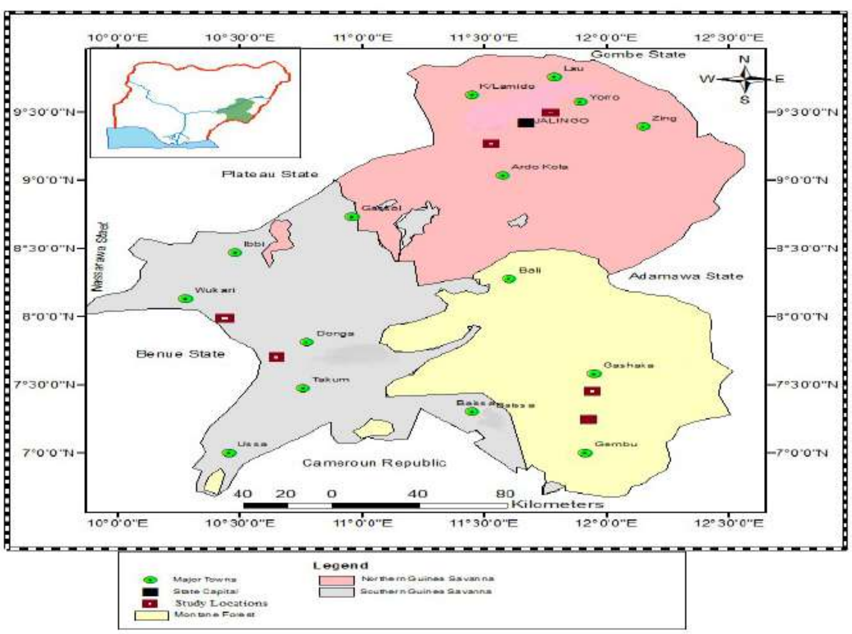

Figure 1: Map of Taraba State Showing the Study Locations
Source: GIS MAU Yola (2023)

Data Collection

Two stage sampling design was used to obtain data in the study. In the first stage, the study was stratified into three study ecological zones namely; Northern Guinea Savanna (NGS), Southern Guinea Savanna (SGS) and Montane Forest (MF). The second stage involved the use of purposive sampling of respondents who have direct association with indigenous woody plant species or its products and the selection of two (2) most essential IWPS in terms of economic (income generated from tree species products and services); social (food, medicine, cultural, religious, raw materials) and ecological (shelter, climate modification and protection) development in each ecological zone. A total of six (6) species were selected in the study, they are *Pterocarpus erinaceus*, and *Beilchmiedia mannii* in MF, *Ziziphus mauritiana* and *Vetellaria paradoxa* in NGS, *Prosopis africana* and *Vitex donniana* in SGS.

A sample size of three hundred and ninety nine (399) respondents (133 respondents per ecological zone) drawn from the target population of Taraba State (2,300,736) using Solvin's formula adopted by Yamane (1967), Otabor and Obahiagbon (2016) and Sells (2018) were used as shown in equation one (1) bellow:

$$n = \frac{N}{1 + N(e)^2} \qquad \ldots\ldots 1$$

Where:

n = Required sample size

N= Total population of the study area

e = Error to tolerance (95% confidence level at a margin of error of 0.05)

Administration of semi-structured questionnaire was done using Snowball sampling method as adopted by Agbelade *et al*. (2017).

Data Analysis

Data were analyzed using descriptive statistics (Frequencies, Percentages, Tables and Bar charts) and quantitative parameters [Relative Cultural Importance indices (RCI) like Fidelity Level (FL) in percentage, Plant Part Value (PPV) in percentage, Reported use (RU), Reported use Value per Plant Part (RU_{PP})] adopted by Hoffman and Gallaher, (2007). According to Salako *et al.* (2018), Fidelity Level (FL) is an instrument used to identify the most preferred plant part for each use category or reason. It measures how often a use report was mentioned. The formula is giving in equation 2 below as described by Friedman *et al*. (1986) and Omire *et al*. (2020):

$$FL\ (\%) = \frac{x}{n} \times 100 \qquad \ldots\ldots 2$$

Where:

x = Total number of respondents who have mentioned a specific use

n = Total number of respondents

Plant Part Value (PPV) is the ratio between the total reported uses for each plant part and the total number of reported uses for the plant (Hoffman and Gallaher, 2007; Omire *et al*., 2020). It is expressed in equation 3 as:

$$PPV\ (\%) = \frac{\Sigma RU_{PP}}{\Sigma RU} \times 100 \qquad \ldots\ldots 3$$

Where:

Σ = Summation

RU_{PP} = Total number of uses for each plant part

RU = Total number of uses reported for the plant

To determine the harvesting impacts for each of the sampled IWPS and their respective plant parts, a specially developed Harvesting Impact (HI) formula derived from an equation previously proposed by De Lucena *et al*. (2013) as adopted by Bruschi *et al*. (2014) was used. The resultant percentages of local use (LU) and harvesting risk (HR) of each plant part were scored (Table 1). The harvesting impacts were calculated using the formula in equation 4 and the criteria given in Table 1:

$$HI = LU_M \times HR_M \qquad \ldots\ldots 4$$

Where:

HI = Harvesting impact

LU_M = mean value of local use (LU) scores were calculated by considering each single use of that species. This value was obtained by adding up the scores assigned to each use and dividing this sum by the number of all the uses cited for that species.

HR_M = mean value of harvesting risk (HR) scores were calculated by considering each single harvesting method or risk of that species. This value was obtained by adding up the scores assigned to each harvesting method or risk and dividing this sum by the number of all the harvesting method or risk cited for that species.

RESULTS AND DISCUSSION

Demographic Characteristics of Respondents in the Study Area

The results of the demographic characteristics of respondents in Table 2 showed that male respondents (55.89%) were more than their female (44.11%) counterpart. This clearly implies that male and younger respondents commonly extract indigenous woody species than female and older respondents. This conclusion is consistent with Meer (2018), who noted a high percentage of male users of woody species in the three ecological zones of Taraba State, Nigeria. This claim was also in line with a study carried out in India where Talukdar *et al*. (2021) affirmed higher proportion of young persons for NTFPs collection compared to middle and older aged people. Majority (46.12%) of the respondents were below 30 years, followed by the age group of 50 years and above (29.07%). Only 24.81% belong to the age group of 31 to 50 years (Table 2). This suggests that they are of an active age for tree harvesting. In contrast, a study conducted by Ampitan *et al*. (2017) recorded majority of female respondents between the age group of 41 to 50 years with wealth of experience, responding to the uses of the indigenous woody plant parts in New Bussa, Niger State, Nigeria.

The marital status and educational level of the respondents revealed that majority (50.63%) were married, 36.84% had secondary school education, and 25.31% had primary school education while 19.55% and 18.30% represent non formal and tertiary education respectively. Occupational distribution of respondents indicates that 28.82% were herbalists, 26.07% were artisans while 22.81% and 22.30% were traders and farmers respectively (Table 2). The respondents' married status may be a sign of a population that is expanding quickly, which is likely to exert extra strain on indigenous woody species. This observation agrees with McCarty (2001) that rapid human population growth rate is the major cause of wild species loss. Fayera, *et al*. (2014) also noticed deforestation as a result of continuous increment of human population. According to them, the direct causes of deforestation are agricultural expansion, wood extraction (logging or wood harvest for domestic use), and infrastructure expansion such as shelter construction (urbanization).

The secondary and primary educational levels as observed in this study imply that respondents will easily adopt sustainable harvesting methods, if awareness campaign programmes are organized for them. Majority of the population in the study area were herbalists, artisans and indigenous woody species traders who were actively involved in woody species exploitation. This finding is in line with the study by Ndangalasi *et al*. (2007); they reported that woody species harvesting account for a large proportion of livelihood such as farming and trading. According to Talukdar *et al*. (2020), many rural people harvest indigenous woody species parts for earning cash by selling into the market for their livelihood.

Harvesting Techniques and Risks Observed in the Study Area

The results of harvesting techniques and risks in Table 3 showed that the *Prosopis africana* stem had the highest harvesting risk (97.74%) of whole plant removal before harvesting the parts, followed by *Pterocarpus erinaceus* stems (96.24%). This harvesting technique was also observed in the stem bark of *Pterocarpus erinaceus* (90.98%) and *Beilchmedia mannii* (70.68%) in MF. Similar to this, all plant parts of *Pterocarpus erinaceus*, with the exception of the seeds (15.04%), showed increased harvesting risks of whole plant removal. This suggests that the plant parts most harmed by the unsustainable harvesting technique of removing the entire plant, which put the plant species at great risk, were the stem and bark. The decision to extract stem and bark in the study area may be linked to the demand for timber, fuelwood and charcoal production products and medicine. In line with this finding, Adekunle and Olagoke (2010) agreed that severe damage is usually inflicted on the forest ecosystem during logging activities. In contrast, this finding disagrees with the report of Singh *et al*. (2014) who identified root as the plant part that was intensively harvested in India using destructive harvesting technique.

The leaves (60.15%) and seeds (72.18%) of *Ziziphus mauritiana* and leaves (60.90%) of *Prosopis africana*, as well as the roots (57.87%) of *Vitex donniana*, on the other hand, showed minimal risks of harvest, where respondents removed plant parts with little or no effects (Table 3). The minimal risks of harvesting leaves and seeds are consistent with the finding of Andel (2006) who noticed that harvesting leaves and fruits is less damaging than felling entire trees for timber or bark harvesting.

Reasons Attributed to Indigenous Woody Plant Species Harvesting and Fidelity Levels

The Fidelity level (FL) values in this investigation presented in Table 4, expressed a wide range of 100.00% to 0.75%. The generation of charcoal and fuelwood from *Vetellaria paradoxa* stems had the highest FL value (99.25%), followed by *Ziziphus mauritiana* leaves for medicinal (99.25%) and seeds for food (98.49%). It was discovered that *Pterocarpus erinaceus* leaves are also frequently utilized in medicine (96.24%). Only a small percentage of respondents (0.75%) indicated that they trade *Vitex donniana* roots. Furthermore, *Pterocarpus erinaceus*, *Vetellaria paradoxa*, *Prosopis africana*, and *Vitex donniana* stems were frequently utilized for building, fuelwood consumption and charcoal production (Table 4). This therefore means that *Vetellaria paradoxa* stem and the leaves of *Pterocarpus erinaceus*, *Ziziphus mauritiana*, and *Vitex donniana* were the most widely preferred and used plant parts. The observation of leaf as the dominant and preferred plant part in the study area is in agreement with Cakilcioglu and Turkoglu (2010); Akhtar *et al*. (2013); Bano *et al*. (2014); Ahmad *et al*. (2014). Bino *et al*. (2014) and Singh *et al*. (2014) also identified leaves as the most preferred and commonly used plant parts. Meer *et al*. (2019) and Todou *et al*. (2016) identified *Ziziphus mauritiana* and *Parkia biglobosa* as one among the top sixteen most preferred and the most commercialized indigenous woody species in Adamawa north region of both Nigeria and Cameroon respectively.

High FL values suggest frequent use of the plant species component for a certain use category by the respondents (Bibi *et al*. (2014). Therefore, the reasons for harvesting indigenous woody species and the corresponding fidelity levels of this finding imply that the local population of the study area used multiple parts of indigenous woody species, including the leaf, stem bark, seed, root, and stem for food, medicine, shelter, and livelihood. This is in conformity with reports of other authors like Bino *et al*. (2014) from Pakistan, Singh *et al*. (2014) from India and Liu *et al*. (2023) from China, which indicated that many people used multiple parts of plant species for various reasons including medicine and food. The timber products obtained from *Pterocarpus erinaceus*, *Vetellaria paradoxa*, *Prosopis africana* and *Vetellaria paradoxa* stems were used for construction, fuelwood consumption and charcoal production while *Beilchmedia mannii* and *Prosopis africana* seeds were used for food. The properties of the sampled species and climatic conditions of the ecological zone in the State may be responsible for the use variation of these species. In line with this, Tukur *et al*. (2013) reported fuelwood and medicine as the key important reasons for indigenous woody species use in Katsina State of Northern Nigeria.

Important Plant Part Values in the Study Area

Plant part values were recorded in Table 5. For *Vitellaria paradoxa*, the stem was the most significant plant component (37.34%). Similarly, *Beilchmiedia mannii* (37.29%), *Pterocarpus erinaceus* (26.71%), and *Prosopis africana* (35.48%) recorded seeds as the most significant plant part value, but *Ziziphus mauritana* (26.93%) and *Vitex donniana* (28.54%) on the other hand recorded leaves as the most significant plant part value. This confirms that the inhabitants in the study area considered stems, seeds and leaves as the most significant plant parts. The finding is in agreement with previous studies of Amwatta (2004), which reported leaves as the most valuable plant part. In contrast, a study conducted by Omire *et al*. (2020), listed fruit as the highest plant part, valued by people in Kenya. Seeds were thought to be valuable plant parts that are used less frequently as observed on the frequency of harvesting. This might be ascribed to factors including inaccessibility, scarcity and non-availability of the product. This means that the use of species or its products frequently does not ensure their value or worth.

The Impacts of Harvesting Indigenous Woody Plant Species in Taraba State

The harvesting impact (HI) was calculated to establish a conservation priority for the sampled IWPS. The high value of HI for a given species or its part indicates the need for a greater level of attention for conservation and sustainable harvest. According to the result of this finding shown in Table 6, *Vittellaria paradoxa*, *Pterocarpus erinaceus*, *Vitex donniana* and *Prosopis africana* stems had the greatest harvesting impact scores of 77.50, 64.00, 62.50, and 58.00, respectively. The largest harvesting impacts were also documented for seeds and leaves, coming in at 49.50 and 42.63 for *Beilchmiedia mannii* and *Ziziphus mauritana*, respectively. This means that stems and seeds are the plant parts that require attention for conservation and sustainable harvest. This result supports the works of Bruschi *et al*. (2014) who reported that high plant part usage especially seeds can impact a species population's capacity for regeneration and may therefore be harmful.

On the other hand, the least harvesting impact was shown in the *Pterocarpus erinaceus* leaf (17.25), stem bark of *Vitellaria paradoxa* (27.50), and roots of *Beilchmiedia mannii* (22.00), *Ziziphus Mauritana* (25.00), *Prosopis africana* (22.00), and *Vitex donniana* (22.00) (Table 5). Furthermore, *Vitellaria paradoxa* had the highest average harvesting impact score (48.65), followed by *Ziziphus mauritiana* (38.18), *Pterocarpus erinaceus* (36.85), *Vitex donniana* (36.70), and Prosopis africana (35.35), while *Beilchmiedia mannii* had the lowest average harvesting impact score (23.90). The study area's top priority species for conservation appeared to be all of the sampled species with the exception of *Beilchmiedia manii.* These findings were consistent with the findings of Lokonon *et al*. (2017), who determined that *Prosopis africana*, *Vitex donniana*, *Pterocarpus erinaceus*, and *Vitellaria paradoxa* were the top priority species for conservation.

CONCLUSION AND RECOMMENDATIONS

The results of this study unequivocally demonstrated that significant harm was caused to the IWPS during unsustainable harvesting techniques of entire plant removal and premature harvest, which impair the reproductive success in response to demand for timber and NTFPs derived from indigenous woody species. The supply of these products for food, medicine and shelter are the major reasons why local population of the study area used multiple parts of the sampled indigenous woody plant species. Local consumers in MF, NGS, and SGS prefer the leaves of *Pterocarpus erinaceus*, *Ziziphus mauritiana*, and *Vitex donniana*, respectively. As timber extraction, charcoal production, and fuelwood consumption were primarily sourced from the stems of *Pterocarpus erinaceus*, *Prosopis africana*, and *Vetellaria paradoxa*, leaf extracts from these plants were used for medicine, while those from *Vitex donniana* were used for food. The quantitative indices used were helpful in pointing the most frequently used and important indigenous woody species parts as stems and leaves. The rural population of Taraba State valued the stems from *Pterocarpus erinaceus*, *Vetellaria paradoxa, Prosopis africana*, and *Vitex donniana* for building, fuel consumption, and charcoal production, while the seeds from *Beilchmedia mannii* and *Prosopis africana* were valued for food. With the exception of *Beilchmiedia mannii*, all the tested IWPS have been classified as priority species because of the harvesting impact; these species are likely to lose their gene pool due to heavy use. The discovery that these species, along with their parts, have significant harvesting consequences has led to recommendations for immediate conservation, sustainable harvest and awareness campaigns.

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Table 1: Scores used to Calculate Harvesting Impacts (HI) for Woody Plants

S/No		Item	Score(s)
1.		**Local use (LU)**	
	a.	High (cited by more than 71% of the respondents)	10
	b.	Moderately high (41–70%)	7
	c.	Moderately low (<41%)	4
2.		**Harvesting Risk (HR)**	
	a.	Destructive harvesting (whole plant or stems) or overexploitation of roots and bark	10
	b.	Removal without causing individual mortality of structures such as bark and roots	7
	c.	Removal of aerial permanent structures such as leaves, stems and sap affecting survival and/or reproductive success	4
	d.	Aerial structures such as flowers and fruits removed without affecting the plant	1

Source: Bruschi *et al*. (2014)

Table 2: Demographic Characteristics of the Respondents

Variable	Frequency	Percentage (%)
Gender		
Male	223	55.89
Female	176	44.11
Total	**399**	**100**
Age group		
Below 30 years	184	46.12
31 -50 years	99	24.81
Above 50 years	116	29.07
Total	**399**	**100**
Marital Status		
Married	202	50.63
Single	197	49.37
Total	**399**	**100**
Educational level		
Primary	101	25.31
Secondary	147	36.84
Tertiary	73	18.30
Illiteracy (no formal education)	78	19.55
Total	**399**	**100**
Occupation		
Farming	104	22.30
Trading	91	22.81
Artisan	89	26.07
Herbalist	115	28.82
Total	**399**	**100**

Table 3: Indigenous Woody Plant Species Harvesting Techniques and Risks Observed by the Respondents

Ecological Zone	Species Scientific Name	Local Name	Harvesting Technique and Risk (HR)	Plant Part Frequency (%)				
				Leaves	Stem bark	Seed	Root	Stem
MF	*Pterocarpus erinaceus*	Madrid	Harvesting whole plant before removing the parts	86 (64.66)	121 (90.98)	20 (15.04)	112 (84.21)	128 (96.24)
			Removal without affecting plant parts	0 (0.00)	0 (0.00)	37 (37.82)	0 (0.00)	0 (0.00)
			Removal which affect plant and reproductive success	40 (30.08)	97 (72.93)	15 (11.28)	82 (61.65)	0 (0.00)
			Removal without affecting whole plant	0 (0.00)	0 (0.00)	10 (7.52)	0 (0.00)	0 (0.00)
	Beilchmiedia mannii	Concoli	Harvesting whole plant before removing the parts	38 (28.57)	94 (70.68)	17 (12.78)	0 (0.00)	59 (44.36)
			Removal without affecting plant parts	56 (42.11)	20 (15.04)	110 (82.71)	5 (3.76)	0 (0.00)
			Removal which affect plant and reproductive success	86 (64.66)	90 (67.67)	130 (97.74)	19 (14.29)	0 (0.00)
			Removal without affecting whole plant	0 (0.00)	0 (0.00)	13 (9.77)	0 (0.00)	0 (0.00)
NGS	*Ziziphus mauritiana*	Magarya	Harvesting whole plant before removing the parts	16 (12.03)	2 (1.50)	8 (6.02)	30 (22.56)	56 (42.11)
			Removal without affecting plant parts	19 (14.29)	0 (0.00)	10 (7.52)	0 (0.00)	2 (1.50)
			Removal which affect plant and reproductive success	76 (57.14)	86 (64.66)	28 (21.05)	40 (30.08)	0 (0.00)
			Removal without affecting whole plant	80 (60.15)	42 (31.58)	96 (72.18)	36 (27.07)	0 (0.00)
	Vitellaria paradoxa	Kadanyar	Harvesting whole plant before removing the parts	16 (12.03)	0 (0.00)	72 (54.14)	50 (37.59)	70 (52.63)
			Removal without affecting plant parts	3 (2.26)	15 (11.28)	0 (0.00)	17 (12.13)	0 (0.00)
			Removal which affect plant and reproductive success	24 (18.05)	48 (36.09)	0 (0.00)	60 (45.11)	0 (0.00)
			Removal without affecting whole plant	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
SGS	*Prosopis africana*	Kirya	Harvesting whole plant before removing the parts	30 (22.56)	9 (6.77)	0 (0.00)	16 (12.03)	130 (97.74)
			Removal without affecting plant parts	9 (6.77)	41 (30.83)	96 (72.18)	37 (27.82)	0 (0.00)

		Removal which affect plant and reproductive success	81 (60.90)	25 (18.79)	21 (15.79)	18 (13.53)	0 (0.00)
		Removal without affecting whole plant	81 (60.90)	26 (19.55)	21 (21.79)	92 (69.17)	0 (0.00)
Vitex donniana	Dinyaa	Harvesting whole plant before removing the parts	91 (68.42)	26 (19.55)	82 (61.65)	50 (37.59)	73 (54.89)
		Removal without affecting plant parts	30 (22.56)	62 (46.62)	39 (29.32)	9 (6.77)	0 (0.00)
		Removal which affect plant and reproductive success	19 (14.29)	50 (37.59)	48 (36.09)	30 (22.56)	0 (0.00)
		Removal without affecting whole plant	37 (27.82)	32 (24.06)	55 (41.35)	77 (57.89)	0 (0.00)

Table 4: Reasons for Harvesting Indigenous Woody Plant Species and their Fidelity Levels

Ecological Zone	Species		Reason	Plant Part Frequency and Fidelity Level					RU
	Scientific Name	Local Name		Leaves	Stem bark	Seed	Root	Stem	
MF	*Pterocarpus erinaceus*	Madrid	Food	65 (48.87)	18 (13.53)	76 (57.14)	11 (8.27)	0 (0.00)	
			Medicine	128 (96.24)	96 (72.18)	103 (77.44)	79 (59.39)	24 (18.05)	
			Fuelwood/ Charcoal	0 (0.00)	5 (3.76)	0 (0.00)	3 (2.26)	18 (13.53)	
			Construction	3 (2.26)	0 (0.00)	0 (0.00)	0 (0.00)	122 (91.73)	
			Trading/Sales	32 (24.06)	20 (15.04)	88 (66.17)	4 (3.01)	102 (76.69)	
			Others (Repellent)	32 (24.06)	6 (4.51)	18 (13.53)	5 (3.76)	9 (6.77)	
			RU_{PP}	**260**	**145**	**285**	**102**	**275**	**1,067**
	Beilchmiedia mannii	Concoli	Food	68 (51.13)	27 (20.30)	100 (97.74)	9 (6.77)	0 (0.00)	
			Medicine	109 (18.95)	70 (52.63)	84 (63.16)	52 (39.09)	5 (3.76)	
			Fuelwood/ Charcoal	0 (0.00)	0 (0.00)	0 (0.00)	8 (6.02)	67 (50.38)	
			Construction	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	43 (32.33)	
			Trading/Sales	6 (4.51)	15 (11.28)	130 (97.74)	15 (11.28)	34 (25.56)	
			RU_{PP}	**183**	**112**	**314**	**84**	**149**	**842**
NGS	*Ziziphus mauritiana*	Magarya	Food	97 (72.93)	0 (0.00)	131 (98.49)	0 (0.00)	0 (0.00)	
			Medicine	132 (99.25)	105 (78.95)	117 (87.97)	89 (66.92)	61 (45.86)	
			Fuelwood/ Charcoal	3 (2.26)	2 (1.50)	0 (0.00)	19 (14.29)	86 (64.66)	
			Construction	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	27 (20.30)	
			Trading/Sales	88 (66.17)	55 (41.35)	127 (95.49)	13 (9.77)	36 (27.07)	

			RU$_{PP}$	**320**	**162**	**375**	**121**	**210**	**1188**
	Vitellaria paradoxa	Kadanyar	Food	11 (8.27)	0 (0.00)	39 (29.32)	0 (0.00)	0 (0.00)	
			Medicine	57 (42.86)	82 (61.65)	108 (81.20)	61 (45.86)	0 (0.00)	
			Fuelwood/ Charcoal	0 (0.00)	17 (12.78)	21 (15.79)	8 (6.02)	133 (100.00)	
			Construction	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	98 (73.68)	
			Trading/Sales	0 (0.00)	0 (0.00)	99 (74.44)	2 (1.50)	67 (50.38)	
			Protection (Shelter)	14 (10.53)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	
			Others (Handicraft, Repellent)	12 (9.02)	4 (3.01)	0 (0.00)	0 (0.00)	22 (16.54)	
			RU$_{PP}$	**80**	**103**	**267**	**71**	**320**	**855**
SGS	*Prosopis africana*	Kirya	Food	0 (0.00)	0 (0.00)	129 (96.99)	0 (0.00)	0 (0.00)	
			Medicine	64 (48.12)	86 (64.66)	89 (66.91)	45 (33.83)	4 (3.01)	
			Fuelwood/ Charcoal	0 (0.00)	16 (12.03)	7 (5.26)	34 (25.56)	126 (94.74)	
			Construction	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	35 (26.32)	
			Trading/Sales	0 (0.00)	0 (0.00)	56 (42.11)	0 (0.00)	86 (64.66)	
			Others (Handicraft)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	15 (11.28)	
			RU$_{PP}$	**64**	**102**	**281**	**79**	**266**	**792**
	Vitex donniana	Dinyaa	Food	122 (91.73)	12 (9.02)	112 (84.21)	17 (12.78)	0 (0.00)	
			Medicine	87 (65.41)	88 (66.17)	45 (33.83)	50 (37.59)	11 (8.27)	
			Fuelwood/ Charcoal	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	66 (49.62)	
			Construction	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	99 (74.44)	
			Trading/Sales	33 (24.81)	14 (10.53)	38 (28.57)	1 (0.75)	49 (36.84)	
			Soil erosion prevention	0 (0.00)	0 (0.00)	0 (0.00)	4 (3.01)	0 (0.00)	
			RU$_{PP}$	**242**	**114**	**195**	**72**	**225**	**848**

Key: RU$_{PP}$ = Report use Value per Plant Part, RU = Report use

Table 5: Report Value use per Plant Part and Plant Part Value of the Sampled Indigenous Woody Plant Species among the Ecological Zones of the Study Area

Ecological Zone	Species	Ecological Index	Plant Part					RU
			Leaves	Stem Bark	Seed	Root	Stem	
MF	*Pterocarpus erinaceus*	RU_{PP}	260	145	285	102	275	**1067**
		PPV	24.37	13.59	26.71	9.56	25.77	**100**
	Beilchmiedia mannii	RU_{PP}	183	112	314	84	149	**842**
		PPV	21.73	13.30	37.29	9.98	19.70	**100**
NGS	*Ziziphus mauritiana*	RU_{PP}	320	162	375	121	210	**1188**
		PPV	26.93	13.63	31.57	10.19	17.68	**100**
	Vitellaria paradoxa	RU_{PP}	94	103	267	71	320	**855**
		PPV	10.99	12.05	31.23	8.30	37.43	**100**
SGS	*Prosopis africana*	RU_{PP}	64	102	281	79	266	**792**
		PPV	8.08	12.88	35.48	9.97	33.59	**100**
	Vitex donniana	RU_{PP}	242	114	195	72	225	**848**
		PPV	28.54	13.44	23.00	8.49	26.53	**100**

Key: RU_{PP} = Report use Value per Plant Part, RU = Report use, PPV = Plant Part Value.

Table 6: Harvesting Impact (HI) for the Sampled Indigenous Woody Plant Species and their Plant Parts

Ecological Zone	Species	Plant Part	LU_M	HR_M	HI
MF	*Pterocarpus erinaceus*	Leaves	4.60	3.75	17.25
		Stem bark	5.20	7.00	36.40
		Seed	6.25	5.50	34.38
		Root	4.60	7.00	32.20
		Stem	6.40	10.00	64.00
		Mean			**36.85**
	Beilchmiedia mannii	Leaves	5.00	7.00	35.00
		Stem bark	5.00	7.00	35.00
		Seed	9.00	5.50	49.50
		Root	4.00	5.50	22.00
		Stem	4.75	5.50	26.13
		Mean			**23.90**
NGS	*Ziziphus mauritiana*	Leaves	7.75	5.50	42.63
		Stem bark	7.00	5.00	35.00
		Seed	10.00	5.50	55.00
		Root	5.00	5.00	25.00
		Stem	4.75	7.00	33.25
		Mean			**38.18**
	Vitellaria paradoxa	Leaves	4.75	7.00	33.25
		Stem bark	5.00	5.50	27.50
		Seed	7.00	10.00	70.00
		Root	5.00	7.00	35.00
		Stem	7.75	10.00	77.50
		Mean			**48.65**
SGS	*Prosopis africana*	Leaves	7.00	5.50	38.50
		Stem bark	5.50	5.50	30.25
		Seed	7.00	4.00	28.00
		Root	4.00	5.50	22.00
		Stem	5.80	10.00	58.00
		Mean			**35.35**
	Vitex donniana	Leaves	7.00	5.50	38.50
		Stem bark	5.00	5.50	27.50
		Seed	6.00	5.50	33.00
		Root	4.00	5.50	22.00
		Stem	6.25	10.00	62.50
		Mean			**36.70**

Key: LU_M = Mean value of local use, HR_M = Mean value of harvesting Risk, HI = Harvesting risk.

EFFECTS OF LEVELS OF PRUNING ON THE VEGETATIVE GROWTH OF CASHEW PLANTATION IN IBADAN, RAIN FOREST ZONE OF NIGERIA

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ABSTRACT
An experiment was conducted in Ibadan, Oyo State, rainforest zone in Nigeria to determine the effects of different pruning levels as a cashew plantation rehabilitation strategy. The pruning treatments were imposed on two tree per treatment on a twenty-year old unproductive cashew tree at 0% (no pruning/control), 25%, 50%, and 75% pruning, replicated three times which was laid in a complete randomized block design. Data were taken on cashew vegetative growth (girth, canopy spread at different directions as well as the crown size diameter) before and after pruning treatments were measured. . No significant difference was observed in the vegetative growth parameters measured before pruning treatments was applied. Canopy Spread (CanSp), Crown Diameter (CrownD), Canopy Radius (CanR), Canopy Ground Cover (CanGC) and Percentage Canopy Ground Cover (PCanGC) at 25% (9.15m) and 50% (7.03m) pruning levels were not different from each other but different from 75% (5.96m) pruning level. The experiment was a year trial, and it was observed that the regeneration of chupons was slow after 3 months of pruning treatment especially in the plot that received 25% pruning. Moreso, investigation is still ongoing.
Keywords: *Cashew; Canopy; Chupons; Pruning.*

INTRODUCTION

Pruning is a tool for improving both wood productivity and forest quality (Nicholas and Brown, 2002). It is also known for redistributing water, minerals, and nutrient within plants (Saritha *et al*., 2021). Pruning is also one of the many agro-techniques that can be used on tree crops that develops quickly, especially the cashew tree (Nayak *et al*., 2018). It is one of the most common management strategies used in both traditional and contemporary cashew plantations around the world (Costa and Bocchi, 2017). Canopy and unproductive tree management are one of the most common problems farmers of cashew struggle with because when unpruned, the plant has its branches interlocked and sprawl to the ground over time. Pruning also serves as a growth stimulator, a means of modifying the cashew tree's architectural structure, as well as a yield enhancement tool. Alvarez *et al*. (2011a) reported that pruning increased the stem growing potential of pruned trees when compared to unpruned trees. More so, physiological procedures within the tree may be altered if pruning was not performed correctly (Grabosky and Gilman, (2007); Fini *et al*., (2011).

According to Eric and Randol (2003), an increase in nutrient resources was observed after pruning which was in a low state before pruning. On the other hand, Hayes (2002) reported that excessive pruning can lead to plant stress, mechanical failure, and weak development of epicormic shoots. Additionally, Collier and Turnblom (2001) noted that severely pruning epicormic branches could result in reductions in clear hardwood yield. In old cashew plantations, poorly pruned old cashew trees have been observed to negatively affect fruit yield production (Amanoudo, 2022). However, pruning is a costly and time-consuming process (Shahbazi *et al*., 2020). Therefore, it is crucial to research the suitability level for rehabilitation, to increase the yield of unproductive cashew plants, manage the plant canopy and enhance elongations of the productivity of the plant. Therefore, this experiment aimed to determine the most appropriate pruning level for cashew rehabilitation.

METHODOLOGY

Moribund twenty-year-old Cashew trees planted at a spacing of 9 x 9 meters, laid in a complete randomized block design were randomly selected at the Cashew field zone of the Cocoa Research Institute of Nigeria (CRIN) Headquarters, Ibadan, Oyo State, situated in the rain forest zone. The two trees selected per treatment were observed before pruning began to determine their level of productivity, which was zero level of productiveness. The trees received four different treatments i.e-0% (Control-where the branches was left unpruned), 25% (One quarter of the branches prune) 50%,(Half of the tree branches prune), and 75% (One third of the tree branches prune) levels of pruning treatments on the selected cashew trees. To prevent pest and disease infestation on the cut surfaces because of the pruning, red oxide paint was applied to the cut surface immediately after pruning. At 3months after pruning, the emerged chupons were counted and recorded but subsequently thinned to accommodate only two vigorously growing chupons. Data on vegetative growth were taken before pruning with a ranging pole placed in the four east, west, south and north direction of the trees and a measuring rule used in measuring these distanced from the tree to the last tip of each direction of the branch's branches. The girth was measured with a measuring time 30cm from the ground, while the height was measured with the measuring tape hanged at the tip of the ranging pole to the ground and a year after pruning, the same measurement before pruning was carried out. Data were subjected to analysis of variance using SAS (2011) statistical software and treatment means separated using the least significant difference ($P<0.05$).

RESULTS AND DISCUSSION

Cashew tree vegetative growth characteristics

The results of the initial vegetative growth characteristics of the cashew trees before pruning treatments were imposed as shown in Table 1 were not significantly different from each other. This could be a result of the trees being of the same age and biotype. This is in line with Richards (1992), that cashew trees of the same age and land area often possess similar leaf patterns and dry biomass accumulation. After the imposition of the pruning treatments as shown in Table 2, there were various levels of significance observed in the growth characteristics of the cashew trees among the treatments which implies that the pruning treatments influenced the vegetative growth of the cashew trees. A similar influence was also observed by Janani *et al*. (2020) and Nayak, (2015) in cashew vegetative growth and canopy management of cashew respectively. Of all the growth characteristics, only the cashew trunk girth was not significant. This could occur as pruning activities didn't take place in this part of the cashew tree. The control treatment in Table 2 had the highest value in all the growth parameters except in girth. For the North, South, East and West side of the canopy (N, S, E and W), 25%Prun (5.7m, 3.45m, 4.02m and 4.94m) were the closest to the control (8.98m, 8.99m,5.38m and 8.71) with significant difference observed in N, S and W and no comparable difference in E respectively.

No significant difference was observed among 25%Prun, 50%Prun and 75%Prun cashew trees in N and S while 75%Prun (2.34m and 2.03m) had significantly lower values than 25%Prun (4.02m and 4.94m) and 50%Prun (3.49m and 7.03m) in E and W. In North-South canopy spread (NS), No significant difference was observed between 25%Prun (9.15m) and 50%Prun (7.03m) but was not both significantly different from 75%Prun (5.96m). East-West canopy spread (EW) also followed the same trend as NS. The result of the Canopy Spread (CanSp), Crown Diameter (CrownD), Canopy Radius (CanR), Canopy Ground Cover (CanGC) and Percentage Canopy Ground Cover (PCanGC) was similar as 25%Prun and 50%Prun was not notably different from each other but comparably different from 75%Prun being the lowest in value of all the treatments.

The growth of chupons did not follow any distinct pattern as shown in Figure 1. However, the 3 pruning levels brought about a quick regeneration of chupons which was in contrast to the report of Patch and Felker (1997b) that re-sprouting of new leaves from pruned trees is one of the problems of pruning. Figure 1 shows the rate of regeneration of the chupons among the pruned cashew trees, and the highest number of regenerated chupons was recorded in the 75% pruned trees (114). This agrees with the report of Janani *et al*., (2020) that heavy pruning brings about excessive vegetative growth.

CONCLUSION

The degree of pruning affected the regeneration rate of the cashew trees growth characteristics and chupon growth differently. Generally, 25% pruned cashew regenerates the slowest, followed by 50% pruned cashew trees which were faster and 75% pruned cashew trees which were the fastest as observed one year after pruning.

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Table 1: Initial cashew growth characteristics of the treatments in a rainforest zone of Nigeria

Treatment	Girth(m)	N(m)	S(m)	E(m)	W(m)	NS(m)	EW(m)	CanSp(m)	CrownD(m)	CanR(m)	CanGC(m2)	PCanGC(%)
0%(Control)	1.49a	8.64a	8.86a	5.56a	8.81a	17.50a	14.37a	251.48b	15.94a	10.62a	21.24a	764.64a
25%Prun	1.25a	10.17a	7.47a	9.79a	9.84a	17.64a	19.63a	346.27a	18.64a	12.42a	24.84a	894.24a
50%Prun	1.85a	11.20a	7.57a	10.16a	9.54a	18.77a	19.70a	369.77a	19.24a	12.82a	25.64a	923.04a
75%Prun	1.76a	10.14a	8.41a	6.97a	5.65a	18.55a	12.62a	234.10b	15.59a	10.39a	20.78a	748.08a

Key, S: South, E: East, W-West, N-North, NS-North south, EW-East West directions, CanSp-Canopy Spread, CrownD- Crown diameter, CanR-Canopy Radius, CanGC-Canopy Ground Cover, PCanGC-Percentage Canopy Ground Cover.

Table 2: Pruned cashew growth characteristics of the treatments in a rain forest zone of Nigeria

Treatment	Girth(m)	N(m)	S(m)	E(m)	W(m)	NS(m)	EW(m)	CanSp(m)	CrownD(m)	CanR(m)	CanGC(m2)	PCanGC(%)
0%(Control)	1.50a	8.98a	8.99a	5.38a	8.71a	17.97a	14.09a	253.20a	16.03a	10.67a	21.34a	768.96a
25%Prun	1.27a	5.70b	3.45b	4.02ab	4.94b	9.15b	8.96b	81.98b	9.06b	6.04b	12.08b	434.88b
50%Prun	1.95a	4.07b	3.00b	3.49ab	3.94b	7.03b	10.97ab	77.20b	9.00b	6.00b	12.00b	432.00b
75%Prun	1.79a	3.90b	2.06bc	2.34c	2.03c	5.96c	4.37c	26.05c	5.17c	3.44c	6.88c	247.68c

Key, S: South, E: East, W-West, N-North, NS-North south, EW-East West directions, CanSp-Canopy Spread, CrownD- Crown diameter, CanR-Canopy Radius, CanGC-Canopy Ground Cover, PCanGC-Percentage Canopy Ground Cover.

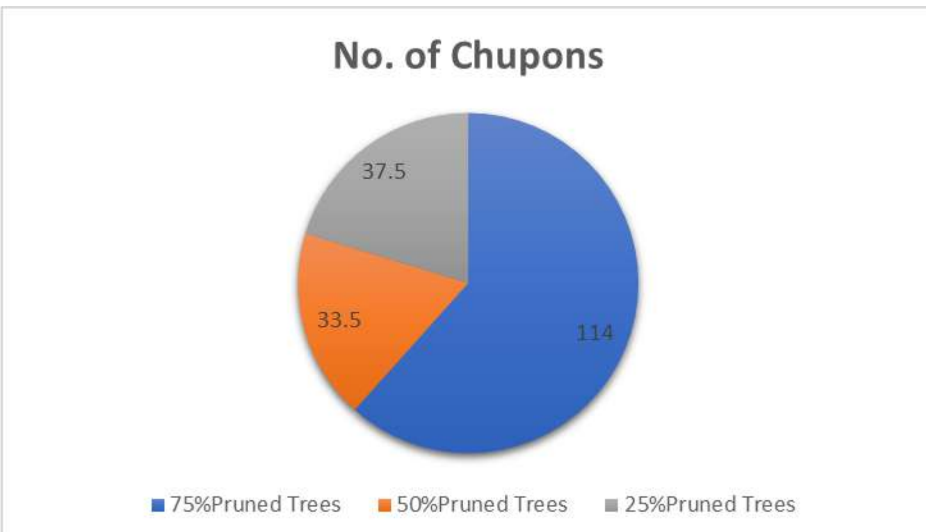

Fig 1: Effect of pruning on the number of chupons regenerated before thinning

EFFECTS OF COPPICING ON THE REGROWTH POTENTIALS OF THREE SPECIES OF MINT PLANT GROWN ON DIFFERENT NURSERY MEDIA

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ABSTRACT
The effect of coppicing on the regrowth potentials of mint plant (Mentha spp) was conducted at the Southern eastern part of Nigeria, where farmers are unaware of mint plant and the best practice to grow the crop. The study was evaluated at the Crop science Research Farm, University of Nigeria, Nsukka from October to December 2021. The experiment was carried out in 2021 during the dry season for a period of 2 months. The pot experiment was laid out in a 4 x 3 factorial in Completely Randomized Design (CRD) and replicated three times. The substrates (topsoil, poultry manure and sawdust) were combined in the ratio of 3:2:1, 3:1:2, 3:3:0 and 6:0:0 and left for six weeks to homogenize. The mint species (Peppermint, chocolate mint and normal mint) planted and their replications were cut back 10cm to the ground and allowed to regrow for 6 weeks. Growth parameters (number of nodes, number of internodes, number of leaves and leaf area) were measured at 3 and 6 weeks after coppicing (WAC). The media 3:3:1 produced more nodes, internodes, leaves and broader leaves than media 3:2:1, 3:1:2 and 6:0:0 at 6 WAC. From this study it can be concluded that media 3:3:0 is recommended for farmers who intend on engaging coppicing on their mint plant (Mentha spp).
Keyword: *Coppicing, Regrowth Potential, Substrates, Mint plant (Mentha spp) and Nursery media*

INTRODUCTION

Mentha genus belongs to the family Lamiaceae and it has about 25-30 species (Hawryl *et al*., 2016). Mint plant is widely dispersed in Europe, Africa, Australia and North America. Mint plants grows mostly in wet locations, moist soils and are mostly found near water bodies such as lake, rivers, and in partial shade on cool moist places. Mint plants can also bear full sunlight (Abbas *et al*., 2022). Mentha are aromatic herb which has an extensively scattered stolon both above and below the ground (Abbas *et al*., 2022). Mint leaves can be consumed in their fresh or dried form (Nayak *et al*., 2020). Coppicing is one of the oldest forestry systems known from many countries worldwide (Evans 1992; Fujimori 2001). It is an obvious fact that there is an increase in the interest of coppicing, yet there is few information on the effect of coppices on site conditions and its ecological characteristics which encompasses soil properties, growth properties of plant species and nature protection (Vacik *et al*. 2009; Matula *et al*. 2012).
The principle of coppicing is the ability to allow woody plants such as trees and shrubs to be cut back and allow to regrow (Jarman *et al*., 2013). Mint plant is not well known by farmers in South East Nigeria, the few farmers who are aware of this plant have difficulties trying to minimize cost in production and also difficulty in maintaining the growth all year round. This study therefore is set to create awareness among farmers and the use of coppicing to minimize cost of production and grow mint plant all year round. The aim of this field study which was executed during rainy season was to determine the effect of coppicing on the regrowth potential of different varieties of mint plant grown on different nursery media.

MATERIALS AND METHODS

The experiment was conducted at the Teaching and Research Farm, Department of Crop Science, University of Nigeria, Nsukka for a period of 2 month. This experiment evaluated the effect of coppicing on the regrowth potential of three species of mint plant (*Mentha species*). The experiment was a 4 x 3 factorial replicated 3 times in CRD. The factor A were 4 media which are combinations of three substrates at different ratio. The substrates used are top soil: poultry manure: saw dust at ratio 3:2:1, 3:3:0, 3:1:2 and 6:0:0 (control) respectively. The three species and their replication were cut back to 10cm to the ground. The media composition was analyzed at the Research Laboratory, Department of Soil science, University of Nigeria, Nsukka. Data was taken at the 3rd and 6th week after coppicing (WAC). Growth parameters such length of leaf, width of leaf, number of leaves, number of nodes and number of internodes were collected. The data collected were analyzed using the software GenStat Discovery Edition 12. The data were subjected to two-way analysis of variance (ANOVA), selecting the appropriate procedure for factorial experiment in CRD. In the case of significant treatment effects, mean separation was by the Fisher's Least significant difference (F-Lsd) procedure at 5% level of probability($P<0.05$).

RESULTS

The result in Table 1 shows that the media combination 3:2:1 has higher clay content, higher pH value, higher amount of Mg^{+}, higher CEC, Higher Al^{3+} and higher percentage Base Saturation than the other 3 media formulation. The control (6:0:0) contains higher proportion of fine sand than the 3 media combinations. The media combination 3:3:1 contains higher proportion of clay sand, has larger proportion of carbon and organic matter content, has more exchangeable bases with exemption of Mg^{+} and has more phosphorus content than the 3 media composition (3:2:1, 3:1:2 and 6:0:0(Control)) as shown in Table 1.

Number of internodes, nodes and leaves after coppicing

The results of media composition and mint effect on number of internodes, number of nodes and number of leaves shown in Table 2 show that the treatment means differed significantly(p=0.05) across 6 weeks after coppicing (WAC)

Media: The media composition of 3:3:1 gave the highest number of nodes, internodes and leaves at 6 weeks after coppicing with mean values of 407.0, 406.0 and 1272 respectively as shown in Table 2 which differed significantly(p=0.05) from the media composition of 6:0:0 (control) which gave the lowest number of nodes, internodes and leaves at 6 WAC with mean value of 102, 101 and 326 respectively as shown in Table 2.

Mint: The chocolate mint has the highest number of nodes, number of internodes and leaves at 6 WAC with mean values of 587, 586 and 1563 while peppermint had the lowest number of nodes, internodes and leaves at 6 WAC with mean values of 69, 68 and 378 respectively as shown in Table 2.

Leaf area(cm^2) after coppicing

The results of the media composition and mint effect on leaf area(cm^2) show that there were significantly (p=0.05) different across 6 WAC as shown in Table 3.

Media: The media composition 3:1:2 gave the highest leaf area(cm^2) at 6WAC with mean value of 13.30cm^2 which were significantly(p=0.05) different from the media composition 6:0:0(control) at 6 WAC with mean value of 8.40cm^2 as shown in Table 3.

Mint: The peppermint specie has the highest leaf area (cm^2) at 6 WAC with mean value of 16.95cm^2 while the chocolate mint has the lowest leaf area (cm^2) at 6 WAC with mean value of 9.16 cm^2 as shown in Table 3.

Interaction effect of mint specie and media composition on number of internodes, number of nodes and number of leaves at 3 and 6 WAC

The results of the interaction effect of mint plant and media composition on number of nodes, number of internodes and number of leaves across 6 WAC show that there was no significant(p=0.05) difference between the treatment means as shown in Table 4. The interaction effect of the media composition 3:1:2 and mint specie chocolate mint produced the highest number of nodes and internodes at 6 WAC with mean values of 669.0 and 668.0 respectively while the interaction effect of the media composition 6:0:0 and mint specie peppermint produced the lowest number of nodes and internodes at 6 weeks after coppicing with mean values of 24.0 and 23.0 respectively. For number of leaves, the media composition 3:3:0 and the mint specie chocolate mint gave the highest number of leaves at 6 WAC with mean value of 2430.0 while the media composition 6:0:0 and the mint specie peppermint gave the lowest number of leaves at 6 WAC with mean value of 132.0 as shown in Table 4.

Table 1: Result of the analysis of the media formulations used in the course of this study

S/D	TC	PS%				pH VALUE		OM%		N	EB(Meq/100g)				CEC	EA(Meq/100g)		P	BS%
		Clay	Silt	F. S	C.S	H_2O	KCl	C	OM	%	Na^+	K^+	Ca^+	Mg^+		$Al3^+$	H^+	ppm	
3:2:1	SL	18	11	29	42	8.5	7.7	1.424	2.456	0.168	0.05	0.1	4.2	3.6	13.2	0.4	1.4	66.2	60.23
3:3:0	SL	14	15	24	67	8.2	7.4	1.788	3.082	0.196	0.07	0.13	4.6	2.2	12	0.2	1.4	77.41	58.33
3:1:2	SL	16	11	30	43	8.2	7.5	1.201	2.071	0.154	0.04	0.08	4.2	2	10.8	0.2	1.4	67.15	58.52
6:0:0	SL	16	15	33	36	6.6	5.8	0.587	1.011	0.126	0.02	0.05	1.8	0.8	10.4	0.2	1.4	10.26	25.67

SD= Sample description, TC= textural class, PS%= particle size, OM%= organic matter, EB= exchangeable base, N= nitrogen, EA= exchangeable acidity, P= phosphorus, BS= base saturation, F. S= fine sand, C. S= clay sand

Table 2: Mean value of the number of internodes, number of nodes and number of leaves at 3rd and 6th WAC

	Number of internodes		Number of nodes		Number of leaves	
Media	**WK3**	**WK6**	**WK3**	**WK6**	**WK3**	**WK6**
3:2:1	210.0	368.0	211	369	530	926
3:3:0	231.0	406.0	232	407	727	1272
3:1:2	195.0	342.0	196	343	62	1097
6:0:0	57.0	101.0	58	102	186	326
F-Lsd $_{(p=0.05)}$	81.9	143.5	81.8	143.5	269.8	472.4
Mint						
Peppermint	39.0	68.0	40	69	217	378
Chocolate mint	335.0	586.0	336	587	893	1563
Spear mint	147.0	258.0	148	258	443	775
F-Lsd $_{(p=0.05)}$	70.9	124.3	70.9	124.3	233.7	409.1

3:2:1 = 3 Topsoil: 2 Poultry Manure: 1 Saw Dust, 3:3:0 = 3 Top Soil: 3 Poultry Manure: No Saw Dust, 3:1:2 = 3 Top Soil: 1 Poultry Manure: 2 Saw Dust and 6:0:0 = 6 Top Soil: No Poultry Manure: No Saw Dust(control). F-LSD= Fisher's Least Significance Difference at 0.05 probability level. NS= non-Significant. Wk= Week

Table 3: Mean value of the leaf area(cm^3) of mint plant at 3rd and 6th WAC

	Leaf length (cm)		Leaf width (cm)		Leaf area (cm^3)	
Media	**WK3**	**WK6**	**WK3**	**WK6**	**WK3**	**WK6**
3:2:1	4.633	7.84	3.133	5.44	7.77	13.29
3:3:0	4.511	7.79	3.056	5.29	7.57	13.08
3:1:2	4.789	8.30	2.889	5.00	7.68	13.30
6:0:0	3.033	5.09	1.911	3.31	4.94	8.40
F-Lsd $_{(p=0.05)}$	0.4269	0.833	0.4503	0.802	0.801	1.488
Mint						
Peppermint	6.042	10.37	3.808	6.58	9.85	16.95
Chocolate mint	3.242	5.50	2.100	3.66	5.34	9.16
Spear mint	3.442	5.90	2.333	4.04	5.78	9.94
F-Lsd $_{(p=0.05)}$	0.3697	0.722	0.3899	0.694	0.694	1.288

3:2:1 = 3 Topsoil: 2 Poultry Manure: 1 Saw Dust, 3:3:0 = 3 Top Soil: 3 Poultry Manure: No Saw Dust, 3:1:2 = 3 Top Soil: 1 Poultry Manure: 2 Saw Dust and 6:0:0 = 6 Top Soil: No Poultry Manure: No Saw Dust(control). F-LSD= Fisher's Least Significance Difference at 0.05 probability level. NS= non-Significant. Wk= Week

Table 4: Interaction effect of mint species and media composition on number of internodes, number of nodes and number of leaves at 3rd and 6th WAC

	NUMBER OF INTERNODES		NUMBER OF NODES		NUMBER OF LEAVES	
Media mint	WK3	WK6	WK3	WK6	WK3	WK6
3:2:1 Peppermint	41.0	71.0	42	72	276.0	477.0
3:2:1 Chocolate mint	380.0	666.0	381	667	688.0	1203.0
3:2:1 Spearmint	209.0	366.0	210	367	627.0	1097.0
3:3:0 Peppermint	56.0	98.0	57	99	259.0	454.0
3:3:0 Chocolate mint	462.0	809.0	463	810	1389.0	2430.0
3:3:0 Spearmint	177.0	310.0	178	311	533.0	933.0
3:1:2 Peppermint	45.0	80.0	46	81	256.0	448.0
3:1:2 Chocolate mint	382.0	668.0	383	669	1148.0	2009.0
3:1:2 Spearmint	158.0	277.0	159	278	477.0	835.0
6:0:0 Peppermint	13.0	23.0	14	24	76	132.0
6:0:0 Chocolate mint	115.0	202.0	116	203	349	611.0
6:0:0 Spearmint	44.0	77.0	45	78	134	234.0
F-Lsd $_{(p=0.05)}$	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

3:2:1 = 3 Topsoil: 2 Poultry Manure: 1 Saw Dust, 3:3:0 = 3 Top Soil: 3 Poultry Manure: No Saw Dust, 3:1:2 = 3 Top Soil: 1 Poultry Manure: 2 Saw Dust and 6:0:0 = 6 Top Soil: No Poultry Manure: No Saw Dust(control). F-LSD= Fisher's Least Significance Difference at 0.05 probability level. NS= non-Significant. Wk= Week

Interaction effect of mint species and media composition on the leaf area(cm^2) at 3rd and 6th WAC.

The results of the interaction effect of mint plant and media composition on leaf area(cm^2) across the 6 WAC show that there was no significant(p=0.05) difference between the treatment means as shown in Table 5.

The interaction effect of the media composition (3:1:2) and the mint specie (peppermint) at 6 WAC has the highest leaf area with mean value 19.47 cm^2 while the interaction effect of the media composition (6:0:0) and mint specie (spearmint) at 6 WAC has the lowest leaf area with mean value 5.53 cm^2 as shown in Table 5.

Table 5: Interaction effect of mint species and media composition on the leaf area(cm^2) at 3rd and 6th WAC.

	LEAF LENGTH (cm)		LEAF WIDTH (cm)		LEAF AREA (cm^2)	
Media mint	**WK3**	**WK6**	**WK3**	**WK6**	**WK3**	**WK6**
3:2:1 Peppermint	6.100	10.33	4.233	7.30	10.33	17.63
3:2:1 Chocolate mint	3.433	5.60	2.500	4.40	5.93	10.00
3:2:1 Spearmint	4.367	7.60	2.667	4.63	7.03	12.23
3:3:0 Peppermint	6.000	10.20	3.867	6.63	9.87	16.83
3:3:0 Chocolate mint	3.567	6.23	2.433	4.27	6.00	10.50
3:3:0 Spearmint	3.967	6.93	2.867	4.97	6.83	11.90
3:1:2 Peppermint	7.033	12.27	4.133	7.20	11.17	19.47
3:1:2 Chocolate mint	3.867	6.63	2.167	3.70	6.03	10.33
3:1:2 Spearmint	3.467	6.00	2.367	4.10	5.83	10.10
6:0:0 Peppermint	5.033	8.67	3.000	5.20	8.03	13.87
6:0:0 Chocolate mint	2.100	3.53	1.300	2.27	3.40	5.80
6:0:0 Spearmint	1.967	3.07	1.433	2.47	3.40	5.53
F-Lsd $_{(p=0.05)}$	**0.7394**	**1.444**	**NS**	**NS**	**NS**	**NS**

3:2:1 = 3 Top Soil: 2 Poultry Manure: 1 Sawdust, 3:3:0 = 3 Top Soil: 3 Poultry Manure: No Saw Dust, 3:1:2 = 3 Top Soil: 1 Poultry Manure: 2 Saw Dust and 6:0:0 = 6 Top Soil: No Poultry Manure: No Saw Dust(control). F-LSD= Fisher's Least Significance difference at 0.05 probability level. NS= non-Significant. Wk= Week

DISCUSSION

The media composition of 3:3:0 produced more nodes, internodes and leaves than the control 6:0:0 at 6 WAC. This conforms with the findings of Sramek *et al* (2015), that coppiced plants thrive better in soils with higher nutrient content. Media 3:3:0 was higher in organic matter content, exchangeable bases and nitrogen than others as shown in Table 1 which ensured optimal plant growth. This conforms with the findings of Handreck, 1992 who reported that optimal plant growth is ensured only if sufficient nitrogen is available for plants. Mint plant thrives on media with high water holding capacity and good anchorage. This could also be as a result of high ratio of poultry manure to sawdust thereby improving the water holding capacity of the media. According to Kieltyka *et al* (2017) peppermint grows particularly well in soils with high water-holding capacity.

CONCLUSION

This study sought to discover the regrowth potential of three species of mint plant raised in four distinct nursery media after coppicing. After coppicing, the media composition 3:3:0 and chocolate mint performed tremendously well as compared to the others. Though Chocolate mint performed best in the field peppermint, peppermint produced a pungent aroma than other mint species due to the higher methanol (%) and volatile oil content

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EVALUATION OF YIELD, MICROBIOLOGICAL AND SENSORY PROPERTIES OF SOME DEHYDRATED MANGO CULTIVARS.

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ABSTRACT
Healthy snacks made from desired-quality fruit were required due to consumer preferences for functional foods. Mango cultivars; Saigon, Ogbomoso, Tommy Atkins, Edward, Haden and Lippene were obtained from NIHORT. Fruits were cut into slices and dehydrated at 52 °C for 10–12 hours. Standard procedures were used to evaluate the samples' production, microbiological composition, and sensory quality. ANOVA was used to evaluate the data at a significance level of 0.05, and response surface approach was used for the sensitivity analysis. After dehydration, the results showed that Haden had the lowest yield, while Saigon had the most. Salmonella, bacteria, and fungi were absent in the samples. In terms of most attributes and overall acceptability, Ogbomoso cultivar received the highest sensory evaluations, which is crucial for the marketing of the product.
Keywords: *dehydration, mango cultivars, yield, sensory properties*

INTRODUCTION

Mango, Mangifera indica, is one of the most important tropical fruits. It is a fleshy drupe of the genus Mangifera, composed of numerous tropical fruit trees of the flowering plant family Anacardiaceae. With a global annual production of 33.5 million tonnes, it was ranked by the FAO as the fifth largest fruit crop in global total production in 2009 (FAO, 2011). Mango has many health-promoting properties, which is why it is at the top of the list of superfruits (Gross, 2010).

Numerous studies (Al-sheraji *et al*., 2011; Hassan *et al*., 2007) have shown that Mangifera species are high in phytochemicals and dietary fiber in all of their constituent parts. They play a big part in fighting free radicals, too (Ajila *et al*., 2010; Abu Bakar *et al*., 2009). Mangos contain sizeable levels of provitamin A, vitamin C, and sugar, and are recognized as a fruit of high commercial worth. Increased fruit consumption, such as that of the mango fruit, has been widely recognised to enhance and preserve quality of life by reducing the prevalence of cardiovascular diseases and particular cancers (Halvorsen *et al*., 2006; Vasco *et al*., 2008).

Food materials can be dried for benefits like quality control, achieving hygienic conditions, and reducing product loss (Corzo *et al*., 2008). According to Dennis (1999), fruit's flavor, as well as the majority of its nutritional value, can be concentrated and conserved by lowering the moisture level of the fruit to between 10% and 20%, which will also prevent bacteria, yeast, mold, and enzymes from spoilage. The market for processing mango into dried slices is still small in developing nations like Nigeria for a variety of reasons, including the availability of cultivars, processing tools, packaging, and consumer preferences. It is essential to create products that meet the needs and tastes of the intended consumer (Grunnert, 2005). Therefore, this study identifies cultivars best for dried slices for optimum yield and sensory attributes.

MATERIALS AND METHODS

Sample preparation

The cultivars of mango used for the experiment were Ogbomosho, Saigon, Lippenne, Edward, Tommy Atkins, Kent and Haden. Each cultivar was washed, air dried and weighed. The fruits were peeled, stone removed and sliced to 0.8 mm using digital Vernier Caliper (Raider Pro RD DC706). Sliced samples were dehydrated (Excalibur 4926T) at 52 °C for 10 - 12 h., allowed to cool and packaged in Polyethylene bag for further analysis. The weights of the fresh and dehydrated samples were noted to determine the percentage of yield.

Microbial and sensory analysis

Microbiological analysis was done on the sample using AOAC 2015 method.

Sensory attributes were evaluated by a group of semi- trained panelists [both men and women (n=25)] using a 5-point Hedonic scale. The dehydrated mango was evaluated for its acceptability with reference to colour, flavour, texture, taste and overall acceptability, as described by Feldeisen and Tucker, 2007.

Data analysis

The I-optimal design module in Design Expert software (Version 13.0.1, Stat-Ease, Inc., Minneapolis, USA) was used to evaluate the data using a response surface methodology to study the interaction between the drying and different cultivars on specific attributes.

RESULT AND DISCUSSION

The pH and Sugar content (brix) of the starting fresh mango cultivars is shown in Figure 1 and 2. Kent had the highest pH but no significant variation was observed among the cultivars while Tommy Atkins had the highest sugar content with no significant variation among the cultivars. The quantity of dried mango after drying showed that Saigon had the highest (Table 1) while Haden had the least quantity, this could be as a result of the ripening stage. The further the maturation, the higher the water content and the water loss after dehydration. Also, the fibre quantities of the cultivars were different but the yields were not significantly different. The moisture content of the cultivars after dehydration will also contribute to the final weight and yield. Cultivar with higher yield after dehydration will be of advantage for the industry. Significant variation was observed among the yield of the cultivars. The moisture content of the dehydrated mango slices ranged from 9.12 and 12.89% (Figure 3), Lipenne had the highest while Haden had the least. Significant variation was observed in the moisture content.

The level of moisture in the slices could account for the shelf stability of the slices. It is known that moisture level above 12% reduces storage time of products. The level of moisture in the samples were lower than 12% except for Lippene hence the samples were expected to have a better storage life.

Table 1: Percentage yield of mango cultivars after dehydration

Cultivar	% yield
Lippenne	18.17
Saigon	19.65
Haden	16.04
Ogbomoso	16.33
Kent	16.33
TommyAtkins	17.92
Edward	18.13
LSD	1.63

Values were mean of triplicate

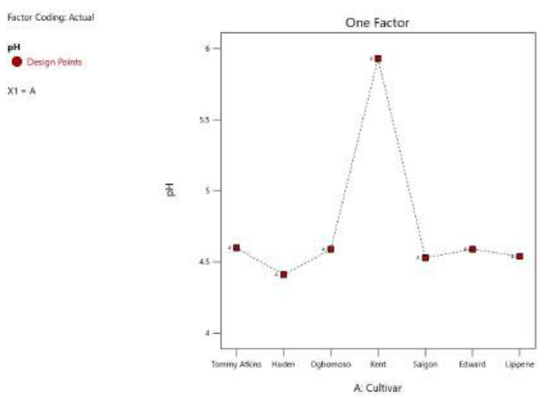


Figure 1: pH of the fresh mango cultivars

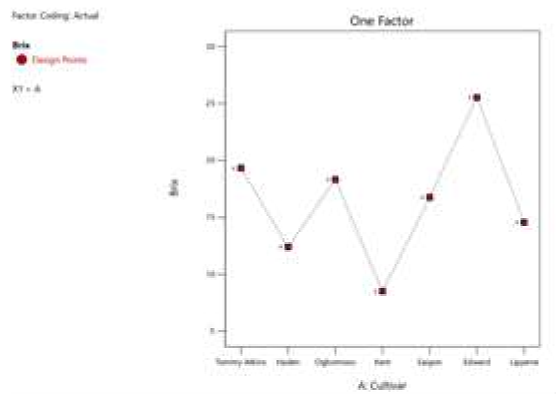


Figure 2: sugar level of the fresh mango culltivars

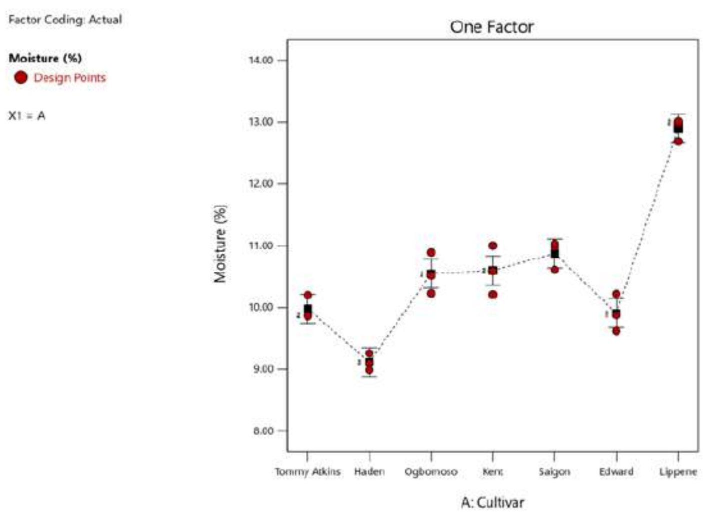


Figure 3 : Moisture content of dehydrated mango cultivars

The result of the microbial evaluation (Table 2) showed no presence of bacterial, coliform and fungal growth after dehydration. This confirms the ability of dehydration process to ensure safe products.

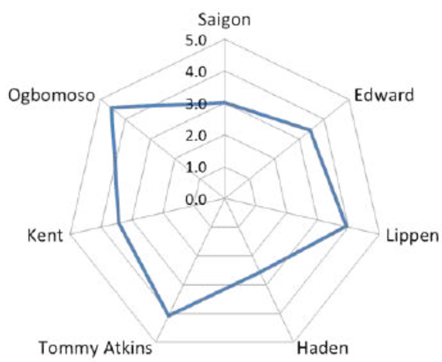
Table 2: Microbial enumeration of dehydrated mango samples

Cultivar	TOTAL BACTERIA COUNT (cfu/g)	TOTAL COLIFORM COUNT (cfu/g)	TOTAL FUNGI COUNT (cfu/g)
Saigon	NG	NG	NG
Kent	NG	NG	NG
Lippenne	NG	NG	NG
Edward	NG	NG	NG
Ogbomoso	NG	NG	NG
T. Akins	NG	NG	NG
Haden	NG	NG	NG

NG – No Growth

Sensory evaluation

The sensory evaluation showed Ogbomoso was the most adjudged (figure 4a-e) in terms of colour, taste and overall acceptability while Tommy atkins were best adjudged for flavour and Texture. This might be because of the varying chemical composition of the cultivars that resulted in the preference in the attributes.



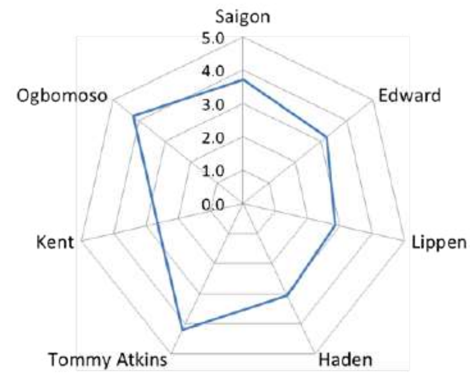
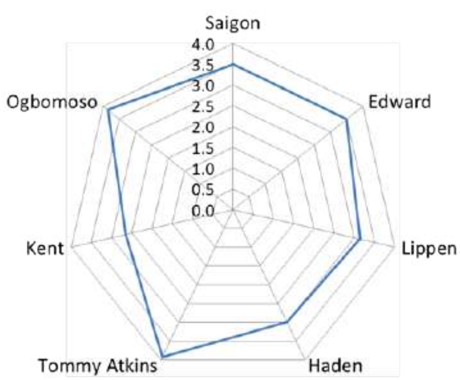


Figure 4a : Sensory evaluation of colour of mango dried Slices **Figure b : Sensory evaluation of flavour of mango dried Slices**



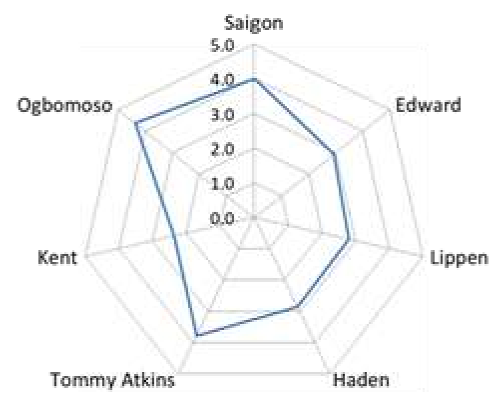


Figure c : Sensory evaluation of texture of mango dried Slices Figure d : Sensory evaluation of taste of mango dried Slices

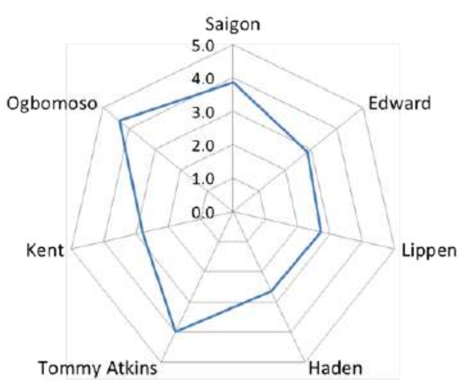


Figure e: Sensory evaluation of overall acceptability of mango dried Slices

CONCLUSION

The cultivars had varying yield and sensory perception/ preferences after dehydration, Saigon had the highest yield which is of advantage to producers of dehydrated slices. However, Ogbomoso cultivar had highest sensory scores in most of the attributes as well as the overall acceptability which is very important in the marketing of the product. Hence, Ogbomoso is recommended for processors to have consumers acceptance and market for the dehydrated slices.

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COMPARATIVE EFFECT OF DIFFERENT SOURCES OF ORGANIC MANURE ON THE PERFORMANCE OF JUTE FIBRE (Corchorus spp.)

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ABSTRACT
An experiment was conducted at Organic farm of Federal college of Agriculture, Ibadan to evaluate effect of different sources of organic fertilizer on the performance of Jute fiber. The experiment was laid in a Randomized Complete Block Design (RCBD) with five treatments replicated three times. The treatment applied at the rate of 45 kg N /ha were: horse dung, Poultry droppings from battery cage, Poultry droppings from deep litter, Cow dung and Control. The variety of seed used was V.35 The parameters taken were, plant height, stem girth, weight at maturity and yield of fibre. The data collected were statistically analyzed the significant means were separated using Duncan Multiple Range Test (DMRT) at 5% level of probability. The result showed that plants of cow dung gave a fibre yield of 0.9g which was not statistically different in weight from those of poultry droppings from deep litter house (0.73g) hence, poultry droppings from a deep litter house is recommended due to its availability.
Keywords: *fibre, jute, droppings, poultry*

INTRODUCTION.

Jute (Corchorus Spp), also called Jew's mallow, bush okra, nalta jute, or jute mallow, the annual herbaceous crop is cultivated as a source of jute fibre and for its edible leaves (Akoroda, *et al.,* 2008). The use of jutta potta cloth was mentioned both in the Bible and Monushanghita-Mahabharat. This indicates the ancient uses of jute materials by the people of these areas (Alim,1978; Islam and Rahman, 2008). The vegetable is cultivated for the stem bark which is used for the production of fibre (Zakaria *et al.,* 2005a). The quest for improvement of soil fertility led to the use of organic manure to improve crop production. Animal manure plays a vital role in soil fertility maintenance due to its intrinsic value as a soil amendment (Williams *et al.,* 1993). The capacity of the manure provides nutrients especially N P and K is one of such benefits. It also increases in cation exchange capacity soil moisture, soil organic matter nitrogen, Phosphorus, pH and reduced soil exchangeable acidity Ano and Agwu (2005), Mbah (2006). However, the release of these nutrients to the plants differ from the various sources of manure for instance, Izunobi (2002), reported that chicken manure, especially those produced in deep litter or battery cage house are the richest known farmyard manure supplying greater amounts of absorbable plant nutrient. Looking at the importance of jute mallow and its benefits, it therefore becomes imperative to consider improving the fertility of the soil for its cultivation, hence the aim of this study.

MATERIALS AND METHODS

The field experiment was conducted at the college organic farm of Federal College of Agriculture Moor Plantation, Ibadan Oyo state. The experimental site is situated at Latitude 7° 24' 3" and Longitude 3° 51' 9". The mean annual rainfall pattern is bimodal. The maximum temperature is about 30.5°c while the minimum temperature is about 21°c.

Land preparation and Experimental Layout

The experimental land was prepared manually, after which the soil was tilled with hoe. Pre- cropping composite soil sample was collected at 0-15cm depth, this was air - dried, sieved with 2 mm diameter mesh , bagged, labelled and taken to the laboratory for analysis. The gross plot size was 96m² which was divided into of three replicates of 2×6 m² (12m²) and each replicate was divided into 5 sub plots of 2×2 m². There was 0.5m furrow between plots and 1m between replicates. Seeds were sown with intra spacing of 5cm and inter row spacing of 20 cm.

Experimental design and treatment

The experiment was laid out in a randomized complete block design (RCBD), with five treatments replicated three times. The treatments were: T 1: horse dung (HD), T2: Poultry droppings from battery cage (PDBC), T3: Poultry droppings from deep litter (PDDL), T4: Cow dung (CD), T5: Control

The various dungs were applied to the soil at the rate of 45kgN/ ha thoroughly spread and mixed with the soil two weeks before planting the viable seeds of corchorus olitorius (Jute mallow)

Cultural practices

Cultural practices carried out include weeding, watering, application of pesticides (Dried Pawpaw leaves were used to prepare pesticide which was applied once every two weeks at the rate of 36 ml/ ha) to combat the attack of caterpillars on the growing jute plant.

Harvesting and Retting

At 16 weeks after sowing, harvesting of jute stems took place by uprooting the whole plant and retting process took place. The harvested stems were retted by soaking them in water for 14 days, thereafter, they were brought out of the water rinsed and beaten with mallet, remove the outer bark and they were then dried and combed out and weighted with a sensitive weighing scale.

Data collection and analysis

Data collections commenced two weeks after sowing, which includes: Plant height(cm), Stem girth(cm), weight of the harvested jute and processed jute fibre. Data collected were taken for statistical analysis using analysis of variance (ANOVA) and the significant means were separated using Duncan multiple range test (DMRT) at 5% level of probability.

RESULTS AND DISCUSSION

Pre- cropping physical and chemical properties of the soil

The result of the physical and chemical properties of the soil used for the experiment is presented in Table 1. It showed that the soil was slightly acidic with pH of 5.03. Total Nitrogen was very low (0.23%), compare to the standard value of (1.6-2) available phosphorus (10.69 mg/ kg) compared to standard value of (7-20) was within range and organic carbon (0.73%) compared to standard value of (1.0-14) was low exchangeable base: potassium, calcium, magnesium and sodium of the soil ranges from 0.03- 1.75 and 2.10 cmol /kg, the texture of the soil was sandy loam.

Nutrient composition of various manure sources used for the experiment

The result of the nutrient composition of the various manure used for the experiment is presented in table 2. Poultry manure from battery cage has Nitrogen content of 0.367, poultry manure from deep litter house has Nitrogen content of 1.63, cow dung has Nitrogen content of 1.23 while horse dung has Nitrogen content of 1.61.

Effect of organic manure on plant height of jute mallow (cm)

The result of the effect of different sources of organic manure on plant height of jute mallow is presented in table 3. At 2WAS, there were no significant differences among all the treatments. At 3WAS It was observed that jute mallow treated manure from battery cage was taller significantly than others (35.56cm) except those treated with dung from deep litter house (29.67cm). However, jute mallow treated with horse dung (22.78cm), cow dung (18.70cm) and manure from deep litter house (29.67cm) were not significantly different from each other in height but significantly taller than control (14.50cm). At 4WAS It was observed that jute mallow plant treated with organic manure from deep litter (57.64cm) was taller significantly than those of horse dung (22.78cm) but at par with those treated with manure from battery cage (50.25cm), and cow dung (56.92cm). However, those treated with cow manure, horse dung and those of control were not significantly different from each other. At 5WAS plants from deep litter manure were significantly (69.67cm) taller than control (33.37cm) but at par with those of battery cage (68.38cm), cow dung (56.00) and horse dung (56.92). The result of this experiment buttresses the work of Izunobi (2002) who reported that chicken manure, especially those produced in deep litter or battery cage house are the richest known farmyard manure supplying greater amounts of absorbable plant nutrient.

Effect of organic manure sources on stem girth (cm) of jute mallow

The result of effect of organic manure sources on stem girth of jute mallow is presented in table 3. At 2WAS, Plant treated with organic manure were significantly higher in girth than control experiment. At 3WAS it was observed that jute mallow treated with organic manure from deep litter was higher significantly (1.31cm) than others except those treated with cow dung (1.07) which in turn was not significantly different from those of battery cage (0.60). Also, plants treated with horse dung (0.49) and control experiment (0.22cm) were statistically similar in girth. At 4WAS it was observed that there were no significant differences among all the treatments except plants from control experiment which had the lowest stem girth (0.48cm). the same trend was observed at 5 WAS. This result might due to the fact that nutrients are easily been released for crop utilization with application of organic manure. Brady, (1999), also opined that, organic manure mineralizes; hence it releases its nutrients for plant uptake and utilization rapidly.

Effect of organic manure on weight at maturity (kg) of jute mallow

The result of effect of various organic manure on weight of jute mallow at maturity is presented in table 4. At maturity it was observed that there were no significant differences among all the treatments. However, jute mallow treated with organic manure from deep litter house had the highest weight (0.40kg) while control experiment (0.10kg) had the lowest.

Effect of organic manure sources on yield of jute fibre (g)

The result of effect of organic manure on yield of jute fibre is presented in table 8, it was observed that jute mallow treated with cow dung gave the highest fiber (0.90g) which was not statistically different from those of deep litter house (0.73) and those of horse dung (0.50) while control experiment had the lowest fibre yield (0.10g). However, jute mallow treated with battery cage (0.47g) and horse dung (0.50g) were not also different significantly from each other in terms of fibre yield but were lower in yield. The effect of litter mixed with the droppings which generates more ammonia and hence more nitrogen could be the reason why manure from deep litter house and the ones from cow dung gave plants with more yield in fibre than those of battery cage house. Researches have also opined that, there is enormous loss of ammonia in the battery cage house which makes the manure to have less nitrogen compare to those in deep litter house Amanullah *et al*., (2010).

CONCLUSION AND RECOMMENDATION

The experiment showed that the use of cow dung or poultry manure at the rate of 45 kg N/ ha was better for production of jute fiber as compared to other sources of organic manure used in this experiment However, poultry manure from deep litter house is recommended due to its availability to farmers.

Table 1: Pre- cropping soil physical and chemical properties

Properties	Value
pH	5.03
Available phosphorus (g/kg)	10.69
Total Nitrogen (g/kg)	0.23
Organic carbon (g/kg)	0.73
Exchangeable Bases (C mol/ kg)	
Ca.	1.75
Mg	0.15
K	0.03
Na	2.10
CEC	4.03
Particle size distribution	
Sand	852
Silt	80
Clay	68
Textural class	Sandy Loam

Source: authors.

Table 2: Nutrient Composition of different types of manure sources used for the experiment.

Types of manure	Composition of nutrients (percentage)							
	N	P	Ca	Mg	K	Na	Cu	Zn
HD	1.61	2.8456	0.75	0.192	0.64	1.68	0.0033	0.0023
PMBC	0.3667	0.4913	0.53	0.13	0.27	0.04	0.0023	0.0009
PMDL	1.663	0.4834	0.68	0.21	0.35	0.04	0.0072	0.0042
CD	1.23	0.5699	0.87	0.179	0.38	1.5	0.0061	0.0072

PMBC = Poultry manure from battery cage house
PMDL = Poultry manure from deep litter house
CD = Cow dung
HD = Horse dung

Table 3: Effect of organic manure sources on plant height (cm) and stem girth (cm) of jute mallow

	Plant Height (cm)				Stem girth (cm)			
Treatment	2WAS	3WAS	4WAS	5WAS	2WAS	3WAS	4WAS	5WAS
Horse dung	11.37a	22.78b	22.78bc	56.92a	0.98a	0.49c	1.88a	2.08a
Deep litter	17.03a	29.67ab	57.64a	69.67a	0.55a	1.31a	1.76a	2.15a
Battery cage	16.51a	35.56a	50.25a	68.38a	0.71a	0.60bc	1.72a	1.92a
Cow manure	12.20a	18.70bc	41.46ab	56.00ab	0.53a	1.07ab	1.53a	1.83a
Control	12.20a	14.50c	23.67b	33.37b	0.14b	0.22c	0.48b	0.63b

Means that have the same alphabets in a column are not significantly different from one another at P< 0.05 by Duncan Multiple Range Test (DMRT).
WAS = weeks after sowing

Table 4: Effect of organic manure sources on weight at maturity (kg) and fiber yield (g) of jute mallow

Treatment (kg N /ha)	Weight at maturity	Fibre yield (g)
Horse dung	0.33a	0.50ab
Manure from battery cage	0.33a	0.47b
Manure from deep litter house	0.40a	0.73a
Cow manure	0.20a	0.90a
Control	0.10a	0.10c

Means that have the same alphabets in a column are not significantly different from one another at P< 0.05 by Duncan Multiple Range Test (DMRT).

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EFFECTS OF MIXTURE OF COW-DUNG AND NPK ON THE GROWTH AND YIELD OF TIGERNUT (*Cyprus esculentus L)* IN POT CONDITIONS: A HOUSEHOLD MINI-CROP PRODUCTION SYSTEM

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ABSTRACT
There is a need to educate people about the production of some ephemeral crops at household levels to serve a secure source of nutrient that it is economically accessible, safe, and nutritious to meet man's dietary needs and food preferences for an active and healthy life. Tigernut is one of the nutritious ephemeral crops that can be produced at the household level with little production factors. This nut plays a vital role in the supply of minerals and vitamins for healthy living. A pot experiment was conducted at Lagos State University of Education Oto/Ijanikin Teaching and Research Farm, Epe campus. NPK 15-15-15 fertilizer and cow-dung were applied at 0, 5 g plus 10, 15, and 20 g cow-dung were mixed and applied per 5kg of soil; cow-dung. There were four levels of application; NFA = No fertilizer application, FA L_1 = 5 g NPK + 10 g cow-dung, FA L_2 = 5 g NPK + 15 g cow-dung, and FA L_3 = 5 g NPK + 20 g cow-dung. Which were replicated three times. The experimental pots were arranged in a completely randomized design under field conditions. The results showed that NPK + Cow-dung application at FA L_1 and FA L_3 (FA L_1 = 5 g NPK + 10 g cow-dung and FA L_1 = 5 g NPK + 30 g cow-dung) have the optimum tiger nut yield. The growth parameters such as; the number of leaves and tiller were not of any high significant difference especially at four and ten weeks after sowing (4 and 10 WAS). The results showed that the mixture of cow dung with NPK fertilizer increased the nut yield of tiger nuts. In conclusion, it can be recommended that a combination of NPK and cow dung is a suitable form of soil amendment for tiger nut production for household consumption of minerals and other essential nutrients needed for the household.
Keywords: *Cow-dung, NPK, tiger nut, household, mini-production*

INTRODUCTION

Nutritional security is a critical concept, defined as "a situation that exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (USDA, 2017). This concept extends beyond the notion of food security, as articulated by the FAO (2020), by considering not only the availability of food but also its nutritional value and the systemic factors that influence an individual's nutritional status. It underscores the importance of a community's access to essential nutrients, not just calories. To address food security comprehensively, requires a holistic approach, commencing from the production and storage systems and encompassing the transportation and distribution of food systems. Such an approach not only ensures food security but also holds the potential for improving diets and health with minimal impact on natural resources (FAO, 2020).

Diet quality serves as a pivotal link between food security and nutritional outcomes and must be a central component of all efforts aimed at achieving the hunger, food security, and nutrition targets of Sustainable Development Goal 2 (SDG 2). Meeting these targets hinges on ensuring that individuals not only have enough food to eat but also that the food they consume is nutritionally adequate (FAO, 2020).

The intricate relationship between food security and nutrition becomes evident in the various manifestations of malnutrition resulting from food insecurity. The quality of the diet consumed plays a central role in this connection. Research has identified that food insecurity is associated with an elevated risk of diverse health issues, including birth defects, anemia (Carmichael *et al*., 2007), reduced nutrient intake, cognitive impairments, aggression, and anxiety (Howard, 2011). Therefore, establishing sufficient access to nutrient-dense foods, such as tiger nuts, through enhanced cultivation and availability becomes a matter of utmost significance.

Tiger nuts, also known as "underground walnuts," hold immense potential as a global food source due to their high yield and wide-ranging applications. Tiger nuts are small tubers of Cyperus esculentus L., which can be consumed fresh, roasted, or raw and are used in various food and beverage preparations, including the popular "horchata de chufa" in Spain (Rubert *et al*., 2011). Despite their widespread cultivation, research on tiger nuts remains limited, constraining their full utilization (Adejuyitan, 2011). Notably, tiger nuts boast a rich nutritional profile, containing lipids, proteins, starch, fibers, and bioactive substances such as organic acids, alkaloids, and phenols (Adel *et al*., 2015). Tiger nut oil, in particular, is akin to olive oil in terms of nutritional value (Roselló-Soto *et al*., 2018). Additionally, tiger nuts are a valuable source of dietary fiber, which aids in preventing colon cancer, obesity, and gastrointestinal disorders (Viuda-Martos *et al*., 2010), and they possess antioxidant properties due to their flavonoid content (Jing *et al*., 2015).

The annual value of tiger nut production in certain regions, such as Spain, is substantial, totaling approximately 3.3 million Euros (CRDO, 2012). In recent years, the popularity of tiger nuts has transcended geographical boundaries, making their way to countries like the United Kingdom, France, Portugal, Argentina, and the United States of America (Rubert *et al*., 2011). In Nigeria, tiger nuts are cultivated primarily in the middle belt and northern regions, where they are locally sold and widely consumed. Their adaptability to diverse climates and soils, coupled with their nutritional richness, positions tiger nuts as a promising crop for improving food security and nutrition. However, there is limited information available on organic cultivation practices for tiger nuts in Nigeria, given their historical status as a wild grass underutilized in agricultural contexts (Adgidzi, 2010).

Tiger nut cultivation thrives in conditions characterized by moderate sunshine, normal temperatures, and well-drained soil with high organic matter content. The tubers typically grow to depths of about 30 cm, although a significant proportion is found at shallower depths, around 10 to 20 cm (topsoil) from the parent plant (Oladele *et al*., 2013). To optimize tiger nut yields, the use of organic practices, including compound compost and other agronomic strategies, is essential, as fertilizer recommendations remain limited and sometimes contradictory (Yarrow and Yarrow, 2005). Given the increasing cost and environmental concerns associated with chemical fertilizers in Nigeria, organic alternatives, such as poultry manure and cow dung, have gained prominence for enhancing soil health and fertility. Cow dung, in particular, is noted for its rich nutrient content and minimal foul odor, making it a viable option for sustainable agricultural practices (Ewulo, 2005).

In light of tiger nuts' health benefits, versatility in production, and the nutrient content of cow dung, there is a pressing need to investigate the effects of a mixture of NPK fertilizer and cow dung on tiger nut cultivation at the household level. This trial aims to promote the availability of essential minerals and vitamins from tiger nuts for households and evaluate their growth and yield performance under these conditions. Therefore, the concept of nutritional security emphasizes the importance of not only food availability but also the nutritional quality of food. Tiger nuts, with their rich nutrient profile, hold promise as a nutritious food source. Research and experiments in tiger nut cultivation, particularly utilizing organic practices and alternative fertilizers, are essential for enhancing food security and nutrition.

METHODOLOGY

This study was carried out at Lagos State University of Education Teaching and Research Farm, Noforija, Epe, Lagos State. Fifteen (15) experimental units consisting of a container of 5kg capacity filled with sand-loamy soil were arranged in a Completely Randomized Design with three (3) replications, leaving an alley of 1m between rows and 1.0m between the pots; for easy access.

Composite soil samples were taken (0 – 15 cm, depth) from the University Teaching and Research Farm, air dried, sieved and sample taken for laboratory analysis. The soil was distributed into 5kg experimental pots and the fertilizer mixtures were applied 2 weeks before sowing. There were four (4) levels of fertilizer application (treatments) using NPK 15-15-15 fertilizers and cow dung.

The application rates or levels are:

a. NFA = No fertilizer application,
b. FA L_{1} = 5 g NPK + 10 g cow-dung,
c. FA L_{2} = 5 g NPK + 15 g cow-dung,
d. FA L_{3} = 5 g NPK + 20 g cow-dung.

The experiment was manually irrigated throughout except on rainy days. Data collected include; plant height, number of leaf and plant tillers, and at harvest the fresh nut weight, and numbers of nuts. All data were subjected to Analysis of Variance (ANOVA, pr $\leq_{0.05}$) significant treatment means were separated using Duncan Multiple Range Tests (DMRT).

RESULTS AND DISCUSSION

The soil used for the experiment was slightly acidic with a pH of 6.4, moderately low in organic carbon, and low in nitrogen concentration, Moreover, the available P, was high and the exchangeable K, Ca, and Na were low with Mg of 2.8 cmol kg^{-1}. The soil particle size distribution shows that it was sandy loam. Considering these parameters, the soil of the experimental site was low in fertility and could not sustain or enhance the full potential capacity for tiger nut yield without fertilizer amendment (Table 1).

At 4 weeks after sowing the plant height was not significantly different under all the fertilizer applications, however, the least plant height was observed under NFA. Similar trends were observed at 8 and 10 weeks after sowing (Figure 1). Under the applications of the mixture of these fertilizers, at 10 weeks after sowing, there was no significant difference in the number of plant tillers, except under NFA where the least number of tillers were observed. However, at 8 weeks after sowing, the number of tillers was not significantly different under the applications; NFA, FA L_1 and FA L_2 but was significantly different at 10 weeks after sowing under the FA L_3 application (Figure 2)

The level of NPK applied to the tiger nut has significant effects on the number of leaves at 4, 8 and 10 weeks after sowing, however, this effect was not pronounced on the number of plant tillers at 4 and 8 weeks after sowing when compared, but, at 10 weeks (10 WAS), there was a significant increase when compared to number of tiller at 8 weeks after sowing (8 WAS). Under NPK application at; FA L_1 (Fertilizer level 1), tiger nut plant leaf increased throughout but was observed to reduce compared to the performance recorded under both NFA and FA L_2 (Fertilizer level 2). This shows that an increase in NPK fertilizer application reduced the number of leaf production of tiger nuts (Figure 3).

At 4, 8 and 10 WAS; weeks after sowing, there was no significant difference in the number of leaves recorded under NFA; no fertilizer application and a similar trend was observed under (FA $L_{2\ \&\ 3}$) at 8 and 10 weeks after sowing. However, under FA L_1, at 8 and 10 weeks after sowing there was a significant difference but not high when compared with the number of leaves under FA L_3 at 8 and 10 weeks after sowing (Figure 3).

Generally, the plant height at 4 WAS (weeks after sowing) was not significantly different under all the 2 fertilizer application levels, whereas, at 8 WAS, the highest value was observed under (FA L_2) which was not significantly different from plant heights recorded under (FA $L_{1,2\ \&\ 3}$) at 10 WAS when compared, but significantly higher when compared with NAF; no fertilizer application (Figure 2).

The highest nut yield was observed under fertilizer application level 1 (148 g/pot) which was not significantly different from the yield obtained under the application of NPK and cow-dung (FA L_3). The number of nuts per application followed the same pattern, showing that the higher the number of nuts the greater the weight. However, this did not apply to the number of nuts under no fertilizer application (NAF) and application level 3(FA L_3) where the fresh nut weights ranged from 20 - 40 nuts per pot (Figure 4).

CONCLUSION AND RECOMMENDATIONS

Tigernut is a proven crop in terms of its nutrition, economic benefits and flexibility for cultivation at any level with common resources. It can be consumed in a variety of forms and it is quite affordable. This research looked into addressing nutrition security through the enhancement of the cultivation and availability of tiger nuts for all households at easy form. It can therefore be concluded that tiger nut production and availability can be enhanced through the use of a mixture of both cow-dung and NPK 15-15-15 to improve small or micro tigernut production. The choice of cow dung as fertilizer results from its availability and minimal foul odor compared to other organic fertilizers.

Based on this conclusion, it is therefore recommended that:

1. Households or farmers should be encouraged to cultivate tiger nuts to increase tiger nut availability in the market.
2. Necessary inputs such as fertilizers with data on their application rates should be provided through all farmers' platforms for use.
3. Adequate extension services should be embarked upon to ensure the right information on the benefits of tiger nut cultivation among households.

Table 1: Chemical and physical properties of the soil used

Parameters	**Values**
pH (Cl)	6.4
Organic C (g kg^{-1})	1.4
Total N (g kg^{-1})	0.3
Available P (mg g^{-1})	55.1
Exchangeable Bases (cmol kg^{-1})	
K	0.65
Ca	26.5
Na	0.38
Mg	2.82
Particle size distribution Values (g kg^{-1})	
Sand	726.0
Clay	140.0
Silt	134.0
Textural class	Sandy loam

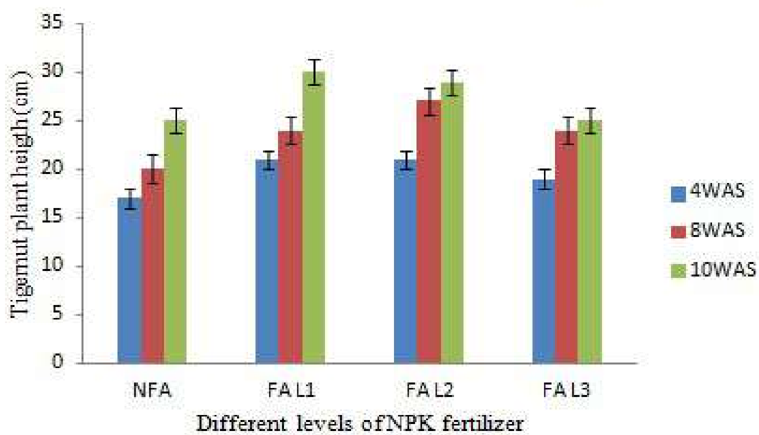

Figure 1: Plant height of Tiger nut under different levels of NPK fertilizer application
Bars represent the standard error (SE), NFA = No fertilizer application, FA L_1 = Fertilizer level 1, FA L_2 = Fertilizer level 2 and FA L_3 = cow-dung + NPK fertilizer.

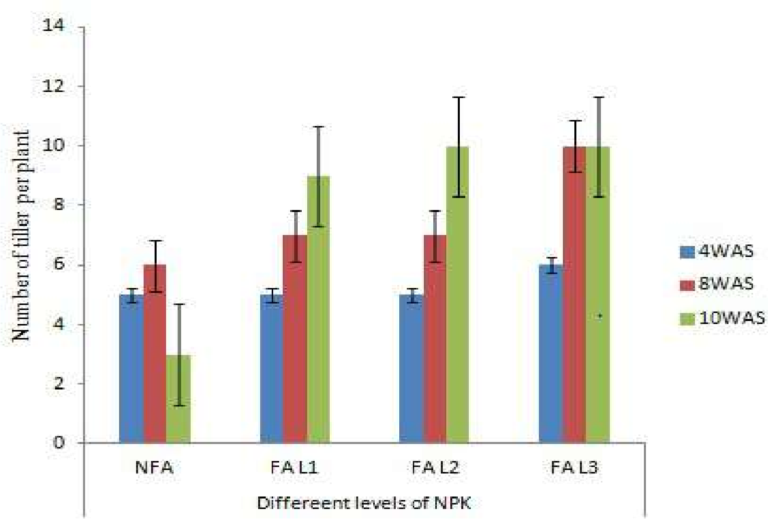

Figure 2: Effects of NPK fertilizer and cow-dung application on the number of tiller of tiger nut at 4, 8 and 10 after sowing

Bars represent the standard error (SE), NFA = No fertilizer application, FA L_1 = Fertilizer level 1, FA L_2 = Fertilizer level 2 and FA L_3 = cow-dung + NPK fertilizer.

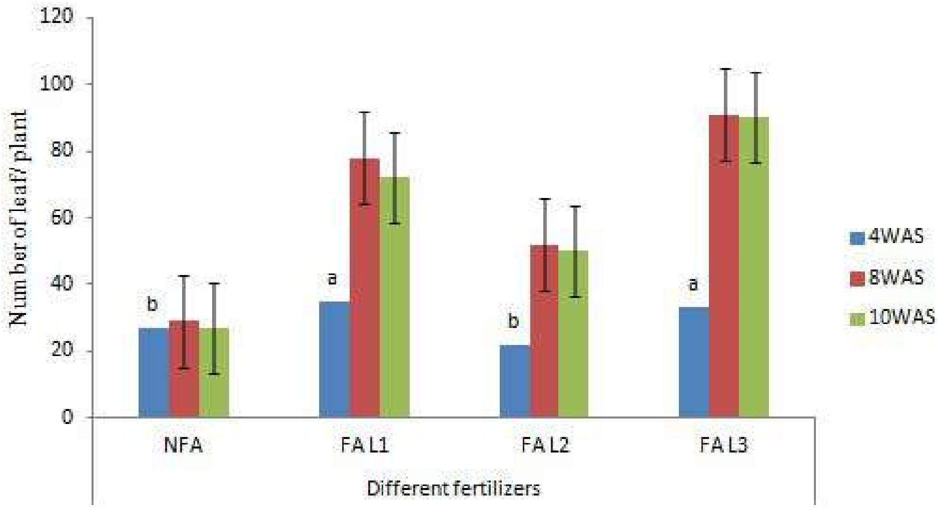

Figure 3: Effects of NPK fertilizer and cow-dung application on the number of leaves of Tiger nut

Bars represent the standard error (SE), NFA = No fertilizer application, FA L_1 = Fertilizer level 1, FA L_2 = Fertilizer level 2 and FA L_3 = cow-dung + NPK fertilizer.

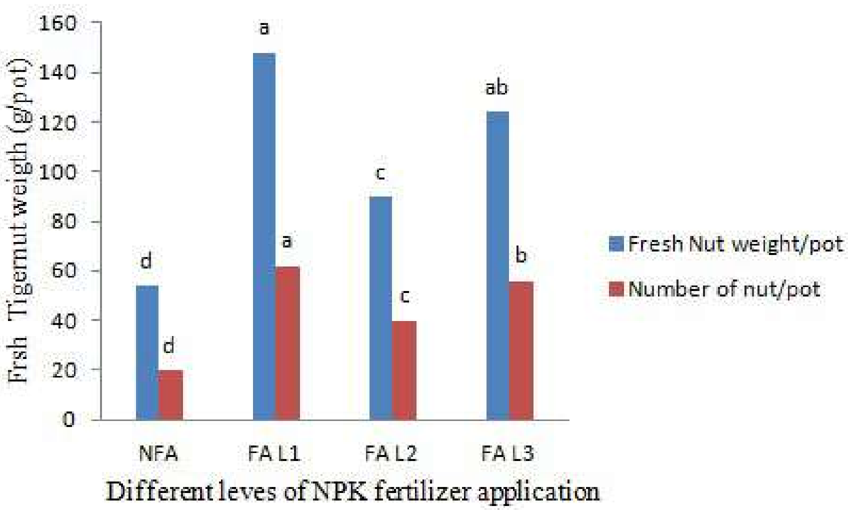

Figure 4: Fresh weight and number of tiger nuts per pot under NPK fertilizer application

Bars labelled with the same letter(s) are not significantly different while 'ns' is no significant difference ($LSD_{0.05}$), NFA = No fertilizer application, FA L_1 = Fertilizer level 1, FA L_2 = Fertilizer level 2 and FA L_3 = cow-dung + NPK fertilizer.

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PHYTOCHEMICAL SCREENING, ANTIOXIDANT ACTIVITY AND SENSORY EVALUATION OF TEA FROM AVOCADO (*PERSEA AMERICANA*) SEEDS AND LEAVES

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ABSTRACT

Avocados are a potential source for natural medications because of their abundant phytochemicals. These components, with their antioxidant benefits, make avocado herbal tea a rich source of nutrients capable of combating degenerative diseases. In order to evaluate its medicinal potential and generate a valuable product, this study compares tea from avocado leaves (AVL) and seeds (AVS) with La Botti Herbal tea (LBT) and Lipton Calming Chamomile (LCC). The phytochemical screening of the tea infusions showed the presence of flavonoids, saponins, and glycosides in all the samples. AVS is the only sample containing alkaloids. Tannin is present in all the samples except AVS. Among all the samples, AVL showed a distinct composition of Vitamin C, total phenol, total flavonoid content, and 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activity. Similarly, AVL possesses distinct sensory attributes and ranks as the most preferred tea sample.

Keywords*: antioxidants, phytochemicals, natural medicine, tea infusion, degenerative diseases*

INTRODUCTION

Plant-based remedies are a cost-effective and less harmful alternatives to synthetic medicines. They are rich in biologically active components and offer the potential for developing novel pharmacological substances (Rouhi-Boroujeni *et al.,* 2015). Among plant species, avocado (*Persea americana*) has been established as a potential natural medicine source due to its diverse phytochemical composition. The fruit is grown in the tropical and subtropical regions of the world for its food and medicinal purposes (Tremocoldi *et al*., 2018; Gupta *et al*., 2018). Avocados are rich in fiber, protein, carbohydrates, sugar, and starch. The fruit is particularly rich in protein, containing about 1–3%, a value higher than that reported in most fruits. Avocadoes are also rich in vitamins, pigments, sterols, and phenolic compounds. (Duarte *et al*., 2016; Tabeshpour *et al*., 2017; Hurtado-Fernández *et al*., 2018; Gupta *et al*., 2018).

The bioactive substances present in avocado exhibit a range of biological actions that can be linked to their antioxidant properties (Tabeshpour *et al*., 2017; Gupta *et al*., 2018; Loh and Lim, 2018; Anwar *et al*., 2022). The peel, seed, and leaves of the avocado plant, however, are often discarded as waste (Tremocoldi *et al*., 2018). The formulation of tea infusions has therefore been proposed as an effective way of utilizing these plant by-products with high phenolic content (Danacioglu and Pekel, M., 2021). The aim of this study was therefore to prepare nutrient-rich herbal tea from avocado seeds and leaves, thereby offering a cost-effective and valuable product, and to compare the prepared formulations with known herbal teas to establish their therapeutic potential.

MATERIALS AND METHODS

Fresh, mature, dark green leaves of avocado plant were collected from the National Horticultural Research Institute in Ibadan. The leaves were washed briefly and blotted dry. Seeds of avocado fruits obtained from Bodija market in Ibadan were removed, washed, and crushed with a manual grater. Samples were dried in an Excalibur Model 4926T Food dehydrator at 50°C.

Extraction Procedure

Tea infusions were prepared using the method of Komes *et al.*, (2010) with modifications. 2g of the sample was boiled in 200 mL of distilled water at 100^{o}C for 5 minutes.

Phytochemical Screening

Tannin and saponin content was determined by the method described by Abulude *et al*., (2022). Glycoside content was determined using the method of Emmanuel and Sani, (2018). Wagner's test for alkaloids was carried out following the method described by Jha *et al*., (2012) and screening for flavonoid content was carried out using the method described by Hossain *et al*., (2013).

Total Phenolic and Flavonoid Content and Vitamin C Content

The total phenolic content using the Folin-Ciocalteu method and total flavonoid content were determined as described by Hossain *et al*. (2013) with modifications. The vitamin C content of the samples was determined using the method of Ikanone *et al*. (2014) with modifications.

Determination of Antioxidant Activity

2, 2-diphenyl-1-picrylhydrazy (DPPH) free radical scavenging assay was carried out using the method described by Patil *et al*., (2015) with modifications.

Sensory Evaluation

On a 5-point hedonic scale, where 1 = dislike extremely, 2 = dislike moderately, 3 = neither like nor dislike, 4 = like moderately, and 5 = like extremely, the sensory evaluation of the freshly brewed tea infusions was carried out by 25 trained panelists. Each panelist received 40 mL of the coded samples to assess its colour, flavor, taste, body and overall acceptability.

Statistical Analysis

The tests were carried out in triplicate. The results were all analyzed in Statistical Package for Social Sciences (SPSS) using one-way analysis of variance and Duncan's Multiple Range Test. The differences were regarded as statistically significant at $p < 0.05$

RESULTS AND DISCUSSION

The results of the phytochemical screening of the tea extracts are presented in Table 2. All the samples contain flavonoids in high concentrations. AVL and LBT contain equal amounts of saponin similarly, AVS and LCC contain equal amounts of saponin. Alkaloids were detected only in AVS, and at low concentration. Glycosides were detected in moderate concentrations in AVS and in low concentrations in the remaining samples. Tannin was not detected in the AVS sample but in other samples with LBT having the highest concentration.

Chemical Properties and Antioxidant Capacity of the Tea Samples

Vitamin C content, total phenolic, and total flavonoids content were analyzed to explain the chemical profile of the tea samples. The results are presented in Figure 1 (b), (c) and (d) respectively. Tea from avocado leaves (AVL) showed a higher content of these components than tea from avocado seed (AVS), La Botti (LBT) and Lipton Calming Chamomile (LCC) samples. For vitamin C content {Figure 1 (b)}, AVL had the highest value of 6.44±0.35 mg/100g. There was however no significant difference at $p <$ 0.05between the LBT (6.09±0.01 mg/100g) and LCC (6.04±0.42 mg/100g) samples while AVS had the lowest value of 5.18±0.50 mg/100g. For the total phenolic content of the samples {Figure 1 (c)}, AVL had the highest concentration of 0.83 ±0.50 mg GAE/100g. This is in agreement with the report of Yamassaki *et al*. (2017) where the amount of phenolic compounds in avocado leaf extract was higher than the levels found in tea, mulberry, blackberry, raspberry, and strawberry leaves. There was no significant difference among AVS (0.08 ±0.01 mg GAE/100g) LBT (0.07 ±0.00 mg GAE/100g) and LCC (0.06 ±0.00 mg GAE/100g). The total flavonoid content showed a significant difference among all the samples in the order AVS (6.25 ±0.80 mg CAT/100g) >AVS (1.14 ±0.80 mg CAT/100g) > LCC (0.43 ±0.04 mg CAT/100g) >LBT (0.20 ±0.02 mg CAT/100g)

DPPH Radical Scavenging Capacity of the Tea Samples

Figure 1 (A) presents the percentage of DPPH radicals that avocado leaves and seeds can scavenge, along with a comparison to other two tea brands. The radical scavenging ability of avocado leaves (AVL) and La Botti Herbal (LBT) tea were significantly higher ($p < 0.05$) than the remaining tea samples. Avocado seed (AVS) had the lowest radical scavenging activity of 40.01%. The value obtained is similar to that reported by Abubakar and Khaerah (2022). These findings indicate that avocado seeds and leaves could serve as natural antioxidant source thereby lowering oxidative stress associated with the development of degenerative disorders.

The results of the sensory attributes of the tea samples are presented in Table 2. There was no significant difference in the color of AVL, LBT, or LCC. AVS, however, received the lowest score. The flavor of AVL is similar to that of LBT. LCC, however, has the lowest score but is statistically similar ($p < 0.05$) to AVS. The taste score was in the order: AVL > AVS > LBT > LC. There was no difference between the tastes of AVL and AVS. Similarly, there was no difference in the taste of AVS, LBT, or LCC. There was no significant difference in the body of the tea sample, and this further confirms that the extraction method described by Komes *et al.* (2010) was acceptable. The overall acceptability score showed that AVL is the most preferred. The sample also compared similarly with AVS and LBT samples. Results also showed similarity among AVS, LBT, and LCC.

Table 1: Phytochemical Constituents of Tea Infusion

Phytochemical	AVL	AVS	LBT	LCC
Saponin	+++	++	+++	++
Tannin	++	-	+++	+
Alkaloids	-	+	-	-
Glycosides	+	++	+	+
Flavonoid	+++	+++	+ + +	+++

+ + +: High concentration; + +: Moderate concentration; +: Low concentration; -: Not detected.
AVL: Avocado Leaf, AVS: Avocado seed, LBT: La Botti Herbal Tea, LCC: Lipton Calming Chamomile: LCC

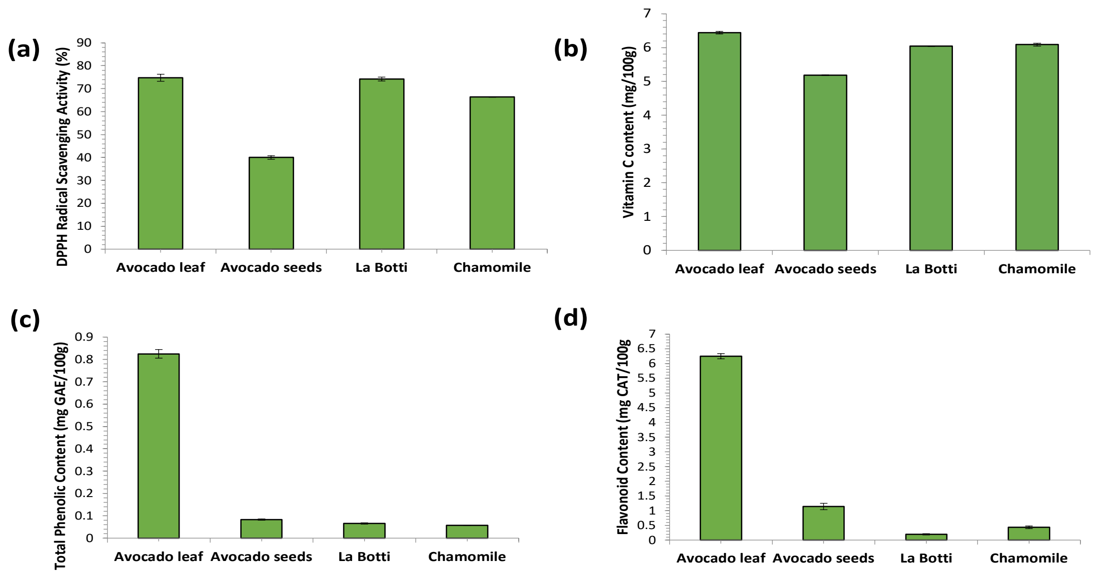

Figure 1: A: DPPH Radical Scavenging Activity of Tea Samples, B: Vitamin C Content of Tea Samples, C: Total Phenolic Content of Tea Samples, D: Total Flavonoid Content of Tea Samples

Table 2: Sensory Evaluation of Tea Infusion

Attribute	Avocado Leaf	Avocado Seed	La Botti Herbal Tea	Lipton Chamomile Tea
Colour	$4.40{\pm}0.68^{a}$	$3.00{\pm}1.12^{b}$	$4.35{\pm}0.59^{a}$	$3.85{\pm}1.04^{a}$
Flavor	$3.65{\pm}0.93^{a}$	$2.80{\pm}1.20^{b}$	$3.65{\pm}1.09^{a}$	$3.20{\pm}1.24^{ab}$
Taste	$3.60{\pm}0.60^{a}$	$3.00{\pm}1.30^{ab}$	$2.80{\pm}1.11^{b}$	$2.65{\pm}1.31^{b}$
Body	$3.95{\pm}0.69^{a}$	$3.25{\pm}1.13^{a}$	$3.60{\pm}1.19^{a}$	$3.30{\pm}1.34^{a}$
Overall Acceptability	$4.05{\pm}0.69^{a}$	$3.45{\pm}1.10^{ab}$	$3.55{\pm}0.95^{ab}$	$3.05{\pm}1.19^{b}$

Mean values with different superscripts within a row are significantly different ($p < 0.05$)

CONCLUSION

This study indicated that the development of tea from avocado leaves and seeds resulted in products with pharmacological potential for the treatment of degenerative diseases. This can be attributed to the phenolic, flavonoid, and vitamin C content of avocado leaves and seeds, which confer significant antioxidant activity on these tea samples. The findings also showed that the bioactive components of the avocado tea are similar to those of the well-known and established La Botti Herbal Tea and Lipton Calming Chamomile brands. The sensory study of the avocado tea samples further revealed that it has a beneficial effect on the consumer market.

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RESPONSE OF FOUR VARIETIS OF CUCUMBER (*Cucumis sativus* L.) TO DIFFERENT FERTILIZER TYPES IN SOUTH WESTERN NIGERIA.

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ABSTRACT

Response of four varieties of cucumber (Cucumis sativus L.) in terms of growth and fruit yield to different types of fertilizer was investigated in a field trial at the National Horticultural Research Institute (NIHORT) Ibadan. The experiment was a 4 × 4 factorial laid out in split plot arrangement with three replicates comprising of the following treatments: variety (poinsett, marketer, marketmore and greengo) and types of fertilizer (control, 100 kg N ha^{-1}organic, 100 kg N ha^{-1} inorganic fertilizer and 1 litre ha^{-1} foliar fertilizer). Growth and yield parameters such as vine length, number of leaves, number of fruits per plant and fruit yield per hectare were investigated and subjected to statistical analysis using the analysis of variance (ANOVA) with the split plots model and significant means were separated using the least significant difference at 5% probability level. The results revealed that the investigated parameters reacted differently to the treatments. It can be recommended from the study that for increased plant growth and fruit yield, greengo cucumber variety should be cultivated with 1 litre ha^{-1} of foliar fertilizer.

Keywords: *Fertilizer, organic, inorganic, foliar, fruit yield.*

INTRODUTION

Cucumber (*Cucumis sativus* L.) is one of the most popular members of Cucurbitaceae (vine crop) family. It is cultivated for fresh fruit which are locally consumed or exported to increase national income. The crop is cultivated in most parts of Northern and Eastern Nigeria. Cucumber (*Cucumis sativus* L.) is thought to be one of the oldest vegetables cultivated by man with historical records dating back 5,000 years (Wehner and Guner, 2004). The crop is the fourth most important vegetable after tomato, cabbage and onion in Asia (Tatlioglu *et al.,* 1993), though its place has not been ranked in tropical Africa because of its limited use. Cucumber is rich in vitamins, calcium, magnesium and other essential nutrient element. In spite of the increasing relevance of cucumber in Nigeria, low yields are obtained in farmers' fields because of declining soil fertility due to continuous cropping and disregard for soil amendment materials. Many studies of various crops have shown significant advantages of applying inorganic fertilizers (Akinrinde, 2006).

Application of fertilizer is one of the ways of improving soil fertility and final yield of crops. Belay *et al*. (2001), Eifediyi and Remison (2010) in their various studies on nutrient requirements of cucumber reported that cucumber responded positively to organic, inorganic or combined nutrient applications for optimum growth and productivity. Scientists seek an alternative means to enhance soil nutrient which is environment friendly and has no lethal effect on the soil. Therefore, the use of liquid fertilizer (which is believed to be organic) was introduced as a panacea to this problem. The objective of this study was therefore to determine the varietal response of cucumber to different fertilizer types.

MATERIALS AND METHODS

The field experiment was conducted at the vegetable research farm of the National Horticultural Research Institute (NIHORT), Idi - Ishin, Jericho, Ibadan (3° 56` E and 7$^0$ 33` N at 168 m above the sea level). The monthly rainfall distribution pattern for Ibadan is bimodal with peaks in June and September. Annual rainfall ranges from 1250 and 1500 mm spanning eight months (March to October) with dry spell in August .The field was ploughed and harrowed twice each to give well pulverized surface. The land area was measured and pegged into three replicates consisting of sixteen plots each, and total of forty eight plots in all. The area of each plot was 4 m^2, separated by alleyways of 1 m between plots. The experiment was designed as a 4 x 4 factorial in a split plots design. Each factorial combination of the factors was replicated three times. The main plots consisted of four varieties of cucumber (Greengo, Poinsett, Marketer and Marketmore). The sub-plots were made up of the control, 100 kg N ha^{-1} inorganic, organic, and 1 litre ha^{-1} foliar fertilizer**.** Two viable cucumber seeds were planted per hill at the depth of 2 cm at the plant spacing of 50 x 50 cm and thinned out to one plant two weeks after planting (WAP). Data collection commenced six weeks after planting. Ten plants were tagged in each plot from which data taken on them were calculated on the average. Vine length, number of leaves per plant, number of fruits per plant and yield per hectare were all determined in this present study. The data collected were subjected to the analysis of variance (ANOVA) using Genstat Discovery for Statistical Package (2014). Means were separated using the Least Significant Differences (LSD) at 5 % probability level ($LSD_{0.05}$)

RESULTS

Results in table 1 revealed that foliar fertilizer application at the rate of 1 litre ha^{-1} produced the longest vine which was significantly higher than those obtained from the same application rate of inorganic, organic and the control. The results also revealed that greengo variety had the longest vine which was significantly longer than that of the other varieties. Table 2 revealed that the number of leaves per plant increased significantly with different types of fertilizer from the control to foliar fertilizer. Foliar fertilizer application resulted in the highest number of leaves which was significantly higher than that of the others. Application of 100 kg N ha^{-1} organic fertilizer gave the number of leaves that was significantly higher than that of the control but significantly lower than that of foliar and inorganic fertilizer types. The results also revealed that greengo variety had the highest number of leaves which was significantly higher than that of the other varieties. There was no significant variation in the number of leaves produced by marketmore and marketer varieties in this present study.

Table 3 showed the effects of variety and types of fertilizer on the number of fruits per plant. Number of fruits increased significantly with foliar fertilizer resulting in the highest number of fruits per plant. Organic fertilizer application gave a value of the number of fruits per plant that was significantly higher than that of the control, but significantly lower than that of the foliar and inorganic application. Greengo variety produced the highest number of fruits per plant that was significantly higher than that of the other varieties, while marketmore variety gave the lowest number of fruits per plant that was significantly lower than that of the other two varieties.

The result as shown in Table 4 revealed that fruit yield ha^{-1}varied significantly with different fertilizer types. Foliar fertilizer application resulted in the highest fruit yield ha^{-1} which was significantly higher than that of the control, inorganic and organic fertilizer types respectively. The value of fruit yield produced by the application of inorganic fertilizer was significantly lower than that of the foliar but significantly higher than that of the control, and organic fertilizer types in this present study. Greengo cucumber variety produced the highest fruits yield ha^{-1} which was significantly higher than that of the others, while Marketmore cucumber variety produced the lowest fruit yield ha^{-1} which was significantly lower than that of other varieties in the experiment.

Table 1: Effects of variety and types of fertilizer on vine Length

Treatment	Vine Length (cm)
Variety	
Marketmore	134.02
Marketer	136.79
Pointsett	140.51
Greengo	144.92
LSD ($_{0.05}$)	1.23
Types of fertilizer (100 kg N $ha^{-1}$and 1 litre ha^{-1})	
Control	128.42
Organic	136.73
Inorganic	141.06
Foliar	143.75
LSD ($_{0.05}$)	0.73

Table 2: Effects of variety and types of fertilizer on Number of leaves per plant

Treatment	Number of Leaves per plant
Variety	
Marketmore	43
Marketer	43
Pointsett	45
Greengo	47
LSD ($_{0.05}$)	0.20
Types of fertilizer (100 kg N ha^{-1}and 1 litre ha^{-1})	
Control	36
Organic	40
Inorganic	44
Foliar	48
LSD ($_{0.05}$)	0.3

Table 3: Effects of variety and types of fertilizer on the Number of fruits per plant

Treatment	Number of fruits per plant
Variety	
Marketmore	11
Marketer	14
Pointsett	17
Greengo	21
LSD ($_{0.05}$)	2
Types of fertilizer (100 kg N ha^{-1}and 1 litre ha^{-1})	
Control	11
Organic	13
Inorganic	16
Foliar	20
LSD ($_{0.05}$)	1

Table 4: Effects of Variety and types of fertilizer application on the fruit yield per/ha

Treatment	Fruit yield ha^{-1} (kg)
Variety	
Marketmore	12308.45
Marketer	13403.29
Pointsett	15298.54
Greengo	17254.09
LSD ($_{0.05}$)	135
Types of fertilizer (100 kg N ha^{-1}and 1 litre ha^{-1})	
Control	11564
Organic	13975
Inorganic	15752
Foliar	18643
LSD ($_{0.05}$)	189

DISCUSION

Cucumber vegetative and yield parameters (Vine length, number of leaves, number of fruit and fruit yield) were influenced by the different fertilizer types in this present study. The highest values were obtained from the application of 1 litreha^{-1} of foliar fertilizer, followed by inorganic and organic respectively, while zero application had the least value. The relative increase in cucumber yield and growth parameters for foliar fertilizer is likely due to direct foliar feeding that delivered appropriate amount of essential nutrients directly to plants with greater nutrient use efficiency. Nafiu *et al.,* (2017) observed that nutrient uptake via foliar feeding was faster than through root feeding. Shobo *et al* (2016) and Nafiu *et al.,* (2017) observed that chemical residues present in foliar fertilizer also protect crops against foliar pests and diseases. Pandey *et al*. (1974), Bradley *et al.* (1976), Yuasa and Aboaba (1981), El-Badawi (1994), Lawal (2000), Agba and Enya (2005) had all reported increase in growth and yield components of cucumber to applied fertilizer.

CONCLUSION

Overall observation showed that among the fertilizer types tested, foliar fertilizer was the best for optimum growth and fruit yield, while greengo cucumber variety proved to be the best. It is therefore recommended that for optimum growth and increased fruit yield, greengo cucumber variety should be cultivated, and foliar fertilizer applied appropriately.

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BIOACTIVE COMPOSITION AND ANTI-OXIDANT ACTIVITIES OF DRIED UNRIPED AND RIPED PLANTAIN PEEL

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ABSTRACT
In this study, bioactive composition and antioxidant activity of unripe and ripe plantain peel were compared. Highest flavonoid concentration of total flavonoid was observed in acetone extract of ripe plantain peel while highest phenolic concentration was observed in aqueous extract of ripe plantain peel. Relatively higher antioxidant activity though not significantly different was observed in unripe peels as compared to ripe plantain peels. No significant difference was observed in total phenolic concentration for ripe and unripe peel in acetone extract. Similar findings were observed for aqueous and methanol extract. Findings from this research indicates that unripe and ripe plantain peels are good source of bioactive compounds with therapeutic values and suggests that more research needs to be conducted on value addition in bid to address mounting global challenge of food loss and waste.
Keywords: *Unripe plantain peel, ripe plantain peel, bioactive compositions, antioxidant activities.*

INTRODUCTION

Musa parasidiasca commonly known as cooking banana, is a staple food grown predominantly in tropical parts of Africa, South America, Central America and Asia (Adeniji *et al*., 2005). It is estimated that 2.11 million metric tons of plantain is grown annually in Africa (Cauthen *et al*., 2019), this implies that plantain peels (40% of fresh fruit weight) accounts for 0.84 million metric tons of plantain wasted annually (Okorie *et al*., 2015). Plantain peels are good source of dietary fibre, starch and protein and can also be used as alternative to flour due to its oil and water holding capacity (Agama-Acevedo *et al*., 2016). Studies has shown that plantain peels possess anti-ageing, anti-inflammatory, antibacterial, anti-hypertensive, antioxidant and antidiabetic properties (Ighodaro *et al*., 2012; Islam *et al*., 2023). This aim of this research is to determine differences in bioactive composition, ascorbic acid and antioxidant activities of ripe and unripe plantain peels using various extracting solvents.

Figure 1: Showing image of peels from (A) ripe and (B) unripe plantain peels

MATERIALS AND METHODS

Sample collection

Ripe and unripe plantain was locally sourced from a local market in Ibadan, Oyo State, Nigeria. The plantain samples were washed, cut open and its peels dehydrated at 50°C with the aid of food dehydrator (Excalibur Model- 4926 T, USA). Dehydrated sample was then pulverized and stored in air tight containers for further analysis.

Extraction of sample

Sample extraction was carried out using method by Vinoth *et al*. (2012). Aqua, ethanol and ethanol were used as solvents for extraction.

Extraction and Determination of Yield
Yield was determined using method as adopted by Oyawaluja *et al*. (2020).

Total Phenolic Content (TPC)
Determination of total phenolic content was conducted using method as adopted by Moo-Huchin *et al.* (2014).

Total Flavonoid Content (TFC)
Total flavonoid content was determined using methods by Ademoyegun *et al*. (2013).

Determination of Ascorbic acid
Ascorbic acid determination was carried out using method by Ajayi *et al.* (2020).

Antioxidant activity
Antioxidant activity using DPPH assay was conducted using method as adopted by Islam *et al*. (2023).

Statistical analysis
Results for the experiment were expressed as means ± standard deviation (n=2). One-way analysis of variance (ANOVA) was used to analyze data with the aid of SPSS ($p < 0.05$).

RESULTS

Table 1: Percentage Yield for ripe (RPP) and unripe (URPP) plantain peels.

	RPP	URPP
Percentage Yield (%)	2.57	2.39

Table 2: Ascorbic acid concentration in ripe and unripe plantain peel

	RIPE (mg / 100mg)	UNRIPE (mg / 100mg)
Total Ascorbic Acid	0.43 ± 0.01	0.52 ± 0.003

Table 3: Total flavonoid, total phenol content and antioxidant activities of plantain peels

	DPPH (%)	TFC (mg/100g)	TPC (mg/100g)
Acetone extract			
RPP	47.92 ± 5.37^{c}	534.81 ± 2.08^{d}	114.7 ± 1.90^{a}
URPP	46.61 ± 2.51^{b}	279.42 ± 5.55^{a}	107.2 ± 0.20^{a}
Aqueous extract			
RPP	24.23 ± 0.26^{a}	345.60 ± 2.08^{a}	195.8 ± 5.30^{c}
URPP	32.74 ± 1.14^{a}	282.85 ± 3.47^{a}	148.9 ± 1.20^{c}
Methanol extract			
RPP	28.12 ± 1.41^{ab}	360.79 ± 2.77^{b}	134.5 ± 3.50^{b}
URPP	59.35 ± 2.28^{c}	378.93 ± 24.26^{b}	121.6 ± 0.40^{b}
Ethanol extract			
RPP	35.17 ± 3.20^{b}	409.32 ± 4.85^{c}	113.9 ± 1.40^{a}
URPP	49.03 ± 1.37^{b}	353.44 ± 7.63^{b}	128.0 ± 2.10^{c}

Key: RPP= Ripe plantain peel, URPP= Unripe plantain peel

DISCUSSION

Result as shown in Table 1 indicates higher yield obtained from ethanoic extract of ripe plantain peel (2.57%) as compared to peels from unripe plantain (2.39%). Higher concentration of ascorbic acid was observed in peels of unripe plantain as compared to ripe plantain peel and is in accordance with deduction by Oduje *et al*., (2015). Highest TFC was observed in acetone extract of ripe plantain peel while higher TPC was observed in aqueous extract of ripe plantain peel. No significant difference was observed in antioxidant activity between ethanoic extracts of ripe and unripe plantain peel. Similar finding was observed for aqueous extract while significant differences was observed between ripe and unripe plantain peels in acetone and methanol extract. Findings from this research indicates that no significant difference was observed in total phenolic content of ripe and unripe plantain peel in acetone, water and methanol extracts.

CONCLUSION

Ripe and unripe plantain peels extracts obtained using various extracting solvent showed varying concentrations in antioxidant activity and bioactive composition, highlighting their pharmaceutical and therapeutic values. Existing research studies on plantain has predominantly focused on the pulp and neglect its peel despite accounting for 40% of the fruit weight. There is need for increased research on value addition for plantain peel, its health benefit and possible non-culinary applications,

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UTILIZATION OF GREEN AMARANTH SHAFT FOR THE CULTIVATION AND PRODUCTION OF EDIBLE MUSHROOMS

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ABSTRACT

Three Pleurotus species (Pleurotus ostreatus, P. pulmonarius and P. florida) were cultivated on green amaranth shaft moistened with water. It was aimed at finding an alternative use for the shaft. Experiment was laid out in a complete randomized design (CRD) in replicates of five. There was no significant difference in the mycelial extension. Average mycelial extension per day was comparable between P. pulmonarius and P. florida (0.25 cm and 0.26 cm respectively) but least in P. ostreatus. The lowest number of fruits was recorded in P. florida. Biological Efficiency (BE) and Production Efficiency (PE) followed the same trend. The number of days to full mycelial colonization and primordial initiation were significantly highest in P. florida (26.00 and 30.00 days respectively). The widest width of pileus and longest length of stipe were recorded in P. pulmonarius (4.37 cm and 4.30 cm respectively). While the heaviest fruit weight was observed in P. ostreatus, the least was recorded in P. florida. These findings suggested that green amaranth shaft is a good and cheap substrate for production of edible mushrooms.

Key words: *Amaranth shaft, Edible mushrooms, Pleurotus pulmonarius, P. ostreatus, P. florida*

INTRODUCTION

In every sector of life, wastes are generated on daily basis: homes, industries, forests and agricultural sectors, to mention a few. These wastes inflict dangers on the environment, becomes a nuisance and source of pollution. Most agricultural wastes are generally incinerated in the open or dumped indiscriminately and, at times burnt, resulting in air pollution. However, value can be added to wastes generated from agricultural and or horticultural sector by recycling them biologically for mushroom cultivation and production. Mushrooms are important food items consequent of their nutritional contents and therapeutic values (Atila, 2017). *Pleurotus* spp, an edible mushroom, has low fat content but high in fibre, rich in vitamins and amino acids (Chang and Miles, 2004). They possess many health benefits such as anticancer, anti-diabetic, anti-oxidant and anti-viral effects (El-Enshasy and Hatti-Kaul, 2013; Wasser, 2014). They have been cultivated on various agricultural or horticultural wastes such as sawdust, cassava peels, corn cobs, sugarcane bagasse, banana leaves, plantain leaves, straw, cotton wastes, coconut coir/ fibre, maize stover, palm bunches (Idowu, 2003; Otunla and Idowu, 2012; Idowu *et al*., 2015). Green amaranth shaft is a horticultural waste that is usually discarded and burnt. This experiment was therefore conducted to determine the suitability of amaranth shaft as a mushroom substrate.

MATERIALS AND METHODS

Sourcing for mushroom spawn

For this research, the mushroom spawns (*Pleurotus pulmonarius* and *P. ostreatus*) were obtained from the pure culture collections from the Mushroom Unit, National Horticultural Research Institute (NIHORT), Idi-Ishin, Jericho, Ibadan, Oyo State, South-West Nigeria.

Collection of Green amaranth shaft (substrate) and preparation

Green amaranth shaft was collected from Seedtech Unit, NIHORT, Ibadan after the seed has been processed. The experiment was carried out in the mycology laboratory, NIHORT, Ibadan. The composting of the shaft was carried out by moistening it with water, wrapped it in a polythene spread sheet and allowed to stay for 48 hours.

Vertical mycelia growth

The shaft was tucked in test tubes of size 20 x 2.5 cm, plugged with cotton wool and covered with aluminum foil. It was replicated five times for each of the mushroom and sterilized in an autoclave at 121 ºC for 15 min. aseptically in an inoculating chamber after allowed to cool; they were inoculated with the spawn of the mushrooms separately. The test tubes were maintained at room temperature of 30 ± 2 ºC and placed in a test tube rack with a millimeter tape of 150 mm to monitor the mycelia growth. Vertical mycelia extension was recorded and the average extension per day calculated.

Mushroom substrate mycelial growth

300 g of the shaft, moistened with water and left for 48 hours, was weighed into heat-resistant transparent polythene bags of size 35 x 10 cm. The bags were replicated five times for each of the mushroom species. The neck of the bag was made with heat resistant PVC (polyvinyl choride) tube and tucked with a cotton plug. The bags were sterilized in an autoclave at 121°C for 15 minutes, brought out, allowed to cool and spawned separately with the mushroom spawn. The bags were transferred into the vegetative room where vegetative growth took place, temperature maintained at 28-30 °C and relative humidity at 82-85%.

Mushroom fructification, harvesting and yield

The substrate bags fully covered with mycelial were moved out of the vegetative room into the cropping house maintained at 24-28 °C and relative humidity at 84-87%. Mushrooms were harvested manually when the in-rolling margins of the pileus began to flatten. The number of fruiting bodies harvested were counted and weighed. Other parameters observed and recorded were the fruit weight, width of pileus, length of stipe, mycelial extension, days to full mycelia colonization and primordia initiation. Biological Efficiency (BE), Production Efficiency (PE) and average mycelial extension were calculated.

Research Design

The experiment was laid out in a complete randomized design (CRD) in replicates of five.

Data Analysis

Analysis of the data collected was done using ANOVA and significant means were separated using Duncan's multiple range test at 5% probability level

RESULTS AND DISCUSSION

Significant growths of the mushrooms were observed on the shaft. These mushrooms have been reported to be one of the most efficient lignocelluloses solid decomposing white rot fungi (Baysal *et al*., 2003) thus, able to utilize the agricultural and horticultural wastes as substrates for mushroom fruit body production. Also, other researchers reported the utilization of various agro-wastes by the white rot fungi (Jonathan *et al*., 2013; Idowu *et al*., 2015). While comparable mycelial extension was observed in the mushrooms (Table 1) however, the average mycelial extension per day was significantly longest in *P. pulmonarius* but not significantly different from that of *P. florida* while *P. ostreatus* recorded the shortest (0.26 cm, 0.25 cm and 0.22 cm respectively). Days to full mycelial colonization and primordial initiation recorded for the three mushrooms followed the same trend; the longest were recorded in *P. florida* (26.00 days and 30.00 days respectively). The least were observed in *P. pulmonarius* which were not significantly different from that of *P. ostreatus* (Table 1). This agreed with earlier reports by Tan (1981) and Ahmad (1986) that spawn running took three weeks in completion for *Pleurotus* spp. Furthermore, Ahmad (1986) observed that in *P. ostreatus* planted on various substrates, primordial initiation was between 23-27 days.

The numbers of fruits recorded in the mushrooms were significantly different from each other (Table 2). The highest was recorded in *P. ostreatus* but not significantly different from what was observed in *P. pulmonarius*. The least number of fruits was recorded in *P. florida* (7.00). The largest size of pileus was observed in *P. pulmonarius* which was not significantly different from that of *P. florida* while the least was recorded in *P. ostreatus* (4.37 cm, 4.30 cm and 3.47 cm respectively). The length of stipe observed followed the same trend (Table 2). Both Biological Efficiency (BE) and Production Efficiency (PE) followed the same trend. While the greatest were recorded in *P. ostreatus*, the least were recorded in *P. florida* (Figure 1). Furthermore, it was observed that the mycelial density of *P. ostreatus* on the shaft was heaviest than that of other mushrooms. This was contrary to an earlier work by Otunla *et al*. (2016) in which the mycelial density of *P. pulmonarius* was heavier on cassia sawdust substrate. The highest mushroom fruit body weight was harvested on *P. ostreatus* (Figure 2). This could be attributed to the heaviest mycelial density observed in *P. ostreatus* consequent of high porosity, level of aeration and the physical nature of the shaft. It was opined that *P. ostreatus* was more virulent on the shaft than *P. pulmonarius* and *P. florida*. Thomas *et al*. (1998) stated that mushroom mycelial density is directly proportional to fruit body yield.

CONCLUSION AND RECOMMENDATION

Statistically, the mushrooms performed well in terms of number of fruits, mycelial extension, days to full mycelial colonization and primordial initiation. However, *Pleurotus ostreatus* performed better on the shaft than *P. pulmonarius* and *P. florida* in terms of fruit body yield. Amaranth shaft may be recommended for mushroom production and further investigation could be conducted in combination with sawdust.

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Table 1: Mycelia extension, average extension per day, full mycelia colonization and primordia initiation of the mushrooms on green amaranth shaft

	Mycelia extension (cm)	Average extension per day (cm)	Full mycelia colonization (Days)	Primordia initiation (Days)
OST	4.13	0.22	24.67	28.67
P	4.27	0.26	24.00	28.00
PF	3.87	0.25	26.00	30.00
LSD	0.55	0.22	1.76	1.76

OST= *Pleurotus ostreatus* P= *P. pulmonarius* PF= *P. florida*

Table 2: Number of fruits, size of pileus and length of stipe of the mushrooms on green amaranth shaft

	Number of fruits	Size of pileus (cm)	Length of stipe (cm)
OST	13.00	3.47	3.30
P	13.00	4.37	4.30
PF	7.00	4.30	3.43
LSD	2.00	0.36	0.33

OST= *Pleurotus ostreatus* P= *P. pulmonarius* PF= *P. florida*

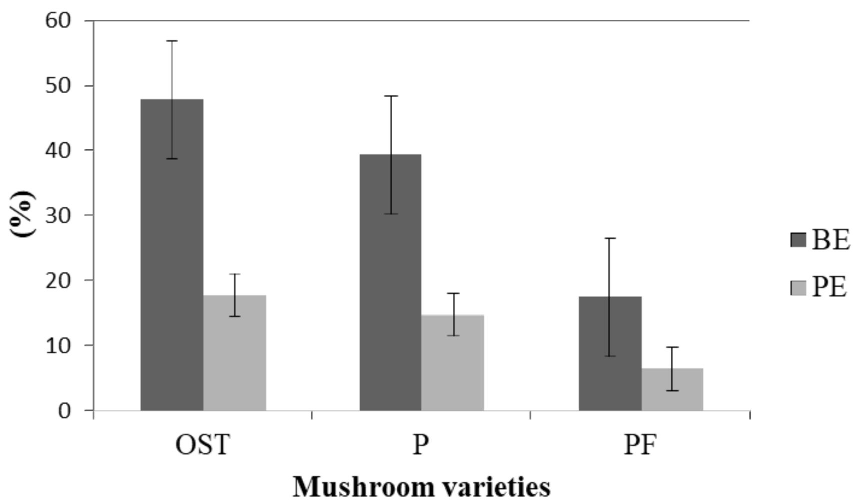

Figure 1: Biological Efficiency (BE) and Production Efficiency (PE) of *P. ostreatus* (OST), *P. pulmonarius* (P) and *P. florida* (PF) grown on amaranth shaft.

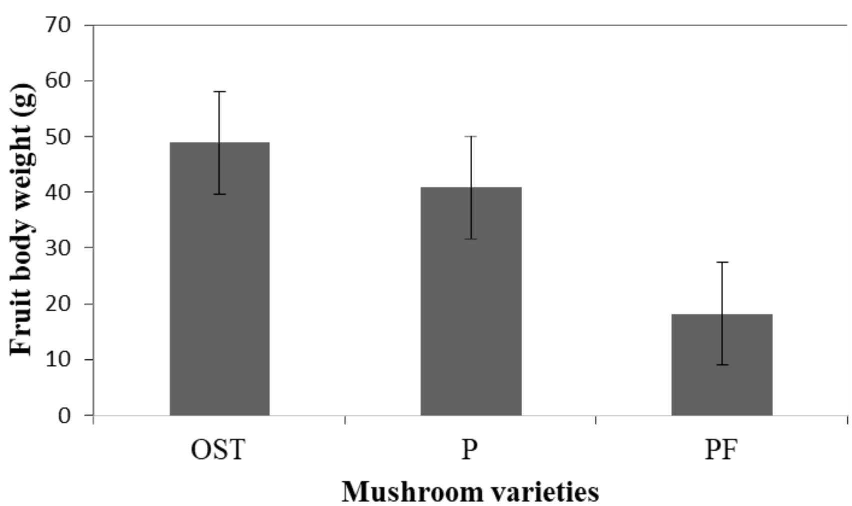

Figure 2: Fruit weight (g) of *Pleurotus ostreatus* (OST), *P. pulmonarius* (P) and *P. florida* (PF) grown on amaranth shaft.

INTERCROPPING AS A MANAGEMENT OPTION IN TOMATO FUSARIUM WILT SUPPRESSION

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ABSTRACT
This study was conducted to determine the effect of intercropping tomato with Marigold or Sorghum on Fusarium wilt incidence and severity. Fungal population and inoculums density of the field was determine before planting. The treatments were; two tomato varieties (Roma VF and Ibadan local) and three cropping systems (tomato-marigold, tomato-sorghum and sole tomato). The experiment was laid out in Randomised Complete Block Design with three replications. The plot size was 3 m x 3 m (9 m^2) separated by 1 m from other plots and blocks with one row of tomato planted between two rows of either marigold or sorghum. Data collected were subjected to statistical and means were separated using Least Significant Difference (LSD) at 5 % probability level. Inoculum density that ranged from 200 - 250 cfu/g^{-1} was obtained in the field. Incidence in Roma –VF/sorghum intercrop was at par with sole cropping and were significantly lower P≤ 0.05 compared to tomato-marigold intercrop. Also. disease severity due to intercropping was not significantly (P ≤ 0.05) different from sole cropping in both years.
***Keywords**: Fungal population, Fusarium wilt, incidence, severity, tomato*

INTRODUCTION

Intercropping is a popular crop production system in subsistence tropical agriculture with effects on pest population dynamics that minimise crop damage. Intercropping guaranteed more profit and less risk of crop failures to the farmers and minimized weed infestation (Reddy *et al.* (1995) as cited by Rajkhowa and Baroova, (2000). Yayock (1988) observed better utilization of soil nutrients, space and reduction in the spread of diseases and pests. Intercropping systems provide greater potential than monoculture for sustained production of food and income, especially for poor farmers in developing countries with limited resources therefore, ensures food security. Intercropping serves as an alternative strategy to traditional application of chemicals for plant disease management by making use of plants with antimicrobial properties (Altieri, 1999). Intercropping tomatoes with onion or garlic has been found to reduce the levels of *Bemisiatabaci, Myzus persicae* and *Phthorimaea operculella* (Afifi *et al*., 1990). Marigold (*Tagetes erecta* L.), a traditional plant in México for the celebration of All Saints Day, has been recognized for its fungicidal, nematocidal and insecticidal properties due to the presence of thiophenes in all its tissues (Riga *et al*., 2005). Tomato plants intercropped with Marigold have shown significantly less foliar and fruit damage by *Alternaria solani* than the non-intercropped tomato (Gómez-Rodríguez *et al*., 2003). They attributed the beneficial effects of intercropping marigold with tomato to three protective mechanisms: allelopathic effect of marigold on *A. solani* conidial germination; reduction in the period with relative humidity ≥ 92%, thus diminishing conidial development; and provision of a physical barrier against conidia spreading. Physiological adaptation due to shading on tomato plants intercropped with marigold could also have some effect on disease suppression (Rojas- Martínez *et al.*, 1999). Intercropping tomatoes with sorghum have controlled whiteflies through effects on arthropod predators and intercropping with cucumber or pepper have delayed the development of *Tomato yellow leaf curl virus* (Al-Musa, 1986). Intercropping tomatoes with sorghum has lead to reduction in fungal disease incidence and severity (Boudreau, 1993), while with cowpea reduced bacterial wilt (*Pseudomonas solanacearum*) on tomato (Michel *et al*., 1997). The objective of this study was to determine the effect of intercropping tomato with Marigold or Sorghum on Fusarium wilt incidence and severity.

MATERIALS AND METHODS

Determination of fungal population in the soil

Soil samples were randomly collected from an endemic field used for the experiment at depth of 0/5cm. Inoculum density of Fusarium species was assessed using soil dilution technique and was expressed as colony forming unit (CFU)/g of soil. The percentage frequency of occurrence was calculated according to Ebele (2011).

$$\text{Percentage frequency} = \frac{\text{Number of times a fungus was encountered}}{\text{Total fungal isolations}} \times 100$$

Experimental Design and treatments

The trial was conducted at Vegetable Research Farm of NIHORT Ibadan, Nigeria. NIHORT is located within latitudes 07° 24.204" N, 003° 50.895" E at 178 m above sea level. The treatments included two tomato varieties (Roma VF and Ibadan local) and three cropping systems (tomato-marigold, tomato-sorghum and sole tomato). The experiment was laid out in randomised complete block design with three replications. The plot size of 3 m x 3 m (9 m^2) was separated by 1 m from other plots and blocks each. Four - week old seedlings of Marigold seedlings were transplanted into the field and sorghum was equally planted the same day. Thirty days after, four weeks old seedlings of Ibadan –Local and Roma VF were transplanted into the field. In the intercrop, one row tomato was planted between two rows of either Marigold or Sorghum.

In these two treatments, rows were 100 cm apart with 50 cm between plants in the intercrop and 75 cm apart with 50 cm between tomato plants in the non- intercrop. Five plants were tagged per plot to serve as representative sample. Disease incidence and severity per plant were assessed every two weeks starting from two weeks after transplanting. Data collected were subjected to statistical using GENSTAT (12^{th} Edition) statistical package. Means were separated using Least Significant Difference (LSD) at 5 % probability level.

RESULTS AND DISCUSSION

Sorghum

F. oxysporum f.sp *lycopersici* had highest frequency of occurrence in both plant and soil collected from the infected field. Occurrence of 80 and 75 % was recorded in infected plant and infested soil respectively. Other pathogens had occurrence that ranged between 5 – 12 % on both plant and soil samples (Table 1). Inoculum density that ranged from 200 - 250 cfu/g^{-1} was obtained in the sampled field under natural infestation which was capable of causing disease (Saremi *et al*. 2011) . *Fusarium oxysporum* f.sp *lycopersici* and other secondary pathogens such as *Penicillium spp*, *Aspergilus niger* and *Aspergilus flavus* isolated from infested field in this study was in agreement with finding of Lim (1972) who stated that secondary pathogens and saprophytes are more likely to be isolated from intensively cultivated soil.

In both years, disease incidence recorded where Ib –local was intercropped with either marigold or sorghum was not significantly different $P \leq 0.05$ from incidence obtained in the sole cropping (Table 2). The result of this study contradicts the findings of Zavaleta -Mejia and Gomez, (1995); Gomez-Rodrigues *et al*., (2003) that tomato intercropped with marigold showed lesser foliar damage by *Alternaria solani* Elis and Martin, Jones and Grout than the non-intercropped tomato. However, disease incidence recorded in Roma -VF intercropped with sorghum was at par with sole cropping although there were significant $P \leq 0.05$ incidence reduction compared to tomato-marigold intercrop (Table 2). This could be that perhaps sorghum acted as a barrier for the movement of pathogen from one place to another in the field. Disease severity in both tomato varieties due to intercropping was not significantly ($P \leq 0.05$) different from sole cropping in both years (Table 3). It could be that proportion of inoculum reduced as result of presence of non host crop (Andrivon, 2003).

CONCLUSION

Intercropping guaranteed more profit and less risk of crop failures to the farmers and minimized weed infestation. Roma-VF-sorghum intercrop could be an alternative strategy to traditional application of chemicals. It could also provide greater potential than sole cropping for the farmers in terms of sustainable food and income generation.

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Table 1: Frequency of occurrence of fungi pathogens isolated from Fusarium wilt infested soil in Ibadan

Pathogen	No of samples	Frequency of occurrence	% occurrence
F. oxysporum	20	15	75
Penicillium spp	20	1	5
A. niger	20	2	10
A. flavus	20	2	10

Table 2: Effect of intercropping tomato with marigold or sorghum on Fusarium wilt incidence

Cropping system	Ib-local			Roma VF		
	Year 1	Year 2	Pooled mean	Year 1	Year 2	Pooled mean
T-M	45.42	47.91	43.54	46.25	30.00	39.79
T-S	49.17	33.33	38.75	48.75	16.67	27.92
Sole tomato	47.92	32.50	41.25	55.00	8.33	25.83
LSD P≤ (0.05)	ns	ns	ns	7.67	ns	12.77

T-M : Tomato- Marigold, T-S: Tomato- Sorghum

Table 3: Effect of intercropping tomato with marigold or sorghum on Fusarium wilt of two tomato varieties in Ibadan in 2013 and 2014 planting seasons.

Treatment	Ib-local			Roma VF		
Cropping system	Year 1	Year 2	Pooled mean	Year 1	Year 2	Pooled mean
T-M	41.66	85.42	63.54	58.33	60.42	59.37
T-S	40.00	66.67	53.33	45.83	45.83	45.83
Sole tomato	53.33	64.58	58.95	60.42	37.50	48.96
LSD P≤ (0.05)	ns	ns	ns	ns	ns	ns

T-M : Tomato- Marigold, T-S: Tomato- Sorghum

GROWTH AND YIELD OF CUCUMBER (Cucumis sativus L.) VARIETIES AS INFLUENCED BY NPK (15:15:15) AND POULTRY MANURE IN ZURU, NORTHERN GUINEA SAVANNA ECOLOGICAL ZONE OF KEBBI STATE

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ABSTRACT
Field experiments have been carried out at Teaching and Research Farm of the Federal University of Agriculture Zuru (lat. 12012.99' N; long. 40 21.90'E; 197m above sea level), at some point of 2020/21 and 2021/22 rainy seasons withinside of the Northern Guinea Savannah area of Nigeria. The region has a protracted dry season this is characterized via way of means of cool dry air (harmattan) that prevails from November to February; and warm dry air extending from March to May. The place has been used for cultivation of vegetable and cereal crops. The purpose of the test turned into to look at the reaction of cucumber (Cucumis sativus L.) varieties to poultry manure and NPK (15:15:15). Treatments consisted of three (3) cucumber varieties (Darina, Market-more and Poinsett-75) and two (2) nutrient sources (NPK (15:15:15), poultry manure and the untreated control; each designed to deliver the endorsed nitrogen dose of 120kg N ha-1. Treatments have been specified in a Randomized Complete Block Design (RCBD) with three replications. Results found out that vine length, crop growth rate, imply fruit length, imply fruit diameter, total number of fruits per plant and fresh fruit yield of Market-more and Point sett varieties have been better with the application of either poultry manure or NPK fertilizer. Result, similarly discovered that all the three varieties (Darina, Market-more and Pointsett-75) attained maximum growth with the utility of poultry manure. Based on the results, it could be concluded that, both poultry manure and NPK mineral fertilizer have exceptionally the equal ability as reasserts nutrients on growth and yield of cucumber, but however thinking about the terrible environmental outcomes and the fee of the later, poultry manure may be advocated. Furthermore, varieties Market-more and Pointsett-75 are better than Darina in phrases of yield.
Keywords: *Cucumber, Darina, Market-more, Pointsett-75, Poultry manure, and NPK (15:15:15)*

INTRODUCTION
Cucumber (Cucumis sativus L.) is a member of the Cucurbitaceae own circle of relatives that is made out of 118 genera and 825 species, unfold specially in tropical and subtropical areas of the world (Ume et al., 2017). According FAO (2019), the maximum vital cucurbits in phrases of global wide overall manufacturing are melons (Citrullus spp.) and cucumber (Cucumis sativus L.). Cucumber originated in India and have become famous at some point of the Egyptian and the Greek-Roman Empire (Renner et al., 2007). It is concept to be one of the oldest greens cultivated through guy with ancient facts courting returned 5,000 years (Wehner and Maynard, 2003). It is a critical vegetable crop grown withinside the temperate and tropical zones of the world. With appreciate to financial importance, cucumber ranks fourth after tomatoes, cabbage and onion in Asia and 2nd after tomato in Western Europe (Eifediyi and Remison, 2010). Soft and succulent, the vegetable crop is loved through guy and eaten in salads or sliced into stew in tropical areas. It is one of the maximum critical marketplace greens withinside the tropics, a monoecious annual climber and creeper that has been cultivated for over 3,000 years (Adetula and Dentan, 2003). It is a gentle succulent plant with excessive water content material and has big leaves that shape cover over the fruit. Organic manure launch vitamins slowly and gradually and turns on soil microbial biomass (Belay et al., 2001).
The use of inorganic fertilizer has now no longer been useful beneathneath extensive agriculture due to its excessive price and its miles regularly related to decreased crop yields, soil degradation, nutrient imbalance and acidity. Mineral fertilizers have been used to offer soil vitamins so that you can preserve highest quality soil fertility situations and wholesome increase of vegetation and yield. Chemical

fertilizers assist the developing plants to face up to pressure situations and in a few instances have been used to accurate plant vitamins deficiencies. The call for of cucumber is at the boom because of the continuing focus of its overwhelming fitness benefits. Despite those benefits, the deliver is low because of low yields recorded through farmers – a hassle related to insufficient adoption of suitable manufacturing practices consisting of varietal desire and crop dietary schedule. Productivity of any crop is a feature of its genetic makeup (genotype) and environment (climate, soil fertility etc.); and those range amongst types. The use of natural manure constitutes a constraint to farmer, due to its bulkiness, fee of transportation and handling. This kind of trouble is solved thru the usage of both natural or inorganic fertilizer. Even aleven though the usage of inorganic fertilizers by myself may also reason issues for human fitness and the environment (Aisha et al., 2007), normally farmers practice a long way beneathneath required quantities to greens like cucumber, which ends up low yield (Dauda et al., 2008). The use of inorganic fertilizer through resource-bad farmers is restrained through its scarcity, price and unavailability at proper time. The use of natural manure on the opposite hand, comes with their barriers as excessive danger of infection, excessive price of transportation and labour because of its bulkiness in addition to a sluggish launch of vitamins for plant uptake (Adekiya et al., 2012). Eneje and Uzoukwu (2012) suggested that, the problem to fulfill the crop's nutrient call for with sole natural manure turned into because of its function gradual nutrient launch coupled with constrained availability in lots of components of the country. The intention of this has a look at became to assess decided on promising cucumber sorts and their responses to specific soil fertility reasserts withinside the examine area.

MATERIALS AND METHODS

Experimental Site

The test was performed in Teaching and Research Farm of the Federal University of Agriculture Zuru (lat. 12012.99' N; long. 40 21.90'E; 197m above sea level), at some point of 2021/22 and 2022/23 rainy seasons withinside of the Northern Guinea Savannah area of Nigeria. The region has a protracted dry season this is characterized via way of means of cool dry air (harmattan) that prevails from November to February; and warm dry air extending from March to May. The place has been used for cultivation of vegetable and cereal crops.

Treatments and Experimental Design

The treatments consisted of three (3) cucumber varieties (Darina hybrid, Market-greater and Poinsett-75) and the two (2) level of fertilizers specifically NPK 15:15:15 and poultry manure, plus the untreated control. Both NPK 15:15:15 and poultry manure designed to deliver the encouraged nitrogen dose of 120kg N ha-1 as follows: a 120 kg NPK (15:15:15) ha-1 and 6.6 t PM ha-1 plus the untreated control. Treatments had been specified in Randomized Complete Block Design (RCBD) with three (3) replications.

Seed Source

Three (3) forms of Cucumber: (Darina hybrid, Market-more and Poinsett-75 had been sourced from the National Horticultural Research Institute (NIHORT), Bagauda sub-station, Kano.

Agronomic Practice

The land changed into ploughed and harrowed to a great tilt. Water channels had been built to facilitate loose and green irrigation. Plot length become 4 x 3m (12m-2) with 1m area among plots and 1.5m among blocks. Each plot became made into four ridges spaced 1.5m aside with the 2 internal ridges constituting the internet plot. Planting changed into accomplished at inter and intra-row spacing of 60 x 40cm, respectively. Tube nicely turned into used because the supply of water wherein water pump device became used to attract water, with resource of transport hoses, to the experimental plots. Irrigation turned into finished at three-five days c language relying at the crop's need. Weeds had been managed manually the use of hand hoe at three and six weeks after sowing (WAS). Cucumber culmination had been harvested earlier than they had been completely mature relying at the variety; and became staggered at three-four days over 3weeks.

Data Collection and Analysis

Data have been gathered on vine duration, shoot dry weights, fruit period and diameter, end result in step with plant and fruit yield. Data generated have been analyzed following evaluation of variance procedure, and remedy method have been separated the use of Duncan's New Multiple Range Test (DNMRT).

RESULTS AND DISCUSSION

Influence of Varieties (Darina, Market-more and Pointsett-75) on the Growth and Yield of Cucumber

The found variations among the 3 styles of Cucumber (Darina, Market-more and Pointsett-75) may be attributed to their genetic make-up. According to Ayoub and Afra (2014), variations amongst vegetation with admire to boom and yield beneath Neath comparable environmental situations are usually the end result of variations of their genetic make-up. Results confirmed great impact of range on Vine duration (Table 3). Pointsett-75 and Market-extra accomplished higher in comparison to Darina in phrases of vine duration. This might be because of their genetic nature which allows them to conform nicely to the given climatic situations. The end result changed into much like the findings of Enujeke (2013) who mentioned that genetic charter of crop sorts affects their boom characters. Similar tests have been additionally pronounced in advance through Pal, et al. (2017). Fruit duration and diameter displayed a more version some of the three (3) varieties (Table 4), Pointsett-75 and Darina sorts recorded better values however are statistically in concord with Market extra range this may be because of genetic nature of the specific sorts, because the environmental situations have been the identical for all of the cucumber types. Similar estimation become said with the aid of using Veena et al. (2012) who said that, culmination diameter and culmination period numerous notably the various accessions because of genetic version. The effects of Total variety of culmination consistent with plant (Table 4), indicated that Point sett range recorded the better values however is statistically in concord with Market greater and Darina types. This would possibly have attributed to their genetic make-up. Similar outcomes have been additionally defined in advance through Umeh (2018), who stated that cucumber types confirmed a tremendous courting with recognize to yield characters beneath Neath the same genetic nature and environmental situations. Darina and Market extra types recorded the better values with appreciate to yield (Table 5). This version is because of genetic variety of sorts, variations in environmental and edaphic situations and potentials to move photosynthetic substances inside plants. Similar estimations for this person in unique cucumber types have been suggested through Adinde et al. (2016).

Influence of NPK (15:15:15) and Poultry manure on growth and yield of Cucumber

Influence of Fertilization on boom and yield of Cucumber Fertilization is most of the diverse agronomic practices that affects boom and fruit yield of cucumber. Balanced nutrient control appreciably elevated cucumber fruit yield. Organic manures deliver vitamins in addition to enhancing the soil bodily and chemical conditions (Belay et al., 2001). Fertilizers (natural and inorganic) play critical position in improving vegetative boom, starch synthesis in addition to translocation. Vine period, for the duration of the developing length recorded the better values with the software of both Poultry manure or NPK fertilizer (Table 3). This can be attributed to the better nitrogen content material of Poultry manure (Table 2) and balanced vitamins in NPK fertilizer which better vegetative boom (Ahmed et al., 2007). The elevated in Vine period with appreciate to application of Poultry manure might be attributed to enormous position performed through chicken manure in enhancing the moisture situation of the soil which improved the discharge of greater nutrient factors. Hamma et al. (2012) suggested that better increase reaction of Cucumber because of utility of Poultry manure should in all likelihood because of enhancing bodily and organic residences of the soil ensuing in higher deliver of vitamins to the Cucumber plant. Ayoola and Adeniran (2006) located that Poultry manure can maintain cropping structures thru higher nutrient recycling which might supply upward thrust to crop development in increase. Crop increase price become peaked with the software of both NPK fertilizer or Cow dung (Table 3). This can be attributed to the considerable function performed via way of means of NPK fertilizer withinside the development of soil fertility, nutrient uptake and improving manufacturing of assimilates at some point of increase. This method that the better the vitamins carried out to the soil, the better the boom characters. This remark is constant with works of Aduloju *et al.* (2010) who mentioned and attributed multiplied boom of crop flora to the discharge of extra nutrient factors thru the moisture that has been made to be had with the aid of using the manure. The good-sized high-quality yield reaction of Cucumber to fertilization is an affirmation of the essentiality of vitamins for the general overall performance of Cucumber varieties. Yield characters inclusive of Mean fruit diameter, Mean fruit period, Number of culminations in keeping with plant, and Fruit yield consistent with hectare have been better with the software of both Poultry manure or application of NPK fertilizer (Table 4). This can be attributed to the huge position performed via way of means of NPK fertilizer withinside the development of soil fertility, nutrient uptake and enhancement of crop yields and the position performed through Poultry manure in phrases of enhancing the soil bodily houses through decreasing soil temperature and bulk density, this suggests that chicken manure turned into with ease to be had withinside the satisfactory shape of smooth absorption with the aid of using the plant roots. This statement agreed with the paintings of Muhammad et al. (2018) who said that, the

Application of 120kg of N from hen manure improves moisture availability which ends up in stepped forward nutrient launch to plant life for elevated yield. The sizable superb yield reaction of Cucumber to NPK should possibly attributed to the function of implemented NPK in improving manufacturing of assimilates in the course of boom and consequent partitioning of those assimilates to Cucumber fruits. Shehata et al. (2012) stated that better NPK fertilizer doses resulted to boom withinside the uptake of N, P and K vitamins which superior the Cucumber yield.

Table 1: Physical and chemical properties of experimental sites soil during 2019/2020 dry session.

	2021	**2022**
	0–30cm depth	
Particles size Analysis		
pH	6.60	6.11
Organic Carbon %	1.04	0.87
Organic Matter %	1.79	2.01
Total N %	0.084	0.093
P mg/kg	0.93	1.05
Ca (Cmol/kg)	0.50	0.78
Na Cmol/kg	0.52	0.62
Mg Cmol/kg	0.80	0.74
K Cmol/kg	1.95	2.56
CEC Cmol/kg	8.40	8.94
Sand %	63.3	61.7
Silt %	24.9	28.2
Clay %	11.8	10.1

Table 2: Chemical Composition of poultry manure (PM)

Parameters	**Poultry manure**	**Parameters**
	2021	**2022**
O. C (g kg^{-1})	3.26	3.26
P^H	6.20	6.20
T. N(mg kg^{-1})	1.83	1.83
Na (mg kg^{-1})	140	140
K (mg kg^{-1})	2500	2500
Ca (mg kg^{-1})	0.55	0.55
P (mg kg^{-1})	8.04	8.04

Means followed by the same letter (s) in a treatment group are not significantly different at 5% level of significance using DNMRT, NS: not significant at 5% level of significance, *: significant at 5% level of significance.

Table 3: Vine length and Crop Growth Rate of Cucumber varieties as influenced by NPK (15:15:15) and Poultry Manure (PM) during 2021/2022 rainy season.

Treatment	Vine Length (cm)				Crop growth rate ($gm^{-2}day^{-1}$)			
	2021		2022		2021		2022	
	6WAS	8WAS	6WAS	8WAS	8WAS	10WAS	8WAS	10WAS
Fertilizer								
Control	7.48^{c}	19.56^{b}	7.67^{b}	45.78^{b}	1.60^{c}	0.99^{d}	0.71^{a}	2.00^{a}
Poultry manure	12.35^{a}	37.94^{a}	15.40^{a}	75.89^{a}	2.16^{bc}	1.09^{b}	0.81^{a}	2.08^{a}
NPK (15;15;15)	10.29^{b}	33.11^{c}	15.51^{a}	69.20^{a}	3.71^{a}	1.03^{c}	0.81^{a}	2.30^{a}
SE±	**0.46**	**1.85**	**0.70**	**1.23**	**0.16**	**0.06**	**0.06**	**0.07**
Variety								
Darina	11.29^{a}	39.54^{a}	17.56^{a}	62.75^{b}	2.60^{a}	1.04^{b}	0.77^{a}	2.17^{a}
Market-more	10.53^{b}	34.75^{ab}	18.72^{a}	75.57^{a}	2.95^{a}	0.74^{ab}	0.80^{a}	2.01^{a}
Pointsett-75	12.17^{a}	28.43^{b}	15.13^{b}	71.50^{ab}	3.20^{a}	1.43^{a}	1.09^{a}	2.43^{a}
SE±	**0.34**	**1.38**	**0.52**	**0.92**	**0.02**	**0.01**	**0.04**	**0.05**
Interaction								
Fert x Var	NS	NS	NS	*	NS	NS	NS	NS

Means followed by the same letter (s) in a treatment group are not significantly different at 5% level of significance using DNMRT, NS: not significant at 5% level of significance, *: significant at 5% level of significance.

Treatment	Mean fruit length (cm)		Mean fruit diameter (cm)		Total Number of fruit plant^{-1}		Fruit yield tha^{-1}	
	2019	**2020**	**2019**	**2020**	**2019**	**2020**	**2019**	**2020**
Fertilizer								
Control	11.78^{d}	18.59^{b}	3.30^{c}	4.56^{b}	9.73^{d}	13.49^{c}	1.58^{c}	5.90^{c}
Poultry manure	16.68^{b}	20.27^{a}	5.51^{a}	6.29^{a}	19.70^{a}	18.38^{ab}	4.59^{a}	15.84^{a}
NPK(15;15;15)	15.97^{c}	19.69^{ab}	5.22^{b}	6.14^{a}	13.29^{b}	21.36^{a}	4.35^{b}	16.74^{a}
SE±	**0.29**	**0.15**	**0.06**	**0.04**	**0.86**	**0.74**	**0.66**	**0.66**
Variety								
Darina	14.65^{b}	19.87^{a}	5.03^{a}	6.01^{a}	12.30^{c}	15.25^{b}	4.19^{a}	11.92^{b}
Market-more	17.13^{ab}	19.43^{a}	4.96^{a}	5.96^{a}	15.33^{b}	21.92^{a}	4.13^{a}	18.86^{a}
Pointsett-75	16.28^{b}	19.11^{a}	5.14^{a}	6.13^{a}	16.01^{a}	14.12^{b}	4.28^{a}	13.33^{b}
SE±	**0.22**	**0.11**	**0.05**	**0.03**	**0.64**	**0.06**	**0.04**	**0.46**
Interaction								
Fert x Var	NS	NS	NS	NS	NS	NS	*	*

Means followed by the same letter (s) in a treatment group are not significantly different at 5% level of significance using DMRT, NS: not significant at 5% level of significance, *: significant at 5% level of significance.

Interaction

The full-size interplay among range and natural and inorganic fertilization on Vine period and Fruit yield (Table five and Table 6). Have really indicated the interdependence and complimentary position of fertilization and range in influencing the manifestation of the potentials of Cucumber types in phrases of boom, improvement and yield as pronounced through Umeh (2018) and Shehata et al. (2012). Point sett range attained better boom in phrases of Vine duration with the software of Poultry manure (Table five). Market greater range attained better yield with the software of Poultry manure and Cow dung. This is probably because of quick mineralized and better nitrogen content material of Poultry manure (Table 6) and ample availability of vitamins from each Poultry manure and Cow dung that more suitable the boom and improvement of Cucumber through growing the price of plant metabolic strategies like photosynthesis and breathing which in flip helped to construct the plant tissue. Similar end result become said through Shehata et al. (2012).

Table 5: Interaction of variety and fertilizer on plant height at 8WAS, at 2022 trial during 2021/2022 rainy season

Variety			
Fertilizer	**Darina**	**Market-more**	**Pointsett-75**
Control	45.661^{f}	56.333^{d}	48.333^{e}
Poultry manure	72.667^{bc}	75.333^{b}	79.667^{a}
NPK(15;15;15)	61.667^{cd}	74.600^{bc}	71.333^{bc}
SE±	**1.069**		

Means followed by the same later (s) are not significantly different at 5% level using DMRT

Table 6: Interaction of variety and fertilizer on Cucumber yield during 2021/2022 rainy season

Fertilizer	**Variety**		
	Darina	**Market more**	**Point sett**
2019			
Control	1.556^{c}	1.250^{c}	1.094^{c}
Poultry manure	4.528^{ab}	4.722^{a}	4.528^{ab}
NPK(15;15;15)	4.563^{ab}	4.278^{b}	4.194^{b}
SE±	**0.614**		
2020			
Control	5.778^{fg}	6.694^{f}	8.306^{e}
Poultry manure	13.556^{cd}	18.278^{b}	15.667^{c}
NPK(15;15;15)	13.667^{cd}	19.056^{ab}	17.500^{bc}
SE±	**0.367**		

Means followed by the same later (s) are not significantly different at 5% level using DMRT

CONCLUSION

Based at the results, it can be concluded that, each poultry manure and NPK mineral fertilizer have fantastically the identical ability as reassets of vitamins on increase and yield of cucumber, however but thinking about the bad environmental consequences and value of the later, poultrymanure might be recommended. Furthermore, sorts Market-more and Pointsett-75 are higher than Darina in phrases of yield.

RECOMMENDATION

From the findings of this take a look at, the subsequent suggestions might be made:

a. Application of both chicken manure or NPK fertilizer can be followed for better Cucumber fruit yield withinside the take a look at area.
b. Variety Market-more can also be taken into consideration because it recorded advanced overall performance a few of the types examined withinside the look at area.

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FERTILITY AND POPULATION IMPACT ON SEED AND SEED YIELD COMPONENTS: THE CASE OF THREE OKRA (*Abelmoschus esculentus* (L.) Moench) VARIETIES IN THE NORTHERN GUINEA SAVANNAH

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ABSTRACT
Two trials were conducted during the 2016 rainy season at the Institute for Agricultural Research (IAR) farm, Samaru and the experimental site for Kaduna Agricultural Development Project (KADP) located at Maigana, Soba Local Government Area in the Northern Guinea Savannah zone of Nigeria to evaluate the impact of fertility and population on okra seed Varieties. The treatments consisted of three okra varieties, four poultry manure rates and two stand densities. The experiment was laid out in a Randomized Complete Block Design (RCBD) with treatments combined and replicated three times at both locations. Based on the results obtained in this study, Yar`balla variety at 2 plants per stand using 6 t ha^{-1} poultry manure gave more seed yield and could therefore be used by farmers to enhance okra seed production in the Northern Guinea Savannah during the rainy season.
Keywords*: seed; yield; density; variety; yar`balla*

INTRODUCTION

Okra (*Abelmoschus esculentus*) is referred to as "a perfect villager's vegetable" because of its robust, productive, fast growing, high yielding nature, fiber content and distinct seed protein (Sanjeet *et al*., 2010). The word "*Abelmoschus*" was gotten from the Arabic word "abu-l-mosk" which means "father of musk" referring to the scent of the seeds while *esculentus* means "full of food". This characteristic is most clearly seen in *Abelmoschus moschatus*. The origin of okra can be traced to Ethiopia (Sathish & Eswar, 2013) from where it spread to the Arabian Peninsula via the red sea, re-entering northern Africa through the Sahara, east into India and South-east Asia (Smith., 2019). 2021 production statistics shows that Nigeria is the second largest producer of okra in the world producing an estimated 1.8 million tonnes per annum, placing the country at second place after India with 10.8 million tonnes per annum (KNOEMA). Okra lays claim to nutritional and medicinal qualities that remain obscured. It has a panoply of culinary traditions all over the world; perhaps the reason why the American college of health care sciences named it a superfood. Among its useful food products are pods, leaves, seeds, industrial fiber and pharmaceuticals. While the unsubstantiated claim that Yang Guifei of China and Cleopatra of Egypt `s outstanding beauty is attributed to their high rate of okra consumption, it is interesting to note that okra`s slime (mucilage) could be the next aloe Vera for skin and hair care (Smith., 2019).

The real substantial food value for okra is found in the ripened seeds which contain oligomeric catechins (2.5 mg/g of seeds) and flavonol derivatives (3.4 mg/g of seeds) while its mesocarp mainly contains hydroxycinnamic and quercetin derivatives (0.2 and 0.3 mg/g of skins). These properties along with the high amount of carbohydrates, proteins, oil content and quality similar to that of soybean enhance its importance in the human diet (Adetuyi *et al*., 2012). The amino acid pattern of the protein renders it an adequate supplement with legumes or cereal based diets (Ndangui *et al*., 2010). Okra seeds have huge potentials to be used; they may be dried and used to prepare vegetable curds, grilled and consumed, roasted and grinded to form or fortify flour (Adelakun *et al*., 2008) and used as caffeine-free substitute for coffee; one of the world`s most consumed beverages (Olivia, 2017). It has industrial applications and is used in confectionaries (Adetuyi *et al*., 2011).

Okra has been considered a minor crop and only little attention is paid to it in the national and international research programs (Schalau, 2002). There is need for more research on okra especially with its seed`s fast growing importance. There is available information on the potential fruit yield of some cultivated okra varieties in the Northern Guinea Savannah region (Okutu and Anika 2010). However, the production of okra seed by farmers is constricted by the dearth of information on high seed producing varieties and thus, warrants the need to find out whether the available varieties in the northern Guinea Savannah could be cultivated efficiently with higher seed yield to meet its increasing domestic and international demands and at the same time produce a healthy alternative to one of the world's most consumed beverages; coffee (Reyes and Cornelis, 2018).

Optimum seed yields have not been attained as a result of continuous decline in soil fertility and decreased use of organic amendments (Akanbi *et al*., 2010). Owing to the growing human and environmental health concerns associated with the use of inorganic fertilizers, there is a need for increased use of organic resources for soil enrichment and improving the productivity and sustainability of already impoverished Savannah soils (Khan *et al.,* 2018). Despite the high nutritive value of okra seeds, organic fertility regimes for high seed production in the Northern Guinea Savannah is yet to be established. Under conditions of sufficient soil moisture and nutrients, suitable population is necessary to efficiently and subsequently produce high seed yields since land is a limiting factor in agricultural production (Danylenko *et al*, 2018). With increasing density, seed yield per unit area increases up to a certain limit, beyond which resources for plant growth and development becomes limited and yield decreases. Therefore, proper stand density is required to attain optimum growth and development of okra that will result in higher seed yield. The result of this research has the potential to advance and transform okra seed production in the Northern Guinea Savannah as it will enable farmers to maximize profit via producing seeds in large quantities by identifying the best variety, the right nutrient regimes and the population density that will produce the highest seed yields. It is in the light of the above that this study was conducted.

MATERIALS AND METHODS

Trials were conducted during the 2016 rainy season at two sites; the Institute for Agricultural Research (IAR) farm, Samaru (11^0 11`N, $7^0$ 38`E and 686m above sea level) and the experimental site for Kaduna Agricultural Development Project (KADP) in Maigana, Soba local Government Area (11^0 39`N;$08^0$ 02`E, 500m above sea level) in the Northern Guinea Savannah zone of Nigeria. The treatments consisted of three varieties of okra (Jokoso, Clemson spineless and Yar`balla), four rates of Poultry manure (0, 2, 4 and 6) t ha^{-1} and two Stand densities (1 and 2) plants per stand (38,167 and 76,334 plants ha^{-1}). Composite soil samples were collected using an Auger at 0-30 cm depth at 4 different points prior to land preparation from each experimental site and analysed in the laboratory for its physico-chemical properties as described by Black, (1965). The poultry manure was also analysed in the laboratory to determine its chemical constituents. The experiment was laid out in a Randomized Complete Block Design (RCBD) with treatments combined, arranged factorially and replicated three times at both locations. Each gross plot was 4.5m x 3m long (13.5m^2) at 75cm and 35cm inter and intra row spacing respectively. Each plot consisted of 6 ridges with the two inner ridges constituting the net plot.

The experimental sites were harrowed and ridged at 75cm apart before planting. A border of 0.5m separated each plot from another while one unplanted ridge separated the replicates. Poultry manure was incorporated into the soil on treatment basis. The ridges were opened at about 15cm depth at the side and manure was measured and incorporated into the soil two weeks before sowing. Okra seeds were dressed with Apron Star 50DS at the rate of 10 g per 4 kg for each variety before sowing. Five seeds were sown per hole at intra row spacing of 35cm on the ridges at both sites. The seedlings were thinned on treatment basis to 1 and 2 plants per stand at two weeks after sowing in both locations. Sowings was done after soaking the seeds in warm water (35^0C) for 6 hours to accelerate and enhance uniform germination. Glyphosate at 1.4 kg ai ha-^{1} was applied prior to land preparation at the rate of 300 ml in 20 L of water to control the emerged weeds before sowing was done at both sites. During the growing period, hoe weeding was done to control emerged weeds at 3, 5 and 7 WAS. A broad spectrum insecticide, Permethrin, was applied at the rate of 300 ml of the formation to 20 litres of water and applied five times during plant growth at five-day interval due to heavy insect pest infestation. It started at 3 weeks after emergence and ended before fruiting (about 6 WAS). Harvesting started at 6 WAS with a picking interval of four days. It terminated at about 9 WAS with a total of 6 harvests in each location. Five plants were randomly tagged from each plot in both sites. Observations on parameters such as number of fruit per plant, number of seeds per pod, seed yield per hectare were carried out. The data collected were subjected to Analysis of Variance (ANOVA) using F-test and the significant differences among the treatment means were compared using Duncan Multiple Range Test (DMRT) as described by Duncan (1955).

RESULTS AND DISCUSSION

Both physical and chemical properties of the soil at the experimental sites at 0-30 cm depth and elemental composition of the poultry manure used are presented in Tables 1 and 2 respectively. The results of the soil analysis indicated that the textural class for the soils at Samaru and Maigana were loam soils. The analysis showed that the soil used in Samaru was moderately acidic while that of Maigana was slightly acidic. The soils were moderate in organic carbon and phosphorus and low in total nitrogen. Exchangeable bases in Samaru were higher than those in Maigana. Calcium and potassium were moderate in both locations while magnesium and sodium were high in samaru, cation exchange capacity was low in Maigana. Chemical properties of the poultry manure (Table 2) used showed a moderate amount of potassium, calcium, phosphorus and sodium while magnesium was low. The nitrogen content in the poultry manure was high.

Table 1: Physical and Chemical Properties of Soil in the Experimental Sites at 0-30cm depth.

Physical properties	**Samaru**	**Maigana**
Sand	430	530
Silt	460	350
Clay	110	120
Textural class	Loam	Loam
Chemical composition		
PH in water (1:2.5)	5.28	6.05
PH in 0.01M$CaCl_2$ (1:2.5)	5.83	5.89
Organic carbon (g kg^{-1})	1.26	1.10
Total nitrogen (g Kg^{-1})	0.43	0.60
Available phosphorus (mg Kg^{-1})	18.31	17.36
Exchangeable bases (cmol Kg^{-1})		
Calcium (Ca)	3.60	3.22
Magnesium (Mg)	1.70	0.80
Potassium (K)	0.22	0.17
Sodium (Na)	0.40	0.23
Cation Exchange Capacity	6.04	4.42

Analyses conducted by Agronomy Departmental laboratory, ABU, Zaria.

Table 2: Elemental Composition of Poultry Manure used for the Experiment during the 2016 rainy season at Samaru and Maigana.

Nutrients	**Amount %**
Total K	1.67
Total C	1.73
Total Mg	0.62
Total Na	1.45
Total N	2.87
Total P	2.10

Analyses conducted by Agronomy Departmental laboratory, ABU, Zaria.

The effects of poultry manure on number of fruits per plant, number of seeds per pod and seed yield per hectare of okra varieties during the 2016 rainy season in Samaru and Maigana are shown in Table 3. The result shows a significant difference in okra fruit number per plant for the three varieties at both locations. Yar`balla and Jokoso produced statistically highest and lowest number of fruits per plant respectively in both locations. Application of poultry manure was observed to significantly increase number of fruits per plant up to 6 t ha^{-1} at Samaru while at Maigana, the control and 2 t ha^{-1} were similar but significantly lower than 4 t ha^{-1} which was also lower than 6 t ha^{-1}. There was no significant increase in the number of fruits per plant when stand density was increased from 1 to 2 plants per stand at both locations.

The effects of poultry manure and stand density on number of seeds per pod of okra varieties during the 2016 rainy season at Samaru and Maigana show that Yar`balla produced the highest number of seeds per pod followed by Clemson spineless and Jokoso at both locations. There was significant difference in the number of seeds per pod with varying poultry manure rates in both locations. Application of 4 and 6 t ha^{-1} poultry manure produced statistically equal and highest number of seeds per pod in Samaru. However, this was not the case in Maigana where application of 6 t ha^{-1} produced the highest number of seeds per pod with 2 and 4 t ha-^{1} application producing statistically equal number of seeds per pod. The control (0 t ha-^{1}) produced the lowest number of seeds in both locations. A significant decrease was observed in number of seeds per pod when stand density was decreased from 2 to 1 plant per stand in Samaru.

The result shows that Clemson spineless and Jokoso produced statistically equal seed weight which was lighter than that of Jokoso in both locations. Application of 0, 2 and 4 t ha-^{1} poultry manure produced statistically equal seed weight in Samaru but were statistically similar in maigana. Application of 6 t ha-^{1} produced the heaviest seed weight per hectare in both locations. There was a significant increase in seed weight per hectare when stand density was increased from 1 to 2 plants per stand.

Table 3: Impact of Poultry Manure and Stand Density on Number of fruit per plant and the Number of Seeds per Pod of okra Varieties during the 2016 rainy season at Samaru and Maigana.

Treatment	**Number of pods per plant**		**Number of seeds per pod**		**Seed yield per hectare**	
	Samaru	**Maigana**	**Samaru**	**Maigana**	**Samaru**	**Maigana**
Variety						
Yar`balla	16.00a	14.00a	119.00a	99.00a	4153.00a	2815.00a
Clemson spineless	15.00b	12.00b	100.00c	91.00c	3221.00b	2201.00b
Jokoso	14.00c	11.00c	108.00b	96.00b	3171.00b	2124.00b
SE $\pm$	0.648	0.562	3.335	4.119	75.540	50.060
Poultry manure (t ha^{1})						
0	13.00d	11.00c	107.00b	84.00c	2788.00b	1798.00c
2	14.00c	11.00c	109.00ab	95.00b	3170.00b	2102.00b
4	15.00b	13.00b	111.00a	98.00b	3582.00b	2652.00ab
6	17.00a	14.00a	111.00a	105.00a	4394.00a	3224.00a
SE	0.748	0.650	3.851	4.756	249.447	176.686
Stand density						
1	15.00b	12.00b	111.00b	96.00b	3273.00b	2773.00b
2	24.00a	18.00a	167.00a	162.00a	5763.00b	4618.00a
SE $\pm$	0.529	0.459	2.723	3.363	70.361	48.095
Interaction						
M x V	NS	NS	NS	NS	NS	NS
M x D	NS	NS	NS	NS	NS	NS
V x D	NS	NS	NS	NS	NS	NS
M x V x D	NS	NS	NS	NS	NS	NS

Means followed by the same letter within a treatment group are not significantly different at 0.05 level of probability
V = Variety, M = Poultry manure, D = Stand density, NS=Not Significant.

DISCUSSION AND CONCLUSION

The significant differences recorded on seed and seed components of the three okra varieties (yar`balla, Clemson spineless and Jokoso) are ascribed to the differences in their genetic component/structure of the varieties used which are attributed to their individual phyllotaxy, light interception and absorption by the leaves, rate of nutrient absorption and utilization, efficiency and transformation of solar energy to chemical energy, efficiency of carbon assimilation, distribution of assimilates to storage points, time taken to produce yield factor and the respiratory losses that take place during the course of their growth and development. These differences are influenced by the dynamics in the climatic and soil factors which they are exposed to, resulting in the production of pods and seeds of various sizes and quantities (Kinder and Umbreen., 2010).

The physical and chemical properties of the soil (Table 1) shows that the Cation Exchange Capacity (useful indicator of soil fertility) for the soil in Maigana was low as compared to that of Samaru which was moderate. This may be the reason for better seed and seed yield components in Samaru than Maigana. This is in line with the studies of Hazleton and Murphy (2007) who stated that Cation Exchange Capacity is an essential soil property that influences nutrient availability, soil pH and soil`s reaction to fertilizers which are all important determinants of crop growth, development and yield.

The number of pods per plant increased with increase in poultry manure application in Samaru. This could be attributed to the high nitrogen content in the poultry manure used as indicated in Table 2 and the beneficial role of manure in mineralization and enhancing soil essential nutrients like nitrogen, phosphorous and potassium for uptake which is essential for vegetable growth and chlorophyll formation as well as promoting root development (Eghball *et al.,* 2002). Manure when decomposed, increases both micro and macro nutrients as well as enhances physico-chemical properties of the soil. Dademol *et al.* (2004) reported that nitrogen content in organic fertilizers enhanced leaf area production, flowering and seed formation in okra. This can be attributed to the fact that poultry manure contains appreciable amounts of magnesium which promotes chlorophyll synthesis that drives photosynthesis. This result is in agreement with the findings of Nehra *et al*. (2001) who stated that higher yield response due to organic manure application is attributed to the improvement of physical and biological properties through mineralization of the soil which resulted in better supply of nutrients that led to better crop yield.

The positive effect of poultry manure on seed components could be due to the contribution made by the manure to the fertility status of the soils. A significant increase was recorded in seed weight per hectare when stand density was increased from 1 to 2 plants per stand. This is due to more number of plants (2 plants per stand) per unit area. This could also be as a result of the higher efficiency of the leaf area for the lower plant population to intercept more solar radiation needed for the production of photosynthate required by okra for seed production. This supports the view of Vargas *et al.,* (2002) who stated that light interception and subsequent growth and development are functions of leaf area index and stand density. It could also be that the adaptation of the varieties to 2 plants per stand in this study which was lower than 111,000 plants ha-^{1} at which Amjad *et al*. (2001) recorded maximum seed yield.

Based on the results obtained in this study, Yar`balla variety at 2 plants per stand using 6 t ha^{-1} poultry manure gave more seed yield and could therefore be used by farmers to enhance okra seed production in the Northern Guinea Savannah during the rainy season.

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PREFERENCE OF HERBAL MEDICINE OVER CONVENTIONAL MEDICINE AMONG ADULT RESIDENTS IN IBADAN METROPOLIS

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ABSTRACT
This study focuses on preference of herbal medicine over conventional medicine among adult residents of Ibadan Metropolis, Oyo State, Nigeria. A total of 200 questionnaires were randomly administered to adult residents in the study area. Descriptive statistics (such as percentages, frequencies) and inferential statistics (correlation analysis) was used for the study. The study shows that there is no significant relationship between perception and use of herbal medicine among residents in Ibadan metropolis. The result also revealed that 51.1% were married, 60% of the respondents were educated of which 36% were (HND/B.Sc) and 24% were Masters' degree holders. Also 17.5% prefer herbal medicine because it is cheap and 16% preferred herbal medicine because it is effective. It is therefore recommended that medical health practitioners need to be conversant with herbal medicines and users of herbal medicine should also consult health care professionals before using herbal medicine.
Keywords: *health care professionals; herbal medicine; Ibadan Metropolis; perception*

INTRODUCTION

Herbal medicines are plant based medicines made from different plant parts, examples; roots, leaves, flower or the whole plant. Each part can have different medicinal uses and the many types of chemical constituents require different extraction method (National Institute of Medical Herbalists). Herbal medicine has its roots in every culture around the world, from the Greeks, to the Celts, the Romans to the Arabs, and the Chinese and even to the Indians (Phair, 2021; truechi.com). Since ancient times, humans have been using natural products such as plants, animals, microorganisms and oceanic organisms, in remedies for prevention and treatment of various aliments (WHO, 2013 and Saad et al., 2015). According to WHO, 65-80% of the world's healthcare practice includes the use of traditional medicine in some way (Pan et al., 2014). The world health organization (WHO) estimates that 80% of the world population relies on complementary and alternative medicines (CAM) or traditional medicine. According to Islahudin, (2017) approximately 70% of the world's population from developing countries prefer herbal medicinal products as a primary source of healthcare. African continent is said to have a long history with the use of plants for medicinal purposes. (Lawal et al., 2009). Africa is a continent endowed with an enormous wealth of plant resources. Over 5,000 different species are known to occur in the forest regions alone, most of these have been used for several centuries in traditional medicine for the prevention and treatment of diseases, this is because traditional medicine is often part of the peoples culture, and as a result it is closely linked to their beliefs (Lawal et al., 2009).

Herbal remedies are usually preferred over conventional medicine as it is perceived to be important for reasons of health and well-being. Herbal remedies have been in use for thousands of years by indigenous tribes and cultures like the Africans, Indians and Chinese. Before the introduction of conventional medicine in the West, our pharmacist (apothecaries) were full of medicinal herbs and folk therapies. While some of the weird treatments are unfounded, many of the ingredients used by our ancestors have been proven to have therapeutic effects. This study is aimed at assessing the usage and preference of herbal medicine over conventional medicines. The result of this study can be used as input for policy makers and other stakeholders to identify and prepare directives to control and legalize herbal medicine practice. The general objective of the study is to ascertain why residents in Ibadan metropolis prefer the use of herbal medicine to conventional medicine.

Study Area

The study was carried out in Ibadan metropolis, the capital of Oyo State, Southwest Nigeria, located on seven hills (average elevated 700 feet (200 meters) 100 miles (160 km) from the Atlantic coast. The 2006 national population census estimated the metropolis to be inhabited by 1.34 million people (NPC, 2006). Politically Ibadan metropolis is made up of five urban local governments, Ibadan North, Ibadan Southeast, Southwest, Northeast and Northwest (Tunde-Francis et al., 2020).

Method of Data Collection and Analysis

A well- structured questionnaire was randomly administer to 200 respondents in the study area. Descriptive statistics (such as percentages, frequencies) and inferential statistics (correlation analysis) was used to ascertain preference and usage

RESULT AND DISCUSSION

Table 1 showed that majority (55.5%) of the respondents were females, this is in concordance with other studies where the percentage of people who use herbal medicine is higher in female than male (Aydin et al., 2008). Females have used complementary and alternative medicine (CAM) in the prevention or treatment of illnesses, this also corroborates by Westfall (2003) who also found that women consider herbs to be safer because they are “milder”, more “natural”, “simpler”, more “familiar” and caused fewer side effects. The study also revealed that most of those who use herbs fall in the age range between 20-30, this shows that youths and young adults are now embracing the use of alternative medicine and most have used a form of herbal medical product to cure one illness or the other. The results also show that 78.5%) of the respondents had tertiary education this is an indication that a lot of educated and enlightened people now patronize herbal medicine practitioners. This finding agrees with that of Venkatesh and Garampalli, 2023) that the educated, middle class have turned to herbal remedies and botanicals all over the world.

Table 2 shows other reasons for pivotal to use herbal therapies by the respondents as follows; because it is cheaper (17.5%), less expensive and at the same time effective (16.0%), natural compare to conventional treatment with 14.0%, conventional drugs are too expensive with (12.0%), presence of different phytochemicals (8.0%), mixed with conventional drugs and have strong belief in natural medicine compare to chemicals(6.0%),respondents was forced to use it and to boost the immune system (5.5%), 5.0% of the respondents did not want to take drug but since it was recommended by an old adult. This corroborates the findings of Yinger and Yewhalaw (2007) that traditional medicine has remained the most affordable and easily accessible source of treatment in primary health care system of poor communities where alternative therapy is the major means of medical treatment in such communities. The potency of such alternative medicine in African traditional communities cannot be over-emphasized. This is why Adefolaju (2014) believes that Nigerians, have a deep belief and reliance on traditional medicine, hence about 80 per cent of the population use it almost exclusively while about 95 per cent use it concurrently with western medicine, because to the Nigerian, traditional medicine treats the entire individual rather than one aspect of him or just his disease.

From Table 3, it shows that there is no perceived benefit/health benefit of herbal medicine to users in Ibadan metropolis. Majority, (95.0%) disagreed that it will relieve symptoms of conventional treatment which they are receiving by indicating “NO”, followed by 79.5% respondents that disagreed that it will improve your psychological/emotional wellbeing (hope, optimism) with (Mean=1.80), followed by 78.5% of the respondent who that disagreed that it will allow you to relax and sleep and it will relieve the symptoms of the illness with (Mean=1.79), followed by 72.0% respondents that disagreed that, to do everything possible to fight the illness with (Mean=1.72), followed by 61.5% respondents that disagreed that it will improve your physical well-being with (Mean=1.62) and 56.5% of the respondents disagreed that it will boost your body’s ability to fight disease(1.57) respectively. This corroborates with the findings of Chitty (2009), Hoslt et al, (2009), and Fakeye et al. (2009), that people also use herbal medicine because of the perception that, it is a safe alternative to conventional pharmaceuticals. Moreover, Welz et al.(2018) opined that people also turn to herbal medicine because they are dissatisfied with the care they received from mainstream/conventional/western medicine especially among those with terminal disease or chronic illness.

Based on the findings, there is no significant relationship between perception and use of herbal medicine among residents in Ibadan metropolis. This is supported by Adesina, (2014) who reported that herbal medicine which is an aspect of alternative medicine is a cultural gem of various communities around the world

CONCLUSION

The role played by herbal medicine in the contemporary health care setting can no longer be dismissed as mere vogue accessed by the uneducated and less privileged. It is definite that people use herbal medicine to treat illnesses despite lack of scientific evidence of safety. It is therefore recommended that health care providers especially, medical health practitioners need to be conversant with herbal medicines commonly used to treat illnesses and rid themselves off misconceptions about herbal medicine. Users of herbal medicine should also consult health care professionals before using herbal medicine to know which to use for a particular illness aside the conventional medical treatment so there will not be counter reactions

Table1: Demographic characteristics of the respondents.

Sex	**Frequency**	**Percentage (%)**
Male	89	44.5
Female	111	55.5
Total	**200**	**100.0**
Age range		
20-30 years	76	38.0
31-40 years	56	28.0
41-50 years	36	18.0
51-60 years	15	7.5
61-70 years	9	4.5
71 years and above	8	4.0
TOTAL	**200**	**100.0**
Marital status		
Married	103	51.5
Single	86	43.0
Widow/Widower	6	3.0
Divorce/Separated	5	2.5
TOTAL	**200**	**100.0**
Educational status		
Primary school certificate	21	10.5
SSCE/WASCE	22	11.0
OND	37	18.5
HND/BS.C	72	36.0
Masters	48	24.0
TOTAL	**200**	**100.0**

Source: Field survey, 2017

Table 2: Preference for herbal therapies

S/N	**Items**	**Frequency**	**Percentage %**
1	Because it is natural compare to conventional treatment	28	14.0
2	Because they have more of the phytochemicals	16	8.0
3	Cheaper	35	17.5
4	Conventional drugs are too expensive	24	12.0

5	Herbal is mixed with conventional drugs	12	6.0
6	Herbal medicine is less expensive and at the same time effective	32	16.0
7	I did not want to take drug	10	5.0
8	I was forced to use it	11	5.5
9	I have strong belief in natural medicine compare to chemicals	12	6.0
10	Recommended by old adult	9	4.5
11	To bust the immune system	11	5.5
	Total	**200**	**100.0**

Source: Field Survey, August, 2017

Table 3: Perceived benefit/health benefit of herbal medicine to users in Ibadan metropolis

S/N	Items	YES	NO	Mean
1	it will directly heal your illness	95(47.5%)	105(52.5%)	1.53
2	it will boost your body's ability to fight disease	87(43.5%)	113(56.5%)	1.57
3	it will allow you to relax and sleep	43(21.5%)	157(78.5%)	1.79
4	it will relieve symptoms of conventional treatment which you are receiving	10(5.0%)	190(95.0%)	1.95
5	it will relieve the symptoms of the illness	43(21.5%)	157(78.5%)	1.79
6	it will improve your psychological/emotional wellbeing (hope, optimism)	41(20.5%)	159(79.5%)	1.80
7	to do everything possible to fight the illness	56(28.0%)	144(72.0%)	1.72
8	it will improve your physical well being	77(38.5%)	123(61.5%)	1.62

Table 4 PPMC summary table showing the relationship between perception and usage of herbal medicine

Variables	N	Mean	Std. Dev	Df	R	P	Sig
Perception of herbal medicine	200	45.6350	11.26795				Not
Use of herbal medicine	200	41.7250	8.88109	198	.038	.593	Sig.

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PERCEPTION OF URBAN GREEN PARK IN IBADAN METROPOLIS OYO STATE

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ABSTRACT
The study examined the perception of urban green park in Ibadan metropolis Oyo state, Nigeria. Structured questionnaire were administered to eighty respondents. Descriptive statistics and logit regression were used to analyze the data. The result showed that nature friendly environment is one of the major factors that may influence the respondents visit to the park. The logit regression shows that age, gender, educational qualification, monthly income, marital status and awareness of the park variable were not statistically significant. Only the variable "Need for the park was statistically significant which means the odd that respondents will be willing to support conservation of the park. Based on the study it was observed that most of the respondents appreciate nature friendly environment and are willing to support conservation of the nature park.
Keywords: *Perception, urban, Green park, Ibadan*

INTRODUCTION

Green Park is a powerful tool in counteracting urban health dilemma. It is a land partly or completely covered with grass, trees, shrubs or other vegetation. Its presence in an area can serve a lot of benefit like providing recreational space for residents, improving physical activity, improve psychological well-being, enhance air and water quality, build climate resilience to flood risk and heat stress Its principally improves the quality of life of the citizen and contribute to the sustainable development of cities People who have more access to green environments tend to walk and be more physically active than those with limited access. Research has shown that when people are exposed to prolonged periods of excessive heat it creates health issues. This problem is made far worse when there is an absence of vegetation. In the face of expanding urbanization and urban population, which have adverse impact on environmental sustainability (Haq, 2011), green infrastructure is considered one of the best planning tools for adaptation to climate change (Yiannakou and Salata 2017). Studies have shown that lands with trees and vegetation produce more relaxed physiological states in people than lands that lack these natural structures, while supporting ecological constancy by providing habitats for wildlife, conserving soil, and enhancing bio-diversity.

In Nigeria, urban green areas are scarce and well below the acceptable standards (9m^2 of green space per city dweller), as suggested by the World Health Organization (WHO, 2010). Despite all the apparent benefits of urban green space the development of a long-term planning strategy for urban green structure has never been a key priority for local (city and regional) policy makers. In light of the above, it is now predominantly essential to incorporate citizens' concerns, preferences and perceptions into the decision-making and planning processes regarding urban green infrastructure. The benefits derived from urban green area and their objective properties should be understood individually (Kothencz and Blaschke 2017). There is need to examine the perception of open green spaces.to encourage and promote green area.

METHODOLOGY

Study area

The study area is Agodi gardens and park. The garden is located in Ibadan North Local Government area. Agodi garden is situated near the Oyo state secretariat complex. It stands out as a green lung in the surrounding urban landscape with a great recreational potential. The garden was established as a biological and relaxation centre to provide recreational as well as educational services for inhabitant and visitor. In 1967 it lost it glory as a foremost centre particularly following its destruction by the famous 1980 flood disaster dubbed Omiyale that swept through the ancient city. The Agodi garden of Oyo state has been completely renovated to contain a zoo, swimming pool, bar and restaurants. It equally contains an indigenous forest, lake, tree plantation, and an abundant of medicinal plants and some rare tree species.

RESULTS AND DISCUSSION

Table 1 shows that most of the respondents are female (52.6%) this may be due to the fact that female like outing and excitement. This is in line with Ode Sang et al. (2016) who identified that women associate a greater sense of well-being with urban green area than men. In this sample size it was also observed that (40%) were married. High percentage of the respondent have formal education, (34%) have HND/B.Sc and (34%) have postgraduate degrees. This may be due to the fact that they are more enlightened about the need and benefit of recreation. (39.8%) of the visitors to the site are business men and women. This may be due to the nature of their job (not stereotype). It was also revealed that the middle age classes (31-50) have the highest visit to the park. this may be due to the fact that they are in their active age.

The result in table 3.0 revealed the perceived factors that influences visit to the park (that is those in the park during the administration of the questionnaire. (33.3%) consider proximity as one of the factors that influences their visit and 46% consider services rendered as one of the factors that influences their visits to the park, Also, 39.7% sees facilities in the site as one of the factor that influences their visit), 43.6 % consider accessibility as one of the factor that influences their visit. Most of the respondents (60%) see nature friendly environment as a factor that influences visits to the park. 44.9% consider cost of transportation as one of the factor that influences their visit. 34.6% consider health benefit as one of the factor that influences their visit, 52.6% consider relaxation as one of the factor that influences their visit while 50.6% consider fun and entertainment as one of the factor that influences their visit to the park. From the table above it was observed that majority of the respondent appreciate green environment.

From the logistic regression result, age, gender, educational qualification, monthly income, marital status and awareness of the park variables were not statistically significant. This implies that age, gender, education, marital status, monthly income and awareness of respondent of Agodi park do not have any meaningful influence on the decision of the respondents to support the conservation of the park. Only the variable "need for the park" was statistically significant. This means that the odds that respondents will be willing to support conservation of nature park in Ibadan based on their perceived need for the park is about 17.9 times more than those that will not be willing to support conservation of the nature park.

CONCLUSION AND RECOMMENDATION

The study has clearly shown that recreational park in Ibadan is highly esteemed with great multifarious potentials to meet both the social and economic needs of the teeming Ibadan metropolitan populace. Based on the result it is obvious that most of the respondents will be willing to support conservation of nature park in Ibadan based on the variable "need for the park" that is about 17.9times more than those that will not be willing to support conservation of the nature park. It is therefore recommended that Non-governmental Organization should be encourage to go into the establishment of more urban green recreational park, this will generate income as well as stimulate a clean and healthy environment.

Table 1: Distribution of Demographic characteristic of respondent (visitors in the park)

Variable	frequency	percentage
Gender		
Male	37	47.4
Female	41	52.6
Total	78	100.0
Education status		
Secondary	8	10.25
HND/B.Sc	36	46.15
Postgraduate	34	43.59

Total	78	100.0
Marital status		
single	38	48.72
Married	40	51.28
Total	78	100.0
Occupation		
Government	19	24.42
Private organization	14	17.94
Self employed	14	17.94
Others (business)	31	39.80
Total	**78**	**100.0**
Household size		
1 - 3	17	21.79
4 – 6	44	56.41
7-12	12	15.39
Total	**78**	**100.0**
Age		
13-20	9	11.54
21-30	22	28.20
31-40	27	34.62
41-50	15	19.23
51-56	5	6.41
Total	**78**	**100.0**

Table 2 Respondents perception on factors that influence visits to the park (park user)

Variable	Very well	%	Well	%	**Don't know**	**%**	**Not at all**	**%**
Proximity	23	(29.5)	26	(33.3)	10	(12.8)	6	(7.7)
Services rendered	20	(25.6)	36	(46.2)	10	(12.8)	2	(2.6)
Facilities in the site	26	(33.6)	31	(39.7)	5	(6.4)	8	(10.8)
Accessibility	29	(37.2)	34	(43.6)	4	(5.1)	1	(1.3)
Nature friendly environment	47	(60.3)	26	(33.3)	1	(1.3)	1	(1.3)
Cost of transportation	17	(21.8)	35	(44.9)	8	(10.3)	6	(7.7)
Health benefit	27	(34.6)	23	(29.5}	15	(19.2)	2	(2.6)
Improvement in quality of air	26	(33.3)	30	(38.5)	6	(7.7)	2	(2.2)
Affordability	11	(14.1)	41	(52.6)	2	(2.6)	5	(6.4)
Learning and education	16	(20.5)	32	(41.0)	9	(11.5)	4	(5.1)
Relaxation	41	(52.6)	32	(41.0)	4	(5.1)	1	(1.3)
Fun and entertainment	39	(50.0)	27	(34.6)	2	(2.6)	3	(3.8)

Table 3: Factors determining respondents' willingness to support conservation

	B	S.E.	Wald	df	Sig.	Exp(B)
Age	-.046	.062	.534	1	.465	.955
Gender	-.280	.740	.143	1	.705	.756
Education	.406	.513	.625	1	.429	1.500
Marital status	.170	.292	.339	1	.561	1.185
Monthly income	.000	.000	.939	1	.332	1.000
Park awareness	-18.636	2.838E4	.000	1	.999	.000
Need for park	2.886	1.319	4.789	1	.029	17.928
Constant	-.773	2.212	.122	1	.727	.461

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EFFECT OF DIFFERENT ROOTING MEDIA AND TIME ON ROOTS OF MARCOTTED Citrus sp, *Citrus sinensis,* AT ISHIAGU, EBONYI STATE NIGERIA

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ABSTRACT
This experiment was conducted to study the effect of different rooting media and time on roots number and roots length of marcotted Citrus sp, Citrus sinensis, sweet orange at the Federal College of Agricuture, Ishiagu, Ebonyi State, Nigeria. A factorial experiment fitted into randomized complete block design, replicated four times. Ishiagu is a tropical environment which lies on Latitude 5^0 57^1N and longitude 7^0 34^1E with an annual rainfall of 1350mm with average humidity of 88% and a mean annual temperature of 29^0C. Twenty stems of a year old were marcotted, on stands of sweet oranges at different months, using different rooting media. Twenty grammes each (20 grammes) of dry shredded coconut shaft, fresh shredded coconut shaft, cotton wool (clinical cotton wool), decayed banana trunk all laced with five grammes of top soil and a 25grammes of top soil as control were used. This was replicated on four different stands of sweet oranges. The numbers and lengths of adventitious roots formed after two months of incubation were studied. Data were subjected to statistical analysis of variance (ANOVA) using Genstat® version 3.0 (2003) software package and significant means were separated using least significant difference (LSD) at 5% probability level. The decayed banana trunk/top soil had highest number of roots as well as longest roots length, followed by fresh shredded coconut fibers/top soil, cotton wool/top soil and dried shredded coconut fiber/top soil, all had improved performances on roots number and roots length more than the top soil only which had least performance. The month of October had the highest number of roots and with longest roots, followed by July, April and January which had the least roots number and roots length.
Keywords: *Rooting medium, Marcotting, Shaft, Sweet orange, Decayed trunk*

INTRODUCTION

Sweet orange, *Citrus sinensis* is a hesperidium. It is a vitamin C rich fruit with many branches and with a shrub habit in growth. It grows to a height less than ten meters tall. It comes to fruiting at age of 2-5 years after planting especially when propagated vegetatively, whereas seeded stands come to fruiting at age of 12-15 years (Opeke, 2012). There are many varieties of sweet orange. The species can be propagated by seeds or budding/grafting. Citrus plants are polyembryonic and apogamic. There are large proportions of the seedlings that are identical with the mother plants which provide propagating plants as clones or pure lines. Cross pollination do occur between different species resulting is variations between seed lots of a pure line. Most seeded stands come to fruiting at 12-15 years after planting depending on the variety. Choice varieties are propagated by bud grafting on a hard variety or by gootee (Phillips, 1977 and Mathew *et al* 1990). Uniformity in performance is obtained by using budding. Budded plants come to fruiting earlier than seedlings (Umeokechukwu *et al.,* 2019). Budding is the accepted method of commercial propagation of sweet oranges. This is the union of scion to stock. Root stocks mostly have advantages of being vigorous in growth, disease resistant, adaptable to soil and climatic conditions (Hartmann et al, 2007).

However, some root stocks are affected by Gumosis a fungi disease and Tristeza a deadly virus disease of citrus in Nigeria (Opeke, 2012), prompting the need for selection of root stocks with the ability to withstand and resist prevalent citrus diseases. (Hartmann et al 2007). The scion and root stock do have interaction which is intrinsic and real, as tastes and nutrient constituents of budded sweet oranges are affected. Different root stocks have shown to affect the different nutrient uptakes for elements like P, K, Ca, Ma and Cu (Njoku and Obasi, 1976). The budding position of the scion on the root stock at lower position increases dwarfness while budding at upper part leads to taller ratios. These inadequacies obtained from clonal scion/root stock propagated citrus crops, prompted the need for air layering/ marcotting. Marcotting is a vegetative propagation method in which stems are rooted while still attached to the mother plant (Hartmann et al 2007). The rooted stems/shoots planted out grow into an exact replica of the parent stock, maintain and being exact of the mother plant in genetic constituents. Marcotting produces seedling that grow to resemble the parent plant when established. This is a vegetative propagation method. The advantage of this method is that all the offsprings have exact characteristics of the parent plants (Maarten *et al*., 1994). The fruits size and the shape are almost same as the parent plant. The taste, colour and nutrient constituent remain exact as with the parent plant, as genetic makeup are the same (Umeokechukw *et al*., 2019)

Plants with soft woods are easily layered by bending the shoot/branch down to the ground with a cut or without a cut on the underside and covered with soil. This causes root initiation, but much faster on the underside of the stem. Such stem is cut off after the production of many roots. However, in an upright hard to bend stems this method becomes impossible or hard. At this point, marcotting becomes the alternative method for multiplication. However, in the developing countries like Nigeria marcotting/layering of trees are rarely carried out for tree crop multiplication and pure line maintenance due to constrains of technical knowledge of required rooting medium, lack of rooting hormones, weather variability and unavailability of controlled environment. This experiment was designed to study the best rooting medium and most appropriate time for marcotting of sweet orange in Ishiagu- Ebonyi state.

MATERIALS AND METHODS

This experiment was carried out at the Federal College of Agriculture, Ishiagu Ebonyi State Nigeria. Ishiagu is located on Latitude 5^0 57^1N and longitude 7^0 34^1E with an annual rainfall of 1350mm, it has an average humidity of 88% and a mean annual temperature of 29^0C (Nwite *et al*., 2008) and is situated on a gentle slope topography. It was a randomized complete block design experiment replicated four times. The treatments were rooting media applied at different months of the year (time). Top soil, dry shredded coconut coir, fresh shredded coconut fibers, cotton wool and decayed banana trunk were used to marcott the sweet orange during the months of January, April, July, October, on stems of one year old with equal diameters. The stems of the sweet orange were girdled with cuts of 2cm, made by removing the bark. The bark was removed to expose the phloem vessel and the cambium. The cambium was scraped off, using a bud knife as to avoid healing back. A ball of medium was placed round the girdle surfaces (each ball medium constituted of fresh shredded coconut fibers/topsoil, dry shredded coconut fibers/top soil, cotton wool/top soil, decayed banana trunk/top soil and top soil only.) The balls were moistening with water and place on the ringed stem and covered with a transparent polyethene (water proof) 1mm thick and tied with twine (Hartman *et al*., 2007). The set ups were allowed to remain for two months before opening. At the end of two months incubation period, they were examined for root initiations. The white polyethene was used for easy examination, (viewing) for root initiation and to reduce the rate of water transpiration (Umeokechukwu *et al*, 2019). The marcotted stems were severed off from the parent plants at the end of the incubation period of two months. The rooting media were carefully removed and the roots washed. Roots in each sample were examined, counted and measured with meter rule.

RESULTS AND DISCUSSION

Number of roots: The analysis of variance indicated a significant difference in the number of roots of the marcotted stems. Result in table 1 shows that decayed banana trunk/top soil had the highest number of roots followed by fresh shredded coconut fiber /top soil. Then cotton wool / top soil was followed by dried coconut fibers /top soil. The least was top soil only which had few roots. Decayed banana trunk/top soil result was influenced by its cool temperature and moisture retention. Hans (1983) reported that temperature of 24-28^{o}C and moisture increased rooting. The decayed banana trunk retained moisture than other treatments. This may had given it advantage over the other treatments as air within the marcotted point was cooler in temperature.

Length of roots: The length of root was significantly affected by the time the shoot was of marcotted. October marcotts, had longer roots than those stems marcotted in the months of July, April and January (Table 2). The months of October and July produced longer roots than April and January and these months of October and July do have more rains with cooler temperatures than April and January. The rains added moisture to the balls reducing transpiration which made the medium to be cooler providing the required temperature for roots initiation.

CONCLUSION AND RECOMMENDATIONS

The rooting of the stems was affected by the medium and the time. The performance of the medium was as a result of the moisture contained in the medium. The decayed banana trunk had higher moisture holding capacity than the rest media. This gave it the advantage over the other media in lowering the temperature of the air around the marcotted stems. Marcotting has shown to require higher relative humidity as obtained in the months of October and July more than in the months of April and January. Marcotting is a good method of producing and maintaining a pure line. It is a promising alternative to budding which is affected by intrinsic scion and root stock interactions. It is recommended that decayed banana trunk/top soil be used to marcott the sweet oranges to produce seedlings and plants of pure lines. It is also believed to contain a phytohormone which promotes root growth based on concentration. It is recommended that decayed banana trunks/ top soil should be used in the marcotting of sweet oranges to produce a pure line of plants with similar character of the parent plants

Table 1: Effect of rooting media and time on Number of initiated roots on Orange marcotted sweet

Treatments	January	April	July	October	Σx	Mean
Decayed banana trunk/top soil	3	20	23	28	74	19
Fresh coconut fiber/top soil	1	19	20	22	62	16
Dried coconut fiber/top soil	0	10	13	16	39	10
Cotton wool/top soil	0	12	16	23	51	13
Top soil only	0	12	11	12	35	8.0
Σx	4	71	83	101	261	
Mean	1	14	17	20		

LSD 0.05 for 2 media means = 0.77, LSD 0.05 for 2 time means = 0.69
LSD 0.05 for 2 media x time means NS

Table 2: Effect of rooting media and time on roots length (mm) of marcotted sweet oranges.

Treatments	January	April	July	October	Σx	Mean
Decayed banana trunk/top soil	6	9	11	15	41	10.0
Fresh coconut fiber/top soil	4	6	9	11	30	8.0
Dried coconut fiber/top soil	0	5	6	10	21	5.0
Cotton wool/top soil	0	5	8	11	24	6.0
Top soil only	0	5	6	8	19	5.0
Σx	10	30	40	55	135	
X	2.0	6.0	8.0	11.0		

LSD 0.05 for 2 media means = 0.41, LSD 0.05 for 2 time means = 0.36
LSD 0.05 for 2 media x time means NS

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COMPARATIVE ANALYSIS OF WET AND DRY SEASON FLUTED PUMPKIN PRODUCTION AMONG SMALLHOLDER FARMERS IN OKIGWE, IMO STATE, NIGERIA

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ABSTRACT
The study compared wet and dry season fluted pumpkin production among smallholder farmers in Okigwe, Imo State, Nigeria. Data were collected with the aid of a well-structured questionnaire and interview schedule using purposive and random sampling techniques. Data were analyzed using descriptive and inferential statistics. Result showed that the smallholder fluted pumpkin farmers in the area had mean age of 39 years with household size of 5 persons and mean farm size of 0.5417 hectare but their mean annual farm income was ₦73,550. Result further showed that, the total costs and total revenues of smallholder fluted pumpkin farmers in wet and dry season production in the study area were ₦148,875 and ₦164,005; ₦280,005 and ₦338,340 respectively. Net return of ₦131,130 and ₦174,335 for wet and dry season production respectively. Benefit to cost ratios were 1.88 and 2.06 respectively and returns on investment were 88K and ₦1.06, with shepherd future of 53.2% and 45.8% for wet and dry season production of fluted pumpkin respectively. Results also, revealed the factors constraining fluted pumpkin production in the area. These factors were inadequate improved varieties of seeds (3.8), high cost of inputs (2.6), inadequate extension contact (3.5), pests and diseases (3.7), instability of product prices (3.4), lack of irrigation facilities (3.3), poor storage facilities (2.7) and lack of processing facilities (2.5). However, the study concluded that fluted pumpkin production in dry season is more profitable compared to wet season production in the study area and recommended that the farmers should join cooperatives, have regular extension contacts and attend seminars and workshops that could improve their production and management skills in both seasons. More attention should be given to dry season fluted pumpkin production to bridge the gap in production for higher profitability.
Keywords: *Comparative, Farmers, Fluted pumpkin, Okigwe, Smallholder*

INTRODUCTION

Fluted pumpkin consumption has increased over the years and it is an important component of the daily diets of Nigerians. The production of fluted pumpkin has increased rapidly as a result of its economic values in terms of monetary return to the growers especially during dry season farming. Fluted pumpkin production can provide all year round income generating employment opportunities for the farmers with little capital investment (Layade, *et al.,* 2020). Fluted pumpkin is perennial when grown on well-drained soils, slightly shaded and mulched but not so soggy soils (Idowu, *et al.* 2007). In the study area, the crop is grown on poor soils as an annual during the rainy season and also during the dry season adopting manual irrigation practices. Majorly, it is grown along-side other crops such as yam, maize, cassava e.t.c. Fluted pumpkin is very important in the diet of children, men, women, nursing mothers as well as livestock due to its high nutritive value. But in Nigeria, the output has not been able to meet the demand for human food not to mention that of livestock feed. As a result of the growing need, the task of producing enough fluted pumpkin poses an increasing challenge. Like other crops, it is affected by the seasonality syndrome, hence, the irrigation practices in dry season. The question is whether there is difference in profitability of dry season/ irrigated and rain-fed practices so far in lieu of excessive dry season or inequitable distribution of rainfall attributed to climate change, hence the need to compare the wet and dry season production in the study area.

However, few studies have compared wet and dry season fluted pumpkin production in Nigeria. Ayoola (2014) assessed the profitability of vegetable farming under irrigation and rain-fed systems using the gross margin, net profit, benefit-cost, shepherd-future and regression approach and concluded that investment on irrigation for vegetable production would be worthwhile for growing commercial vegetable enterprise in the study area.

Olowa and Olowa (2016) assessed the profitability of growing fluted pumpkin on commercial scale in Ikorodu Lcal Government Area (ILGA) using frequency distribution, percentages, means, gross margin, net profit, benefit-cost and Shepherd-Future analyses, and exponential regression model of combined profit function for irrigation and rain-fed systems. Results showed that fluted pumpkin farming was equally undertaken by both male and female mostly between 41-50 years old, with no formal education and average family size of 6 per household, net profit of ₦380,150 and ₦207,150 and benefit-cost ratios of 2.7 and 3 for rain-fed and dry season/irrigated practice respectively. According to them, farm size and level of education have positive correlation while age and costs of fertilizer, labour and planting materials were negatively related to farmer's profit at 1% and 5% significant level and maintained that, farmers should not invest in irrigation for fluted pumpkin production and that, increased access to land, fertilizers and improved seeds would promote profitability and commercialization of fluted pumpkin enterprises in Nigeria. None of thess studies was specifically comparing the wet and dry season production of fluted pumpkin in the study area, hence, the need for this study. Specifically, the study sought to compare the costs and returns of wet and dry season fluted pumpkin production and identify the factors constraining smallholder fluted pumpkin production in the area

METHODOLOGY

The study was conducted in Okigwe, Imo State, Nigeria. It is located on latitude $5^o\ 3^1$ N, and longitude $7^0\ 23^1$E above 131m above sea level with average rainfall of 2330mm per annum. It has agrarian communities and farmers there are horticultural crop producers owing to the presence of the national horticultural research institute in the area. Purposive and simple random Sampling techniques were adopted for this study. The study purposively selected three (3) farming communities that are predominant in fluted pumpkin production, namely; Agbobu, Umulolo and Umuawa Ibu. Twenty (20) smallholder fluted pumpkin farmers were selected randomly from each of the three (3) farming communities to give sixty (60) smallholder fluted pumpkin farmers for the study.

Primary data for this study were sourced with the aid of well-structured questionnaire and interview schedule in the case of illiterate farmers. Data generated for this study were analyzed using the following tools, namely: descriptive statistics such as frequencies, means and percentages; cost and return analysis such as net return, return on investment, cost-benefit ratio and shepherd future; and continuum scale.

Model Specification

The costs and returns analysis that was used for this study is expressed thus:

$$NR = TR - TC \quad (1)$$

$$TR = Q \times P \quad (2)$$

$$ROI = NR/TC \quad (3)$$

$$BCR = TR/TC \quad (4)$$

$$SF = (TC/TR) \times 100 \quad (5)$$

Where,

NR = Net return on fluted pumpkin vines and fruit (Naira)

TR = Total revenue from fluted pumpkin vines and fruits (Naira)

TC = Total Cost of fluted pumpkin production (Naira)

Q = Quantity of fluted pumpkin vines and fruits (Kilogram)

P = Unit price of fluted pumpkin vines and fruits (Naira)

ROI = Return on investment in fluted pumpkin Production (Naira)

SF = Shepherd future (Percentage)

Continuum Scale

The smallholder fluted pumpkin farmers' responses were collected in a 4-point continuum scale as Strongly Agreed (SA), Agreed (A), Strongly Disagreed (SD) and Disagreed (D) by assigning scores 4, 3, 2 and 1 respectively. The results were calculated thus:

$$\text{Mean Score (X)} = \frac{(\sum SA \times 4) + (\sum A \times 3) + (\sum SD \times 2) + (\sum D \times 1)}{\sum(SA+A+SD+D)} \quad (6)$$

Alternatively,

Mean Score (X) = $\frac{\sum FN}{Nr}$

Where; F = Frequency of each response, N = Nominal value, Nr = Number of respondents

The value for decision making was achieved thus:

$$\frac{4+3+2+1}{4} = \frac{10}{4} = 2.5$$

However, any value ≥2.5 was considered a constraint and otherwise, not a constraint on fluted pumpkin production in the study area.

RESULTS AND DISCUSSION

From Tables 1, the total costs and total revenues of smallholder fluted pumpkin farmers in wet and dry season production in the study area were ₦148,875 and ₦164,005; ₦280,005 and ₦338,340 respectively. Net return of₦131,130 and ₦174,335 for wet and dry season production respectively. Benefit to cost ratios were 1.88 and 2.06 respectively and returns on investment were 0.88 and 1.18, with shepherd future of 53.2% and 45.8% for wet and dry season production of fluted pumpkin respectively. The benefit-cost ratios of 1.88 and 2.06 showed that every ₦1 invested on fluted pumpkin, returns on investment were 88k and ₦1.06 respectively. These results implied that dry season smallholder fluted pumpkin production in the area was more profitable and shepherd future of 53.2% and 45.8% showed higher economic efficiency in dry season. These findings were in line with Olowa and Olowa (2016) whose work reported net profit of ₦380,150 and ₦207,150; Shepherd-future of 36.6% and 28.5%; benefit-cost ratios 2.7 and 3.5 for fluted pumpkin farming during rainy season and dry season respectively. They maintained that the results of benefit-cost ratios indicated that fluted pumpkin farming during dry season yielded greater revenue in excess of operational and overhead costs when compared to rainy season farming. Similarly, the shepherd-future indicated greater economic efficiency in the production of fluted pumpkin farming during dry season relative to rainy season. This result disagreed with similar studies in literature (Gani and Omonona, 2009; Ayoola, 2014; Olowa and Olowa, 2016) and maintained that, farmers should not invest in irrigation for fluted pumpkin production and that, increased access to land, fertilizers and improved seeds would promote profitability and commercialization of fluted pumpkin enterprises in Nigeria. Nwauwa and Omonona (2010) maintained that fluted pumpkin production under irrigation system was more profitable compared to rain-fed system, thus agreeing with the findings of this work.

From Table 2, these factors include; inadequate improved varieties of seeds (3.8), high cost of inputs (2.6), inadequate extension contact (3.5), pests and diseases (2.7), instability of product prices (3.4), lack of irrigation facilities (3.3), poor storage facilities (2.7) and lack of processing facility (2.5). These findings were in line with Nwosu, *et al,* (2012) whose work reported poor availability of inputs, pests and disease infestation, inadequate information about input and output prices, and poor road network respectively as constraints on profitable fluted pumpkin production. The result was consistent with Onyebinama (2004) who reported that farm input markets face several constraints which range from accessibility and affordability of inputs owing to its high prices. The result of poor extension contact concurs to the finding of Unammah (2003) who reported that poor ratio of extension agent to farmers in most developing countries resulted in farmers not having access to improved technologies. The results also agreed with Mustapha *et al.* (2016), FAO (2006) who reported pest and diseases, inadequate credit facilities and high interest rate, perishability of produce, water shortage and lack of ready market as major constraints on profitability of vegetable production. Okpeke and Adaigho (2016) agreed with this finding as they reported lack of storage facilities, and scarcity of viable seeds as major constraints on fruited pumpkin production. Goni, *et al.* (2013) generally agreed with the findings of this work that rain-fed agriculture is the most common practice in Nigeria as more than three quarters of the country's agricultural area is rain-fed and subsistence in nature.

Table 1: Costs and Returns on Wet and Dry Season Smallholder Fluted Pumpkin Production

Inputs Used	Wet season unit price P1 (₦)	Wet season quantity Q1	Wet season total cost TC1 (₦)	Dry season unit price P2 (₦)	Dry season quantity Q2	Dry season total cost TC2 (₦)
Variable Inputs						
Labour (Mandays)	1,500	33	49,500	1,500	32	48000
Seed (Pods)	1,120	27	30,240	1,120	21	23,520
Fertilizer (Kg)	500	22.3	11,150	500	15	7500
Poultry manure (bag)	600	5	3,000	600	5	3,000
Pesticides (litres)	3500	2	7,000	3500	2	7,000
Stakes (stands)	150	36	5,400	150	36	5,400
Transportation	-	-	9000	-	-	9000
Water (gallon)				10	2500	25000
Total variable cost (TVC)			**115,290**			**128,420**
Fixed Inputs						
Land (Hectares)	50,000	0.5417	27,085	50,000		27,085
Hoes	1,500	1	1,500	1,500		1,500
Cutlasses	500	2	1,000	500		1,000
Baskets	500	3	1500	500		1500
Bags	300	5	1500	300		1500
Harvesting knife	500	2	1000	500		1000
Watering Can	-	-	-	500	2	2000
Total fixed cost (TFC)			**33,585**			**35,585**
Total cost(TC)=TVC+TFC			**148,875**			**164,005**
Revenue From;						
Fluted Pumpkin Vines (Kg)	150	1,508.3	226,245	300	1007.8	302,340
Fluted Pumpkin Pods (Pods)	1,120	48	53,760	2000	18	36,000
Total Revenue (TR)			**280,005**			**338,340**
NR= TR – TC			**131,130**			**174,335**
BCR= TR/TC			**1.88**			**2.06**
ROI = NR/TC			**0.88**			**1.06**
SF= (TC/TR)100			**53.2%**			**48.5%**

Source: Field Computation, 2022

Table 2: Factors Constraining Fluted Pumpkin Production in the Study Area (n=60)

S/N	Factors	Mean Score (X)	Decision
1.	Inadequate improved varieties of seed	3.8	**A constraint**
2.	High cost of inputs	2.6	**A constraint**
3.	Inadequate extension contact	3.5	**A constraint**
4.	Nature of land ownership	1.6	Not a constraint
5.	Pests and diseases	2.7	**A constraint**
6.	Instability of product prices	3.4	**A constraint**
7.	Poor market information	1.3	Not a constraint
8.	Poor feeder road	1.5	Not a constraint
9.	High cost of transportation	2.3	Not a constraint
10.	Unstable Government policies	2.1	Not a constraint
11.	Lack of irrigation facilities	3.3	**A constraint**
12.	Inadequate credit facilities	2.4	Not a constraint
13.	Poor storage facilities	2.7	**A constraint**

14.	Lack of processing facilities	2.5	**A constraint**

Source: Field survey, 2022

CONCLUSION

From the major findings of the study, the benefit-cost ratios of 1.88 and 2.06 showed that every ₦1 invested on fluted pumpkin production, return on investment were 88k and ₦1.06 respectively and shepherd future of 53.2% and 48.5% respectively implied high economic efficiency for wet and dry season smallholder fluted pumpkin production. This implied that dry season smallholder fluted pumpkin production in the area was more profitable.

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YIELD OF SWEET CORN *(Zea mays L.)* AS INFLUENCED BY SOWING DATES AND PLANT SPACING IN DADIN KOWA, GOMBE STATE, NIGERIA

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ABSTRACT
The study was conducted at the Teaching and Research Farm, Federal College of Horticulture, Dadinkowa, Gombe State, Nigeria during the cropping season of 2022 to evaluate the influence of sowing dates and plant spacing on growth and yield of sweet corn (Zea mays L.). The treatments consisted of two sowing dates; Early sowing (SD1) 6th June and late sowing (SD2) 20th June and plant spacing of 30×20 cm, 30×25 cm and 30×30 cm laid out in Randomized Complete Block Design (RCBD) with three replications. The results showed significant difference between the sowing dates where the second sowing date (SD2/20th June) recorded the highest yield. For spacing, significant difference was also observed on yield per plot and per hectare where 30x30cm recorded the highest values. Therefore, late sowing date of 20thJune and Spacing of 30×30cm were suggested for farmers.
Keywords*: sweet corn, variety, sowing dates, spacing*

INTRODUCTION

Sweet corn (*Zea mays*) is an annual plant from the family of poeceae that comes in three colors: Yellow, White and bicolored (USDA 2016). Sweet corn contains a genetic mutation on the *su locus* that causes the endosperm to store at least twice as much sugar as field corn. As soon as corn is harvested, the sugar begins converting to starch, reducing the sweetness. Therefore, Sweet corn should be refrigerated or preserved within two to six hours of harvest to ensure best quality and retention of sweetness (USDA 2016). Although there is only one maize *(Zea mays L.)* species, it is so variable in its morphological, physiological, and other properties, which makes it the most variable plant species among cereals. This diversity is especially noticeable on seeds that are classified according to their shape, structure, and chemical composition. One of the initial classifications is mainly based on the shape and structure of grain (dent, flint, sweet, popping, soft, waxy, semi-dent and starch sweet maize). Seed heteromorphism is defined as the ability of a plant to produce multiple types of seeds, which is a common strategy of survival under the unpredictable climate conditions (Bhatt and Santo, 2016). This seed trait affects the seed ability to disperse, germinate, to be dormant and persistent in the soil. (El-Keblawy *et al.,*2015).

The seed number to seed size ratio is a starting point in the theory of ecology and evolution of survival and reproduction in the plant world. There are few explanations for the existence of advantages of the development of large seeds under different living conditions. The production of sweet corn (*Zea mays)* in the study area is poorly practiced due to limited technical knowhow that lead to poor emergence and seedling vigor associated with altered starch synthesis alleles in sweet corn which are exacerbated in the presence of unfavourable environmental condition which is the main factors restricting the spread of sweet corn in to the study area

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MATERIALS AND METHODS

This field trial was conducted during rainy season 2022, at the Teaching and Research Farm, Federal College of Horticulture, Dadin-kowa, Yamaltu Deba Local Government Area of Gombe State, Nigeria. The research area is located at the latitude of 11° 30N, longitude of 10° 20E with an altitude of 24°m above the sea level (Kowal, 2013). The experiment consisted of two sowing dates (Early June 6th as SD1 and late June20th as SD2) and the spacing of 20×30 cm, 25×30 cm and 30×30 cm laid in a Randomized Complete Block Design (RCBD) in three replications each with six plots making up a total of eighteen (18) plots. The size of each plot was 2×2m²(4m²). One meter space was left between replications and 0.5m between plots.

Data were collected on number of cobs, cob length, cob diameter, 100 seeds weight, yield in kilogram per plot and yield in kilogram per hectare (after harvest). Data collected were subjected to analysis of variance (ANOVA) and means were separated using Least Significant Difference (LSD) at 5% level of probability.

RESULTS AND DISCUSSION

The results in Table 1 indicated that there was no significant difference between both sowing dates and spacing intervals on number of cobs per plant which could be due to the fact that one variety was used and genetic influence might have played a vital role in arriving at this results even though the results disagreed with the findings of Chavan*, et al,.(2009)* which revealed that winter sweet corn sown in 45th meteorological week (5–11 November) gave maximum mean cob yield of 199.75 q ha^{-1} with maximum values of nutrient uptake and net returns than the subsequent delayed sowing. The plant spacing of 60 cm x 20 cm (83, 333 plants ha^{-1}) resulted in higher nutrient uptake over wider spacing of 60 cm x 40 cm (41, 666 plants ha^{-1} a) and 60 cm x 20 cm (27, 777 plants ha^{-1}). The results also showed that there was no significant difference between the treatments on Cob Length (cm) and this indicated that this parameter was not influenced by the sowing dates and the spacing intervals used in the research. The results were in contrast with the findings of Ron Goldy *et al*, 2018. These results disagreed with the findings of Mahapatra *et al*. (2004) and Hamzeh A. *et al*. (2015) who revealed significant difference of sowing date and sweet maize hybrids on number of days to emergence tassel, number of days to anthesis, number of days to Emergence spikelet, plant height, cob height, stem diameter, plant dry weight, cob dry Weight, number of grain rows, cob diameter, 1000 kernel weight, cob length and net weight grain harvest per plant. Mean comparisons showed that the highest grain yield was for Ex08716636 variety and it was obtained on 15 May planting date

The results on Cob Diameter (cm) showed significant difference between the sowing dates where 20th June recorded the highest value of 16.25 (cm) while 6th June had 13.86 (cm), but no significant difference was recorded on plant population (spacing). This results agreed with that of Bhutto *et al,*.(2015). Bhutto *et al,*.(2015) who reported that Yield components and grain quality parameters such as plant height, number of cobs per plant, cob length, grains per cob, grain yield, protein, starch and oil content of maize varieties were significantly affected by different sowing dates. The results on 100 Seeds weight per plot showed significant difference between the sowing dates where 20th June (SD2) recorded the highest mean value of 11.44g while 6th June (SD1) had 9.33g but no significant difference was recorded between the spacing intervals. This might be due to the suitability of the second sowing date to the crop in the study area. This result on sowing dates was in line with the findings of Hamzah *et al*.,(2015) whose investigation revealed significant difference of sowing date and sweet maize hybrids on number of days to emergence tassel, number of days to anthesis, number of days to emergence spikelet, plant height, cob height, stem diameter, plant dry weight, cob dry weight, number of grain rows, cob diameter, 1000 kernel weight, cob length and net weight grain harvest per plant but contradicted the findings of Rathod *et al,*.(2018) whose results revealed that, spacing 60×20 cm2 recorded significantly higher green cob (91.93 q ha-1) and fodder yield (318.65 q ha-1) While, Significantly higher protein content in cob (6.97%) and fodder (2.92%) was recorded in spacing 60×30 cm2 (S3)

The results on number of seeds per cob revealed that 20th June (SD2) recorded the highest mean value of 388.1 while 6th June (SD1) had 226.4 but no significant difference was recorded between the spacing intervals on this parameter. The results was in agreement with the findings of Bhutto *et al,*.(2015) who reported that yield components and grain quality parameters such as plant height, number of cobs per plant, cob length, grains per cob, grain yield, protein, starch and oil content of maize varieties were significantly affected by different sowing dates but contradicted the findings of Rathod M. *et al,*.(2018) whose results revealed that, spacing 60×20 cm2 recorded significantly higher green cob (91.93 q ha-1) and fodder yield (318.65 q ha-1) While, Significantly higher protein content in cob (6.97%) and fodder (2.92%) was recorded in spacing 60×30 cm2 (S3). The results on yield per plot revealed that highly significant differences were recorded where 20th June (SD2) recorded the highest mean value of 3.56kg while 6th June (SD1) had 2.25kg. For spacing, 30x30 cm recorded the largest value of 3.03kg while 30x20 and 30x25 cm recorded values that are statistically at par (2.82 kg and 2.88kg respectively). The results was in agreement with the findings of Atakul *et al*,.(2012) who reported that the duration of tasselling, plant height, first ear height, ear length, ear diameter, number of ears per plant, fresh husked ear yield, fresh unhusked ear yield and marketable ear number were statistically significant for sowing times and varieties; Bhutto *et al,*.(2015) who reported that Yield components and grain quality parameters such as plant height, number of cobs per plant, cob length, grains per cob, grain yield, protein, starch and oil content of maize varieties were significantly affected by different sowing dates. The results on spacing was in agreement with the findings of Rathod *et al,*.(2018) whose results revealed that, spacing 60×20 cm2 recorded significantly higher green cob (91.93 q ha-1) and fodder yield (318.65 q ha-1) While, Significantly higher protein content in cob (6.97%) and fodder (2.92%) was recorded in spacing 60×30 cm2 (S3).

The results on yield in kilogram per hectare revealed that highly significant differences were observed between the sowing dates where 20th June (SD2) recorded the highest mean value of 8917kg/ha while 6th June (SD1) had 5639kg/ha. For spacing, significant difference was recorded where 30x30 cm recorded the largest value of 7583kg/ha followed by 30x25 cm with 7208kg/ha while 30x20 had the lowest value of 7042kg/ha. The results was in agreement with the findings of Bhutto *et al,*.(2015) who reported that Yield components and grain quality parameters such as plant height, number of cobs per plant, cob length, grains per cob, grain yield, protein, starch and oil content of maize varieties were significantly affected by different sowing dates, and that of Rathod *et al,*.(2018) whose results revealed that, spacing interval of 60×20 cm2 recorded significantly higher green cob (91.93 q ha-1) and fodder yield (318.65 q ha-1) While, Significantly higher protein content in cob (6.97%) and fodder (2.92%) was recorded in spacing 60×30 cm2 (S3).

Table 1: Influence of sowing Dates and Spacing on the Yield Characters of Sweet corn grown in D/kowa

Treatments	NC	CL	CD	100SW	SC	Yield/Plot	Yield/ha
Sowing Date							
6th June	1.378	18.53	13.86	9.33	226.4	2.25	5639
20th June	1.489	18.73	16.25	11.44	388.1	3.56	8917
P<f	NS	**	**	**	**	**	**
LSD	0.3044	1.438	1.492	1.009	39.51	0.0920	229.9
Spacing							
20×30cm	1.367	17.14	15.13	10.17	305.5	2.82	7042
25×30cm	1.500	17.22	15.65	10.50	298.8	2.88	7208
30x30cm	1.433	16.58	14.39	10.50	310.0	3.03	7583
P<f	NS	NS	NS	NS	NS	**	**
LSD	0.3728	1.900	1.428	1.235	48.40	0.0920	229.9

Key: NC = Number of Cob, CL = Cob length, CD = Cob Diameter, 100SW= 100 Seeds Weight, SC = Seeds/Cob.

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COMPARATIVE ADVANTAGE AND EFFECT OF POLICY ON TEA PRODUCTION IN NIGERIA

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ABSTRACT
The study examined the comparative advantage and the policy effect on tea production in Nigeria. One hundred and two (102) tea farmers were randomly selected from the study area. Primary data were collected from the sampled farmers with the use of structured questionnaires administered through Open Data Kit (ODK). The data collected were analysed using Policy Analysis Matrix (PAM) which was utilized in determining the comparative advantage and effect of policy on tea cultivation. A budgetary analysis was prepared to estimate the cost of inputs and output and eventual comparative advantage and policy protection on tea farming in Nigeria. Policy indicators such as Domestic Resource Cost (DRC) and Social Cost Benefit (SCB) was make use of in evaluating comparative advantage while indicators such as Nominal Protection Coefficient (NPC), Effective Protection Coefficient (EPC) and Profitability Coefficient (PC) were used for assessing policy protection on tea production. The results from the analysis showed that Nigeria has comparative advantage in tea production, and hence can produce tea for export; earn foreign currency thereof.
Keywords: *Comparative Advantage, PAM, Tea, Effect of Government Policy*

INTRODUCTION

Agriculture is very important to be able to achieve economic sustainability of a nation and it is a vital productive sector in Nigeria apart from oil, in terms of its contribution to Gross Domestic Product and employment it generation (Dike & Njoku, 2019); Afrogha O.O and Afrogha, F.T, 2022). Sustainable agricultural development in any country is propelled by agricultural policy and programmes (Udeh *et al*., 2021). The Nigerian government has come up with various strategies to improve its economic growth and development and move away from mono economy system. Agricultural development policy of government in Nigeria has led to different agricultural policies and programmes (Idowu *et al,* 2007; FMARD, 2016; Onuzurika *et al*., 2020; Kalagbor and Hary, 2021). This commodity policy was targeted at supporting activities of farmers in the areas of research, extension, selling abroad and price control (Manyong *et al*., 2005. Over the years, there have been various agricultural policies with many policies formulation that suffers lack of continuity (Alexander, 2022). Also, political instability and lack of sustainability of policies and programs are the cause of the problems. Most political office holders have the erroneous belief that a government could only be accessed based on completely new policies and programs. Contradiction in policy is another major challenge; some agricultural policies and programs of government are designed to oppose rather than being jointly harmonizing and supportive of the existing one.

Tea (*Camellia sinesis* (L) Kuntze) is an evergreen shrub tree belonging to camellia genus in *Theacea* family that produces young shoots through guided pruning to maintain a plucking table for regular tea leaves harvest that are processed into tea beverages. It is the cheapest beverage in the world and consumed by large number of people across religion and culture hence; it represents one of the major components of world's beverage market (FAOSTAT, 2021; FAO, 2022). Tea plays a major role in local economy development, poverty reduction and food security in emerging nations and is a significant commodity crops in the world (Raj. 2020; FAO, 2022). Tea plants (*Camellia sinesis* L) have being neglected and underutilized in Nigeria (Ipinmoroti, *et al*, 2018; Olasimbo, 2021). Tea is known for its high nutritional value, has high antioxidant, antimicrobial and anticarcinogenic, properties, (FAO, 2022). It is a commodity of high value with extensive value addition capacity for economics of scale and cultivated mostly by women. Tea has contributed largely to the GDP of growing countries and has a growing international market in health food industry (UNO, 2020).

Tea is cultivated mostly in Taraba State of Nigeria; there is over 50,000 hectares of suitable land for tea cultivation on Mambila plateau in Nigeria. Tea was introduced into the country in the mid 70's by Bohea Limited, a United Kingdom Company which established a project comprising 450 hectares of irrigated estate on Mambilla plateau. This is the first commercial Tea planting of a total land areas planted with about 1,200 hectares in the 70's with an annual production of 1,600 tons which meets only 10% of local needs leaving 90% of the suitable land underutilized (Oluyole *et al.,* 2019). The production figure for Nigeria compared to other producing countries globally shows there is need to exploit the potential inherent in tea as a commercial commodity by expanding land areas of tea cultivation (Oluyole *et al.,* 2017; 2018;2019). Nigeria began tea production on a commercial scale in 1982 on the Mambilla plateau of Taraba state situated between longitude 110^{o}E and 120^{o}E and latitude of 6.50^o N and 80^o N. It has a scale-tropical climate and an elevation of about 1550m above sea level (Oluyole *et al.,* 2017).

Comparative advantage is a nation skill to produce a certain good or service at a lower minimal cost than others. The principle of comparative advantage opined that a nation will sell abroad the goods or services in which it has its highest comparative advantage and import those in which it has the smallest comparative advantage. Comparative advantage is therefore the ability to produce a product by optimal input mix relative to other products that could be produced. This theory was first propounded by David Richado in 1817; he focused on international trade and generalized the idea into an economic law, the law of comparative advantage (Smith, 2010). Nigeria has great comparative advantage in tea production. This is because there are large areas of land for tea production in Taraba state that have not been utilized. Also, with the introduction of tea into the lowland areas of some states in Nigeria (Ondo, Lagos, and Edo) by the Cocoa Research Institute of Nigeria. Tea when compared with other crops would have a comparative advantage and could also generate income for the country through its export. Thus, the reason for this study

METHODOLOGY

The study was carried out on Mambilla plateau in Taraba State. Random sampling procedure was used to select a total of 421 tea farmers from randomly selected 30 communities on the plateau. Primary data were obtained from the selected farmers through the use of structured questionnaires administered through Open Data Kit (ODK). The data collected were analysed using Policy Analysis Matrix (PAM) in defining the comparative advantage and effect of policy on tea production (Monke and Pearson, 1989). indicators for measuring comparative advantage are domestic resource cost (DRC), and social cost benefit (SCB) (Javed et al., 2006; Habibullah, 2010; Khai, 2013; Hassanpour et al., 2013; Smith, 2010; Elzaki, 2014) while the effects of policy was measured with nominal protection coefficient (NPC), effective protection coefficient (EPC), and profitability coefficients (PC) (Morris, 1990; Rangasamy, 2003; Marrewijk, 2007; Encylopedia, 2009; Oguntade, 2011). PAM was selected for the study because of its strength in assessing the policy effect on comparative advantage and farm gate profit. PAM is good in influencing investment policy on efficiency in resource allocation and comparative advantage. PAM is also known for its impact on evaluating policy on agricultural research and moving technology. PAM was utilized for the study by incorporating revenue and cost valued at private and social prices for tea production (Master and Nelson, 1995). The budgetary analyses of input and output prices were valued at private and social cost. The data was analyzed to estimate the comparative advantage and effect of government policy on tea production.

RESULTS AND DISCUSSION

The financial analysis for Tea production systems is as presented in Table 1. The total quantity of tea produced among the farmers was 908,042kg and this gave revenue of ₦245,181.32 and ₦433,033.76 valued at private and social value correspondingly. Proceed of ₦224,761.46 and ₦323,335.62 at private and social value in turn was attained in the production system. Tea production system had output transfer of -₦187,258.44. The production system had negative output transfer as shown in the table. This implied higher social returns than the private revenue; existing market price of tea is lesser than the boarder price. This further shows that there was a deterrent to tea output and government policies did not provide incentive for the private prices of tea. The production system had tradable input transfer of ₦-88677.49. The result further showed that tea production system had negative tradable input transfer signifying that private prices for tradable raw materials are lower than their similar international prices. Thus, indicating a hidden tax on the tradable input utilized in the cultivation of tea. The factor transfer of tea production systems had factor transfer of ₦0. The result showed positive values for tea production. The profit transfer of tea production systems had profit transfer of -₦98,574.95. The result showed negative values for the production system. There is an indication that the impact of policies was not favorable to tea production.

Table 1: Policy Analysis matrix for tea production in Nigeria

Item	Revenue	Cost of tradable input	Cost of domestic factor	Profit
Private prices	245,781.32	14, 175.56	34,050.15	197,555.61
Social prices	433,033.76	102,853.05	34,050.15	296,130.56
Divergences	-187,252.44	-88,677.49	0	-98,574.95

Domestic Resource Cost (DRC) for tea cultivation in the study areas is as presented in Table 2a DRC value of 0.1 derived which was less than one. This is an indication that the cost of inputs utilized in tea cultivation was lesser than the value added; signifying efficiency utilization of scare domestic resources in tea cultivation. Also, implying that, it is better off, with the maximum comparative advantage. The standard is, the lower the DRC, the larger the level of efficiency in production (Fazleen, 2017; Ude et al., 2013). Social Cost Benefit (SCB) result for tea production management systems is as shown in Table 2. SCB in production was 0.33. This implied that the value of tradable input cost and domestic factor cost used in tea cultivation at social prices was lesser than the income at social prices under the existing market place condition. SCB results point to the fact that addition of cost of tradable raw material and domestic factors costs are fewer than the gross income under the prevalent output and input market conditions. This is in agreement with (Voinescu & Moisoiu, 2015) which found that rice processing has comparative advantage in the study area.

Nominal Protection Coefficient (NPC) value 0.56 was derived for tea production which was not as much as one, implying that the private price for tea output was lower than the comparable world price for tea. Also, it denotes the system did not receive incentive from government policy since the participants are receiving a smaller amount in private prices in comparison to social prices. The results further showed; that the yield prices are lesser than the boarder prices. This might be due to policy such as currency devaluation and exchange rate which increased the cost of maintaining tea farms. Effective Protection Coefficient (EPC) value of 0.70 was generated for tea production and it was not as much as one. The implication of this is that the gain at market price was not as much as the gain at world price. Therefore, the farmers did not receive incentive from policy interventions. The PC value of 0.91was generated for tea production was less than one implying that private profit was not as social profit. This indicates that the private profit was lower than the profits estimated at the international price. Therefore, there was no motivation in the marketing. There is a further indication that the farmers were not secure by government policy.

Table 2: Indices of comparative advantage and policy effects

DRC	SCB	NPC	EPC	PC
0.10	0.33	0.56	0.71	0.91

Source: Field Survey, 2021

CONCLUSION AND RECOMMENDATION

The study was carried out to evaluate the comparative advantage and policy protection on Tea production in Nigeria for export. Tea budget was prepared for financial and economic cost valued at private and social prices. The study concluded that Nigeria has comparative advantage in production of Tea and it can be produced for export. Present agricultural policy of Nigerian government does not provide incentives and protection to tea production.

RECOMMENDATION

Based on the above the study recommends an urgent government intervention in tea production in terms of input subsidies and price legislation. The Nigerian government must take into account the tea production sub-sector in general agricultural and marketing policies. Policies aimed at providing relevant protection for tea producers must be prioritized to ensure the growth of the sub-sector.Policy should target reducing input cost and increased productivity of tea. Local production should be encouraged to gain maximum income from tea marketing.

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THE IMPACT OF THE ADOPTION OF ELITE RICE VARIETIES ON THE PRODUCTIVITY OF FARMERS IN SHENDAM LGA, PLATEAU STATE

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ABSTRACT
This research work focused on the Impact of the Adoption of improved (elite) rice varieties on the productivity of the farmers in Shendam Local Government Area of Plateau State. Data for the study was collected through the administration of questionnaire and interview schedule. A multistage sampling technique was used to select the sample size. In the first stage, Durok District was purposely selected being renowned for rice production. Secondly, four villages were randomly selected and finally, twenty rice farmers were randomly selected from each of the villages; giving a total sample size of eighty respondents. Descriptive statistics (means / frequency counts and percentages) was used to analyze the data. The analysis of varieties of rice cultivated reveals that majority of the farmers (70%, $\bar{x}$ = 0.70) cultivated the elite varieties while only 30% ($\bar{x}$ = 0.30) cultivated the local varieties. The impact of the adoption of the elite varieties on the productivity of the farmers was more positive (70%, $\bar{x}$ = 0.70) as against only 30% ($\bar{x}$ = 30) that did not adopt. Major constraints associated with the adoption were inadequate funds and sources of certified seed. Based on the findings, it was recommended among others that Government should grant loans to farmers to enable them procure improved or certified seeds from right sources and other necessary farm inputs.
***Keywords**: Adoption, Elite rice varieties, Productivity of farmers and Yield*

INTRODUCTION

Rice serves as an important staple food in the diet of most Nigerians. It is a very versatile crop and there are many varieties of rice adapted to various environment and cultivation practices (Luc *et al*, 2010). In recent years, rice production in the country has been expanding at the rate of 6% per annum with 70% of the production increase due to land expansion and only 30% being attributed to an increase in productivity (Okoruwa & Ogundele, 2006). Rice production in Nigeria is dominated by small holder farmers who use traditional methods that are characterized with problem of low productivity. Productivity in the last four decades is centered on increasing the number of new varieties and a positive increasing trend in the rate of adoption of modern varieties (Awotide, 2012).
Though increase may not wholly be attributed to varieties improvement in rice production, there is potential for further improvement in productivity (Awotide, 2012). They believed that access to and adoption of improved (elite) rice varieties would go a long way in raising the productivity of small scale rice farmers and consequently improve their livelihood. Productivity increase in agriculture has the capability of reducing poverty through increase in farmer income and reduction in food price, thereby improving food security.
In the West Africa sub-region, Nigeria has witnessed a well-established growing demand for rice as propelled by rising per output consumption and consequently the insufficient domestic production need to be complemented with enormous import both in quantity and value at various time (Afolami and Ragasa, 2015). The enormous importation has however been considered by various regimes as an avoidable drain

on the country's foreign exchange earnings in view of the abundant natural endowments for expanded production in Nigeria (Fashola, *et al*, 2007).

Reports by Oyekanmi (2008) from research stations (based on their on- station and field trials) showed that the adoption of the technologies and improved management practices should lead to substantial yield increase in rice production. The invariability underscores the significant role that technology stand to play in attaining the much needed growing in the rice subsector. Gabre and Haggblade (2001) however predicted such growth on productivity gained through greater technical and allocative efficiencies of the farmers in the response to the changing technological and production environment. This study therefore seeks to determine the impact of adoption of improved (elite) rice varieties on the productivity of farmers in Shendam LGA of Plateau State.

Aim and objectives of the study

The aim of the study is to access the impact of adoption of elite rice varieties on the productivity of farmers in Shendam LGA of Plateau State. The specific objectives include the following:

a. To investigate the varieties of rice cultivated by the farmers in the study area
b. To determine the yield of the rice farmers in the study area
c. To access the level of adoption of the new rice (elite) varieties in the study area.

MATERIALS AND METHODS OF DATA COLLECTION

A well-structured questionnaire and oral interview were used for data collection from respondents. The instruments carry relevant questions that would elicit responses relevant to the study.

Sampling technique and sample size

A multistage sampling technique was used to select the sample size. In the first stage, Durok district was purposively selected due to the fact that it is renowned for rice production. In the second stage, four (4) villages from Durok district were randomly selected including Kalong, Shimankar, Samunaka and U/ Rina. In the third stage, 20 respondents were randomly selected from each of the four villages, making a total of eighty (80) respondents as the sample size considered for the study.

Method of Data Analysis

Data collected were analyzed using descriptive analysis such as frequency counts, means and percentages.

RESULTS AND DISCUSSIONS

Results in Table 1 shows that 56 (70%, $\bar{x}$ = 0.70) respondents have been cultivating improved varieties of rice on their farm while 24 (30%, $\bar{x}$ = 0.30) used the local varieties. This is an indication that the farmers preferred the improved or elite varieties of rice over the local varieties, this agrees with the study of Oyekanmi *et al* (2008) that development and dissemination of improved rice varieties and other inputs as a composite package to rice farmers would increase production through productivity. Table 2 is the distribution of respondents according to their sources of seed and information. The results indicate that 67% ($\bar{x}$ = 0.625) of the respondents secure their seed for planting from right or certified sources e.g. National seed centre, Extension Agents, Agricultural Development Programme while 30 ($\bar{x}$ = 0.375, 37.5%) of the respondents were still using local seed source. It shows that majority of the respondents got their seeds for planting from standard sources. This is in agreement to the findings of Tologbonse (2002) that extension agents are important source of agric information.

In Table 3 which is the distribution of the respondents according to yield indicated that 45 (56.25%, $\bar{x}$ = 0.562) of the farmers got yield range of 10-50 bags, 10 farmers ($\bar{x}$ = 0.125) got yield of between 51 - 100 bags and 13 farmers ($\bar{x}$ = 0.162) got 101 – 150 bags, 12 farmers (15%, $\bar{x}$ = 0.15 got yield ranging from 151 bags and above. This result could be due to the fact that most of the farmers are smallholder farmers.

Table 4 indicates the level of adoption of the modern varieties by the respondents. The result revealed that 38 farmers (47.5%, $\bar{x}$ = 0.475) adopted the cultivation of modern varieties of rice at moderate level, 33 farmers (41.2%, $\bar{x}$ = 0.412) adopted the improved varieties production at high level, 7 farmers ($\bar{x}$ = 0.875, 8.75%) adopted at low level while only 2 farmers (2.5%, $\bar{x}$ = 0.25) do not adopt at all. This shows

that the adoption of the elite rice varieties in the study area is at an appreciable level. There is prospective potential for high adoption of elite rice.
The results in Table 5 is the distribution of respondents according to the impact the cultivation of elite rice varieties had on their livelihood. The results indicated that 56 ($\bar{x}$ = 0.70, 70%) had positive impact while only 24 respondents ($\bar{x}$ = 0.30, 30%) indicated no impact. It is an evidence that the production of modern varieties of rice has gone a long way in improving the standard of living of the respondents in the study area.

CONCLUSION
From the study, it is concluded that the adoption of elite varieties of rice has brought a great positive impact on the lives of the farmers. It has improved the productivity of the farmers greatly evidenced in enormous increase in yield. The use of good seed of improved varieties for cultivation from good sources is commendable and encouraged to maintain and sustain the productivity and continuous adoption of rice elite varieties by small holder farmers.

Table 1: Variety of Rice cultivated

Variety	Frequency	$\bar{x}$	Percentage (%)
Local	24	0.3	30
Improved	56	0.70	70
Total	**80**		**100**

Source: Field study, 2022

Table 2: Source of Seed

Source	Frequency	$\bar{x}$	Percentage (%)
Local	30	0.37	37.5
Standard	50	0.625	62.5
Total	**80**		**100**

Source: Field study, 2022

Table 3: Yield

Yield	Frequency	$\bar{x}$	Percentage (%)
10-50	45	0.562	56.25
51-100	10	0.125	12.5
101-150	13	0.162	16.25
151 and above	12	0.15	15
Total	**80**		**100**

Source: Field study, 2022

Table 4: Level of Adoption

Level	Frequency	$\bar{x}$	Percentage (%)
High	33	0.412	41.2
Moderate	38	0.475	47.5
Low	7	0.875	8.75
None	2	0.25	2.5
Total	**80**		**100**

Source: Field study, 2022

Table 5: Impact of Adoption on Standard of Living

Impact	Frequency	$\bar{x}$	Percentage (%)
Positive	56	0.70	70

None	24	0.30	30
Total	**80**		**100**

Source: Field study, 2022

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OPTIMISATION OF DNA EXTRACTION PROTOCOL FOR PLANTS WITH HIGH LEVELS OF SECONDARY METABOLITES AND POLYSACCHARIDES: ROSE AS A CASE STUDY

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ABSTRACT:
This study introduces an improved DNA extraction method, focusing on roses as a representative plant species with high secondary metabolite and polysaccharide content. Roses, prized for their essential oil, ornamental value, and economic importance, are increasingly studied using molecular techniques like PCR-based markers. However, the presence of polysaccharides and polyphenols in rose DNA hampers its suitability for PCR analysis. The study employs a modified cetyltrimethylammonium bromide (CTAB) procedure, with the innovative omission of phenol during extraction, to boost DNA yield. A critical step involves washing with HEPES buffer to remove polyphenols and polysaccharides, followed by the combined use of potassium acetate and chloroform to eliminate proteins and polysaccharides. Subsequently, the DNA is precipitated and quantified using a UV-spectrophotometer. This optimized protocol consistently yields high-quality DNA, ranging from 980 to 1800 µg/g of fresh leaf weight, suitable for PCR analysis and gel electrophoresis. It offers a valuable resource for extracting DNA from other plant species confronted with similar challenges related to secondary metabolites and polysaccharides.
Keywords*: Rose, cetyltrimethylammonium bromide (CTAB), DNA extraction, PCR analysis, secondary metabolites.*

INTRODUCTION

Roses are prized not only for their beauty but also for their economic significance and use in various fields, including perfumery and medicine. The fragrant essential oil derived from roses is a key component in high-grade perfumes. Medicinally, roses are known to invigorate the blood and possess astringent properties. Furthermore, their ornamental appeal adds to their value (Chrubasik *et al*, 2006). In molecular biology, PCR-based molecular markers have gained favour over morphological markers (Guena *et al*, 2000), with applications ranging from genotyping to biodiversity evaluation. However, working with rose DNA poses challenges due to its high levels of polysaccharides and polyphenols, which hinder PCR applications (Porebski *et al*, 1997). Polysaccharides make DNA viscous and reduce enzyme activity, while polyphenols covalently bind to DNA, making it less suitable for analysis (Okpodu and Abdullah-Israel, 2011). Obtaining high-quality genomic DNA from roses is essential for various molecular biology applications, including genetic engineering and gene expression analysis (Xu *et al*., 2004). Roses, being rich in secondary metabolites like flavonoids and phenolic compounds, as well as polysaccharides, require tailored DNA extraction protocols. The presence of these compounds often leads to low DNA yields and impurities (Hedman and Rådström, 2013).
Roses are not only beloved for their aesthetics but also hold economic and scientific significance (Schenk *et al*., 2023). Overcoming the challenges posed by their unique chemical composition is crucial for unlocking their genetic potential and harnessing their benefits across multiple domains. Specialized DNA extraction protocols are pivotal in this endeavor (Bocso and Butnariu, 2022). The optimization of DNA extraction from roses with abundant secondary metabolites and polysaccharides offers vital progress in plant molecular biology. It addresses challenges in rose DNA extraction, providing a blueprint for

customizing protocols for similar plants. This advancement will boost the effectiveness of plant genetics and genomics research. This study aims to evaluate a simple, rapid, and efficient protocol for the extraction of DNA from rose specie.

MATERIALS AND METHODS

Sample Collection:

Young and tender leaves of 25 accessions of roses were collected from the floriculture garden of the National Horticultural Research Institute in Ibadan and stored at -80°C until use.

DNA Extraction Method:

The DNA extraction was performed at the Biotech Molecular Laboratory of the National Horticultural Research Institute, Jericho, Ibadan, Nigeria. The extraction method used was the modified hexadecyltrimethylammonium bromide (CTAB) procedure, which incorporates a phenol-absent extraction step to enhance the yield. Prior to extraction, a washing step was performed to remove organic molecules and excess water. The washing buffer used prior to the actual extraction process is the Hepes-NAOH buffer. The inclusion of the Hepes buffer was one of the additional steps tried for the removal of polysaccharide.

HEPES Buffer Solution:

HEPES buffer is one of Good's zwitterionic buffers, which has a pH range of 6.8-8.2. It is widely employed in cell culture media due to its capacity to maintain a stable pH in the face of changes in carbon dioxide concentration. The HEPES Buffer (1 M, pH 7.5) was prepared using the following steps:

- Prepare 800 mL of distilled water (dH2O) in a suitable container.
- Add 238.3 g of Hepes to the solution.
- Adjust the pH of the solution to the desired level using 10N NaOH.
- Add distilled water until the total volume reaches 1 L.

The extraction procedure involves employing high concentrations of polyvinylpyrrolidone (PVP) (4% [w/v]), CTAB (3% [w/v]), and β-mercaptoethanol (3% [v/v]) in the extraction buffer with a high salt concentration. This is done to eliminate polyphenols and polysaccharides. Furthermore, a combination of potassium acetate and chloroform was utilized to remove proteins and polysaccharides. Subsequently, DNA was precipitated by adding an equal volume of isopropanol and 0.1 volume of sodium acetate. The resulting DNA pellet was then re-suspended in 100μL of sterile distilled water, and the DNA concentration was determined using a UV-spectrophotometer at 260 nm. The DNA samples (Stock) were stored at -20°C prior to analysis.

RESULTS

Qualitative and Quantitative Analysis of Extracted DNA

The DNA yield was measured using a UV-Visible spectrophotometer (PerkinElmer) at 260 nm. DNA purity was determined by calculating the absorbance ratio A260/280. Polysaccharide contamination was assessed by calculating the absorbance ratio A260/230 (Pushkoova *et al*., 2019). For quality and yield assessments, electrophoresis was performed on all DNA samples in a 1.0% agarose gel, stained with Ethidium Bromide, and bands were observed using a gel documentation system. This protocol resulted in high yields of DNA. The average yield of DNA ranged from 980 to 1800 μg/g of fresh weight of leaves. The results indicated that the DNA quality is sufficient for polymerase chain reaction (PCR) analyses. It is also suitable for extracting high-quality DNA from other plants with high levels of secondary metabolites and polysaccharides.

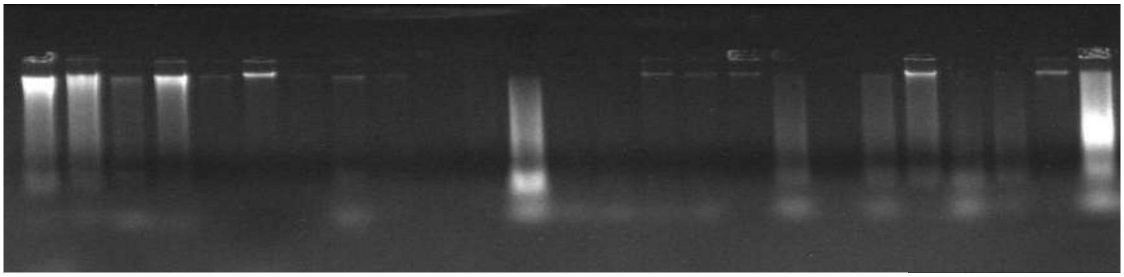
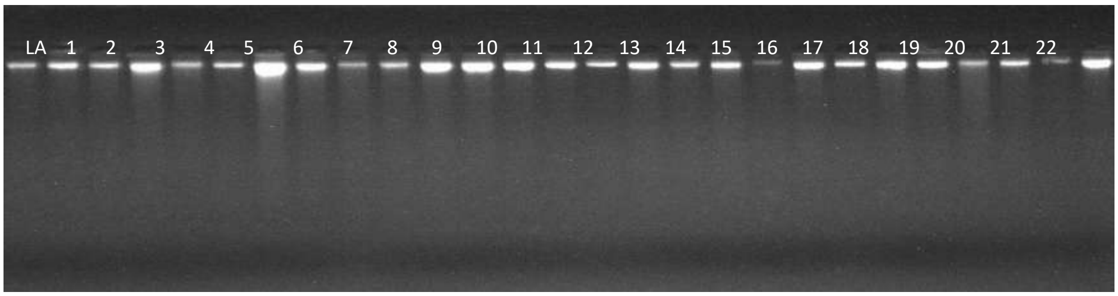


Fig 1: Gel electrophoresis of DNA extraction protocol without HEPES wash.



DNA suitable for a broad range of molecular biology applications was successfully extracted from rose plant containing high levels of secondary metabolites. These metabolites oxidized the DNA irreversibly, which hinders amplification of DNA by PCR through inhibiting the action of enzymes such as Taq polymerase (Moreira and Oliveira, 2011). The use of Hepes buffer in the initial washing step helps in the maintenance of enzyme structure and function at low temperatures and standardised pH (Turaki *et al*., 2017). The protocol development is a modification over the CTAB method. The development procedure was optimized by making use of the Hepes Buffer in addition to higher concentrations of other chemical compounds; this is known as the Optimised cetyltrimethylammonium bromide (CTAB) method (Turaki *et al*., 2017). The broad applicability of the optimized extraction method was demonstrated by its success in obtaining high-quality genomic DNA from rose plants. Previous research has shown that the presence of a high level of β-mercaptoethanol effectively eliminates polyphenols (Sahu *et al*., 2012). Consequently, a high concentration of β-mercaptoethanol was incorporated into the protocol, making it suitable for extracting high-quality DNA. Additionally, the inclusion of NaCl at concentrations exceeding 0.5 M, in combination with CTAB, is recognized for its ability to remove polysaccharides during DNA extraction. (Moreira and Oliveira, 2011). Zhang and Stewart, (2000) reported that higher concentration of PVP (2.5%) with lower molecular weight (10,000) rather than 40,000 has the tendency of producing DNA with higher quality. PVP with low molecular weight has less tendency of precipitating with the nucleic acids as compared to PVP with high molecular weight thus yielding sufficient amount of polyphenol-free DNA (Leza *et al*., 2017).

CONCLUSION

In conclusion, this protocol allows for simultaneous DNA extraction from numerous samples of plants with high level of metabolite and secondary polysaccharides, and does not need expensive reagents or equipments while producing clean and high quality DNA that is suitable for most genetic analysis purposes. The protocol should be applicable to other recalcitrant plant species with some modifications.

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Table 1: Yield data without hepes

Sample ID	Nucleic Acid	Unit	A260 (Abs)	A280 (Abs)	260/280	260/230
1	34.1	ng/µl	0.683	0.53	1.29	0.25
2	22.7	ng/µl	0.455	0.217	1.09	0.13
3	43.7	ng/µl	0.874	0.651	1.34	1.44
4	32.1	ng/µl	0.642	0.358	1.09	0.13
5	52.7	ng/µl	1.054	0.691	1.33	0.16
6	51.6	ng/µl	1.033	0.891	1.16	0.13
7	146.8	ng/µl	2.936	1.782	1.65	0.38
8	124.6	ng/µl	2.493	1.881	1.33	0.36

9	29.6	ng/µl	0.591	0.369	1.6	0.2
10	35	ng/µl	0.7	0.412	1.5	0.12
11	57.3	ng/µl	1.145	0.915	1.25	0.15
12	35.7	ng/µl	0.714	0.499	1.33	0.12
13	25.7	ng/µl	0.514	0.272	1.39	0.11
14	28.3	ng/µl	0.566	0.349	1.52	0.11
15	39.4	ng/µl	0.787	0.464	1.6	0.2
16	53.1	ng/µl	1.062	0.77	1.38	0.3
17	16.4	ng/µl	0.327	0.148	1.21	0.11
18	23.6	ng/µl	0.472	0.26	1.62	0.13
19	41.8	ng/µl	0.836	0.437	1.71	0.12
20	68	ng/µl	1.36	0.998	1.36	0.48

Table 2: Yield data with hepes

Sample ID	Nucleic Acid	Unit	A260 (Abs)	A280 (Abs)	260/280	260/230
1	1536.9	ng/µl	10.738	6.34	1.89	1.46
2	1652.2	ng/µl	13.043	7.593	1.82	1.38
3	1529.4	ng/µl	10.589	6.27	1.99	1.38
4	1134.9	ng/µl	0.698	0.456	1.83	0.85
5	1804.6	ng/µl	16.091	8.235	1.95	1.42
6	1525.6	ng/µl	10.512	5.225	2.01	1.85
7	1177	ng/µl	23.541	11.861	1.98	1.79
8	1112.3	ng/µl	22.246	11.875	1.87	1.11
9	1915.6	ng/µl	18.312	9.391	1.95	1.39
10	1810.3	ng/µl	16.206	8.182	1.98	1.86
11	1454.1	ng/µl	9.081	4.445	2.04	1.99
12	1426.5	ng/µl	8.529	4.2	2.03	1.96
13	1228.9	ng/µl	4.578	2.418	1.89	1.69
14	1374.4	ng/µl	7.487	3.906	1.92	1.45
15	1403.7	ng/µl	8.075	4.93	1.84	1.26
16	1317.1	ng/µl	6.342	4.013	1.88	1.23
17	1236.1	ng/µl	0.723	0.451	1.86	4.29
18	1929.4	ng/µl	18.587	9.211	2.02	1.58
19	1923.6	ng/µl	18.473	9.174	2.01	1.65
20	1473.4	ng/µl	9.469	4.601	2.06	2.15

THE IMPACT OF SOME BENEFICIAL MICROORGANISMS IN HORTICULTURE

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ABSTRACT
Rhizosphere-living bacteria that exert a global beneficial effect on plant growth are referred to as plant growth promoting rhizobacteria (PGPR). Examples of PGPR for crop development include genera such as Azospirillum, Bacillus, Pseudomonas, Rhizobium, Serratia, and Streptomyces. They play significant roles in biotic stress management when in contact with host plants using different methods. The methods include single inoculation (this involves the use of one bacterium to enhance the growth of plants), double inoculation (this involves the use of two or more bacteria to enhance the growth of plants) or co-inoculation (this involves the use of bacteria and fungi concurrently to enhance the growth of plants). Co-inoculation method has been identified to give the best results. The association of plant growth promoting fungi (PGPF) such as Glomus spp. with roots of various plant species has also been documented to modulate growth, morphology, nitrogen assimilation, resource allocation and mineral uptake of the host plant and also improves host reproductive fitness by enhancing plant growth, increase biomass and grain yield of crop plants. However, adequate knowledge on the mechanisms by which PGPR and PGPF act on the plants are still lacking. Therefore, this study will broadly bring to light various PGPR and PGPF for future research in horticultural crop improvement.
Keywords: *Beneficial microorganisms, horticulture, plant growth-promoting fungi (PGPF), plant growth-promoting rhizobacteria (PGPR), phytohormones, symbiosis*

INTRODUCTION
The use of microorganisms as inoculants in practical production especially plant growth-promoting rhizobacteria (PGPR) played an important role as a supplement to improve the growth and yield of horticultural crops (Jaime and Dilfuza, 2013). It was documented that PGPR are able to improve plant growth by increasing rate of seed germination and seedling emergence, minimizing the adverse effects of external stress factors and protecting plants from soil-borne pests and diseases. Medicinal plants harbor a distinctive microorganism due to their unique and structurally divergent bioactive secondary metabolites that are most likely responsible for the high specificity of the associated microorganisms (Qi *et al*., 2012). PGPR also help plants to grow by providing soluble phosphate converted by acidification from insoluble mineral phosphates, or via mobilization of other essential nutrients that can also help in plant growth improvement (Bertrand *et al*., 2001). Plant growth-promoting microbes found in the rhizosphere of various plants grown in different soils and climatic conditions were established to provide a wide spectrum of benefits to plants which include; (a) increasing the rate of seed germination and seedling emergence (b) minimizing the adverse effects of external stress factors and (c) protecting plants from soil-borne pests and diseases (Souza *et al*., 2015). There are two types of beneficial rhizosphere bacteria, those forming a symbiotic relationship with the plant and those that are free living in the soil and root (Barriuso *et al*., 2005). Various plant growth-promoting rhizobacteria strains have also proven to increase nutrient availability in the rhizosphere through synergism between the plants and the rhizobacteria (Cakmakci *et al*., 2005).

Arbuscular mycorrhizal fungi (AMF) for horticultural crop production

Plant growth-promoting fungi (PGPF) attract considerable interest as bio-fertilizers due to their multiple beneficial effects on plant quantity and quality and also, their positive relationship with the ecological environment. Plant growth-promoting fungi are non-pathogenic saprophytes that suppress diseases of crop plants caused by fungal and bacterial (Shivanna *et. al.,* 1996; Naziya *et. al.,* 2019 and Chandanie *et. al.,* 2006). Colonization of roots with PGPF can also lead to systemic resistance in distal parts of the plant (Meera 1995; Munoz, 2008). The association of PGPF with roots of various plant species affected with microbial infection has been documented to modulate growth, morphology, nitrogen assimilation, resource allocation and mineral uptake of the host plant and also improves host reproductive fitness by enhancing plant growth, increase biomass and grain yield of crop plants (Emmanuel and Babalola, 2020; Fasusi *et. al.,* 2023). The use of *Alternaria* sp. A13 and *Salvia miltiorrhiza* together under greenhouse conditions enhanced the dry root biomass and secondary metabolite accumulation.

S. miltiorrhiza seedlings colonized by *Alternaria* sp. A13 showed significant increment in fresh weight, dry weight, and contents enhancement (Zhou *et. al.,* 2018) (Table 2). Arbuscular mycorrhizal fungi (AMF) played an important role as a supplement to improve the growth and yield of several medicinal and aromatic plants (MAPs). Arbuscular mycorrhizal fungi (AMF) are also known to increase the growth of many plant species, including MAPs when inoculated with the plants (Selvaraj *et al*., 2008) (Table 2). In *Glomus coronatum*, *G. mosseae*, *G. etunicatum*, *G. geosporum*, *G. viscosum*, and *G. rubiforme* in the rhizosphere of *Smilax aspera* and *Helichrysum litoreum* there was occurrence of AMF species (Turrini *et al.,* 2010). AMF increase plant growth and oil content by stimulating the root system which allows the plant to exploit a greater volume of soil. In *Solanum viarum* plant, there was an improvement in plant growth and increase in mineral contents of leaves samples such as phosphorous, potassium, zinc, copper, manganese and iron content after treatment with AMF.

Co-inoculation of different beneficial microorganisms on host plants

Co-inoculation of different beneficial microorganisms on host plants has been reported by many investigators to improve the absorption of nitrogen (N), phosphorus (P) and mineral nutrients by plants when compared to single inoculation (Bashan and Holguin, 1997). *Lysinbacillus fusiformis* PM5 and PM24 produced 100 μg per ml indo-3-acetic acid (IAA) in defined medium, and considered as a promising potential mechanism for developing plant growth in inoculation conditions (Park *et al*., 2005). Inoculation of medicinal plants with PGPR also influenced the quality and quantity of bioactive constituents and their potential in agriculture, pharmaceutical and medicine (Sharma *et al*., 2015). Co-inoculation activity in species belonging to *Azospirillum*, *Azotobacter*, *Pseudomonas*, *Bacillus*, *Burkholderia*, *Bradyrhizobium*, *Sinorhizobium* and *Trihoderma* (Sudhakar *et al.*, 2000; Hemavathi *et al*., 2006; Hossainzadah *et al*., 2011; Rajasekar and Elango 2011) (Table 1). *Ocimum* spp. when inoculated with *Glomus fasciculatum*, there was an increased in shoot and root growth weight, biomass and essential oil content of *Azotobacter chroococcum* and *A. awamori* (Vinutha, 2005) (Table 1).

Hemavathi *et al*., 2006 (Table 1) also made similar observations in *Ocimum basilicum*, where plant growth increased after inoculation with *G. fasciculatum, Pseudomonas fluorescens* and *Bacillus megaterium*. Inoculation of *A. chroococcum* strain into *Adathoda vasica,* there was an improvement in the root, shoot, growth and dry weight (Anantha, 2006) (Table 1). A significant increase in shoot and root growth, increase in nitrogen content of root (20%) and shoot (52%) of *Galega orientalis* after co-inoculation of *Pseudomonas trivialis* strain 3Re27 with *Rhizobium galegae* HAMBI 540. Improved mineral nutrition explains the promotion of root and shoot growth. Plants inoculated with PGPR take up N, P, K and microelements more efficiently from the soil (Cakmakci *et al*., 2005). Two isolates of PGPR, *Bacillus subtilis* and *Pseudomonas fluorescens,* increased the yield of *Chrysanthemum cinerariifolium* up to 27% (Mishra *et al*., 2010) (Table 1). PGPR strains *P. fluorescens* and *B. megaterium* significantly increased plant height, root length, root girth, alkaloid content and N, P, K, Ca and Mg uptake in *Catharanthus roseus* in comparison to the un-inoculated control (Karthikeyan *et al*., 2010) (Table 1).

Zingiber officinale plants inoculated with *G. mosseae* significantly increased plant growth and also inoculation of *Pelargonium graveolens* with *G. fasciculatum*, *A. chroococcum*, and *Pseudomonas* spp. (Sharma *et al*., 1997). The plant growth and NPK uptake of *Stevia rebaudiana* increased after inoculation with *A. chroococcum, P. fluorescens* and *G. fasciculatum* (Earanna, 2007). Combined inoculation of *Begonia malabarica* and *Calamus thwaitesii* with *G. mosseae, B. coagulans* and *Trichoderma viride* enhanced the growth, biomass, nutrients, and production of secondary metabolites (phenols, ortho-dihydroxy phenols, tannins, flavonoids and alkaloids) (Selvaraj *et al*., 2008) (Table 1). In *S. viarum*, there was an improved in plant growth and increase in phosphorous, potassium, zinc, copper, manganese and iron content after treatment with PGPRs (*G. aggregatum, B. coagulans* and *Trichoderma harzianum*) (Hemashenpagam and Selvaraj 2011) (Table 1). There was a positive effect observed by Hosseinzadah *et al*., 2011 (Table 1) when *Azospirillum lypoferum, A. chroococcum* and *P. fluorescens* were inoculated together with increased in the growth dry weights of shoot and root, NPK content of leaves and roots of *Calendula officinalis*. Combination of PGPR strains *Azospirillum, Azotobacter, Pseudomonas* and *Bacillus* significantly increased plant height, root length, and alkaloid content in *Withania somnifera* compared to the un-inoculated control (Rajasekar and Elango 2011) (Table 1). Three strains of rhizobacteria *Pseudomonas plecoglossicida, Bacillus sp*. and *L. fusiformis* strains identified by 16S rRNA gene sequence analysis were co-inoculated with *Arabidopsis thaliana* and two Datura species (*Datura stramonium* and *D. tatula*), the utilization of beneficial PGPR isolates has great potential to stimulate the growth and development of plants under different culture conditions (Bilal *et. al.,* 2016).

CONCLUSION

The role of plants growth promoting microorganisms cannot be over-emphasized. The great potential of microorganisms was found to have a great potential for use as bio-inoculants to increase production of horticultural crops. These microorganisms will be useful in producing toxic chemical free food, herbals and improve sustainable plant production. The use of beneficial microorganisms (PGPR and PGPF) as bio-inoculant in horticulture has been elucidated. Therefore, for healthy and large scale horticultural crop production, beneficial microorganisms are encourage to be used as bio-fertilizer to enhance food production.

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Table 1: The list of some beneficial bacteria and their host horticultural crops

Beneficial bacteria	Crops	References
Azotobacter chrooccocum	*Adathoda vasica*	Sudhakar *et al*., 2000
	Catharanthus roseus	Karthikeyan *et al*., 2010
	Calendula officinalis L.	Hosseinzadah *et al*., 2011
	Morus alba	Vinutha 2005
	Stevia rebaudiana	
	Ocimum spp.	Earanna 2007
	Ocimum basilicum	Ordookhani *et al*., 2011
	Withania somnifera	Rajasekar and Elango 2011
Azosprillum lipoferum	*Morus alba*	Sudhakar *et al*., 2000
	Ocimum basilicum	Ordookhani *et al*., 2011
Bacillus coagulans	*Begonia malabarica L*	Selvaraj *et al*., 2008
	Solanum viarum	Hemashenpagam and Selvaraj, 2011
Bacillus megaterium	*Ocimum basilicum*	Hemavathi *et al*., 2006
	Withania somnifera	Rajasekar and Elango, 2011
Bacillus subtilis	*Chrysanthemum sp.*	Mishra *et al*., 2010
	Origanum majorana L.	
Pseudomonas fluorescens	*Catharanthus roseus*	Karthikeyan *et al*., 2010
	Chrysanthemum sp.	Hosseinzadah *et al*., 2011
	Origanum majorana L,	Earanna 2007
	Ocimum basilicum	Hemavathi *et al*., 2006
	Stevia rebaudiana	Mishra *et al*., 2010
	Withania somnifera	
Pseudomonas sp	*Ocimum basilicum*	
Pseudomonas putida	*Ocimum basilicum*	Ordookhani *et al*., 2011

Table 2: The list of some beneficial fungi and their respective horticultural crops

Beneficial fungi	Crops	References
Glomus mosseae	*Begonia malabarica L*	Selvaraj *et al*., 2008
Glomus aggregatum	*Solanum viarum*	Hemashenpagam and Selvaraj, 2011
	Ocimum spp.	Vinutha 2005
	O. basilicum	Hemavathi *et al*., 2006
	Phyllanthus amarus	Earanna 2007
	Stevia rebaudiana	Earanna and Bagyaraj 2004
Trichoderma harzianum	*Solanum viarum*	Hemashenpagam and Selvaraj, 2011
Trichoderma viride	*Begonia malabarica* L.	Selvaraj *et al*., 2008

INFLUENCE OF DIFFERENT ROOTING MEDIA ON SPROUTING AND GROWTH OF THUJA (*Thuja occidentalis L.*)

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ABSTRACT
This study was conducted at the Horticultural section of Adekunle Ajasin University, Akungba Akoko, Ondo State, Nigeria between June and August, 2019 to evaluate the effect of different rooting media on the sprouting and growth of Thuja plant. The experiment was laid out in Completely Randomized Design (CRD) having four replicates. The different rooting media treatments used were: Topsoil (TS), Fresh sawdust (FSD), Cured sawdust (CSD), Topsoil + Fresh sawdust (TS+FSD) 1:1 v/v, Topsoil + Cured sawdust (TS + CSD) 1:1 v/v. At the end of 8 and 10 weeks after planting (WAP) data were collected on the percentage of Thuja survival, number of roots, length of root, number of new leaves and visual quality of the plant at 10 WAP. The results indicated existence of significant differences (p<0.05) among the different rooting media with respect to their effects on sprouting and the growth attributes of Thuja. Of all the rooting media, at 8 and 10 WAP, Top soil + Cured sawdust (TS + CSD 1:1) gave the highest number of roots at 10.75, 12.95 for 8 and 10 WAP, respectively. Similarly, at 8 and 10 WAP, TS + CSD1:1 gave the highest value of Thuja root length of 11.74 cm, and 14.75 cm for 8 and 10 WAP, respectively. TS + CSD1:1 gave the highest value of Thuja number of leaves produced at 7.25, 10.25 for 8 and 10 WAP, respectively. In visual quality assessment, TS + CSD1:1also had the highest value of 5.00. Sprouting and growth of Thuja is thus enhanced by using TS + CSD1:1.
***Keywords**: Plant propagation, Rooting media, stem cuttings, Thuja occidentalis*

INTRODUCTION

Thuja (*Thuja occidentalis*) is a conifer tree widely used as an ornamental plant. It belongs to the family Cupressaceae. It is an evergreen tree growing up to a height of six (6) to thirty- eight (38) meter at a slow rate having an even and symmetrical canopy with a soft compact framework and pyramidal structure in outlook (Gilman *et al*., 2006). It develops well in partial shade, but will perform better under full sunshine. Thuja is mostly propagated through stem cuttings obtained from stem tip. It could also be propagated through seeding and layering. The cutting is taken from the current year's growths that are firm but flexible as cutting from older growth are less likely to root (Dyer, 2018). Thuja possesses beautiful leaf shape and texture and so is used extensively as specimen or spot plant in landscaping.. It is equally used as screen plant to create an attractive privacy around a family gathering spot or children's play area, used as narrow hedges, as background to flower beds, in rockery, for guard strip around parking lots, for median planting in high way, as avenue plant and as reclamant plants also. It is sometimes grown as Christmas tree. In India, it is used as wind breaks. (Ilem 2016; Soga *et al.,2018)*. It attracts high economic returns to the grower as a single Thuja plant costs between ₦1,500.00, and ₦5 ,000.00 in Nigeria, depending on the size (Afrimash, 2020).
Apart from its ornamental uses, Thuja wood is usually utilized for guitar sound board. It is also being extensively used for building of beehives (Bucur, 1995). Medicinally, Thuja is used as an herbal medicine. Thuja leaves and oil (Thujone) are also used for treating cold sores, bacteria skin infection, joint and muscle pain. It is used as insect repellant and as flavouring agent in food and beverages (Thuja, 2018). As important as this plant is, it has a very low genetic and physiological capacity for adventitious

root production. This then, limits its large scale cultivation. Economically, the demand for this ornamental plant compels that the 'difficult-to-root' phenomenon should be resolved. This study was thus carried out with the objective of exploring different locally available, cheap rooting media and determining their effects and the best one for raising *Thuja occidentalis.*

MATERIALS AND METHODS

The experiment was conducted at the Horticultural Nursery Section of Adekunle Ajasin University, Akungba Akoko, Ondo State, Nigeria, between June and August, 2019. Average annual rainfall is between 1100 – 2000 mm per annum with mean temperature ranging between 26ºC and 28ºC and mean relative humidity is about 62%. The experiment was laid out in a completely randomized Design (CRD) with four replicates. Stem cutting of Thuja's tip part (15cm long each) was planted at the rate of one stem cutting per black polythene bag of dimension of 24 x 21cm - filled with required medium. The five rooting media and mixtures used are: Top soil (TS), Fresh Saw dust (FSD), Cured saw dust (CSD), Top Soil + Fresh Saw dust 1:1 (TS+FSD) and Top Soil + Cured Saw Dust 1:1 (TS+CSD).

Data were collected on: Percentage of plant survival as affected by the growth media at ten (10) weeks after planting (WAP), Number of roots and root length – at eight (8) and ten (10) week after planting (WAP), Number of new leaves produced – at eight (8) and ten (10) week after planting (WAP), Visual quality of the treatments at ten (10) week after planting (WAP). Prior planting, the physical and chemical analysis of the media were carried out to determine the texture and the nutrient concentration of the rooting media**.** Data collected were subjected to Analysis of Variance (ANOVA) and the treatments means were separated using Fisher's Least Significance Difference (LSD) at 5% level of probability.

RESULTS

Physical and Chemical properties of soil and rooting media used in the experiment

The textural class of the soil was sandy loam with 80.1% sand, 10.5% silt and 9.4 % clay. (Table 1.) The pH value of TS +CSD 1:1was 5.55, TS + CSD (1:1) had the highest concentration of available nitrogen (3.72g/kg) followed by CSD (3.62 g/kg), Sole TS had the highest concentration of Phosphorus (54.8mg/kg) followed by TS + CSD (1:1) (42.60mg/kg), The highest available Potassium was in CSD (2.60cmol/kg) followed by TS + CSD. FSD had the highest value of organic carbon (430.5g/kg) and sole TS (19.2/kg) had the least value (Table 1).

Growth parameters

The growth media had effect ($P<0.05$) on survival of Thuja at 10WAP. 100% survival of Thuja plant was observed in TS, CSD and TS +CSD 1:1. There was marginal decrease in the percentage survival recorded for TS +FSD1:1(75%). The FSD had the least (25%).(Table 2)

The growth media used also had significant effect on the number of roots produced at both 8 and 10WAP except in treatment with TS and CSD in both 8 and 10 WAP. Thuja raised in TS +CSD 1:1 significantly had higher number of roots than the rest, FSD had the least number of root produced. (Table 3).Thuja root length in TS +CSD 1:1 significantly longer than in others treatments at 8 and 10 WAP except in CSD at 8WAP.The least length of root produced at 8 and 10 WAP was recorded in FSD (Table 4) The number of new leaves produced at 8 and10 WAP was significantly higher ($p<0.05$) in the TS +CSD1:1(7.25) There was no significant difference in TS +CSD1:1in comparison with CSD The mean value of Fresh Sawdust was significantly lower ($p<0.05$) (Table 5)The rooting media had significant effect on the visual assessment of the treatments at 10WAP, except for plants raised in TS +CSD1:1 and CSD that showed no significant variance. (Table 6)

Table 1: Physical and chemical characteristics of soil and other Rooting media used in the experiment

PARAMETERS	TS	FSD	CSD	TS+ FSD 1:1	TS+ CSD1:1
Organic Carbon (g/kg)	19.20	430.50	196.35	232.40	202.25
pH	5.04	5.76	5.94	5.42	5.55
Nitrogen (g/kg)	2.12	3.54	3.62	2.65	3.72

Phosphorus (mg/kg)	54.80	11.20	35.60	32.40	42.60
Calcium (cmol/kg)	2.24	3.03	5.50	2.64	3.58
Magnesium (cmol/kg)	0.74	1.02	2.15	0.92	1.43
Potassium (cmol/kg)	0.56	0.36	2.60	0.46	1.56
Sodium (cmol/kg)	0.37	0.28	0.56	0.29	0.40
Iron (mg/kg)	0.04	20.00	430.00	9.80	214.00
Zinc (mg/kg)	28.20	44.00	68.00	30.40	46.80
Manganese (mg/kg)	348.00	93.00	476.00	224.00	438.00
Copper (mg/kg)	7.20	8.00	6.00	7.80	6.70
Particle size analysis					
Sand % =	80.1				
Silt %=	10.5				
Clay % =	9.4				
Textural class- Sandy loam					

Table 2: Percentage of survival of Thuja plant as affected by different rooting media

Treatments	Survival
TS	1.00a
FSD	0.25c
CSD	1.00a
TS+FSD 1:1	0.75a
TS+CSD 1:1	1.00a
LSD	0.34

Table 3: Effect of rooting media on number of adventitious roots produced at 8 and 10 WAP

Treatments	**Weeks after Planting**	
	8	**10**
TS	7.00b	8.25c
FSD	0.00d	0.50e
CSD	8.25a	8.75b
TS+ FSD	2.50c	3.00d
TS+CSD	10.75a	13.75a
LSD	2.51	2.05

Table 4: Thuja root length (cm) as affected by the rooting media at 8 and 10 WAP

	Weeks After Planting	
Treatments	**8**	**10**
TS	4.50b	9.75b
FSD	0.00c	1.00c
CSD	10.75a	11.50b
TS+FSD 1:1	7.05a	7.75b
TS+CSD 1:1	11.75a	16.75a
LSD	2.02	4.13

Table 5: Effects of different rooting media on number of Thuja leaves produced at 8 and 10 WAP

Treatments	**Weeks After Planting**	
	8 WAP	**10 WAP**
TS	5.00b	7.00b
FSD	0.50c	0.75d
CSD	6.25a	8.25b
TS+FSD 1:1	3.00b	4.25c
TS+CSD 1:1	7.25a	10.25a
LSD	15.30	15.10

Table 6: Visual assessment of the sprouted Thuja plants

Treatments	**Visual rating value**
TS	3.00b
FSD	1.00d
CSD	4.00b
TS+FSD 1:1	2.00c
TS+CSD 1:1	5.00a
LSD	0.61

Rating key: Excellent - 5; V. Good - 4; Good - 3; Poor - 2; V. Poor - 1

DISCUSSION

The lower survival percentage in Fresh Sawdust is in line with observations of Jose *et al* (2018) and Akintoye *et al* (2012), that Fresh Sawdust greatly inhibits plant survival and growth due to its toxicity, high cellulose and lignin content, hence is not fit for use in raising cuttings or seedlings in the nursery. Studies by, Barbara (2010) and Bhadway (2014) also supported these findings. The 100% survival of Thuja plants in TS, CSD, and TS + CSD (1:1) is a pointer to the suitability of these growth media for its survival. Ade Oluwa *et al* (2014) and Ebere *et al* (2017). The Thuja plant cuttings raised in TS + CSD (1:1)consistently gave the highest mean values of the parameters measured. This could not be unconnected with the desirable physical and chemical characteristics of the rooting media. TS + CSD (1:1) had a pH value of 5.55 which favoured the growth of Thuja. This agreed with Soga *et al* (2018), who stated that coniferous shrubs and trees have preference for lower pH levels of between 5.00 – 5.55 for good growth and development as more nutrients are made available for its absorption at this pH range. The higher number of roots and root length value for Thuja plant at 8 and 10 WAP in TS + CSD (1:1) are in agreement with the report of Olosunde *et al* (2012) and Fagge *et al* (2019), who noted that apical cuttings and some selected stem cuttings raised in TS + CSD and CSD formed the lengthiest roots in their findings. At 8 WAP, there existed no significant difference in the number of Thuja plants' roots and the length of roots between CSD and TS + CSD (1:1) at 8WAP. However, significant differences occurred at 10 WAP in both the number of roots and length of roots produced. The reason could be partly because TS + CSD (1:1) combined good features of both media in terms of rich organic matter, nutrients and porosity which provides better opportunity for growth. So, according to Oluwafemi *et al* (2017) heterogeneity of the media (physically and chemically) is a good factor that makes the medium used in raising ornamental plants the best because of additive relationship between the media component and the complementary role of the mixtures. The highest number of leaves recorded in TS +CSD 1:1 followed by CSD could be attributed to high presence of minerals needed by the plants in the media particularly Nitrogen (3.72g/kg), Phosphorus (42.60mg/kg) and Potassium (1.56cmol/kg) which is higher than that of other media (Table 1) This high fertility status was due to its decomposed organic matter content which is rich in nutrients that in turn translated to vegetative development of Thuja. Mathad and Nalwadi (1989). Akanbi and Togun (2002) also added to this fact that nutrients availability especially Nitrogen greatly influences and determines the vegetative development of plants.The least growth value was consistently recorded for FSD despite the level of Nitrogen in it (3.54 g/ kg) higher than that of the Topsoil. This could be as a result of its having very high organic carbon content (430.50g/kg). This makes the loss of Nitrogen in the medium easy as microbes try to decompose it. In other word, immobilization of available Nitrogen in the medium occur due to high Carbon - Nitrogen ratio (C: N) effect. Olosunde *et al* (2008) Barbara (2010). Visual assessment of Thuja in the different media used showed that the appearance of the plant grown in Topsoil + Cured Sawdust according to the rating index used was better when compared with other media.

CONCLUSION

The Top soil + Cured Sawdust (1:1) proved to be the best medium in raising and for overcoming the difficulty in raising *Thuja* as it produced the highest number of roots, root length, number of new leaves produced and had the best rating in physical outlook.

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EFFECT OF NPK FERTILIZER APPLICATION RATES ON GROWTH AND YIELD OF ONION (*Allium cepa* L.) IN KABBA, NIGERIA

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ABSTRACT
Food insecurity remains a major challenge in Nigeria and insufficient nutrient intake causes severe malnutrition affecting the populace. Six fertilizer application rates were evaluated for their effect on growth and yield of onion at College of Agriculture, Kabba, Kogi State, Nigeria. The fertilizer application rates comprised of 0 kg h^{-1} NPK (20:10:10), 50 kg h^{-1} NPK, 100 kg h^{-1} NPK, 150 kg h^{-1} NPK, 200 kg h^{-1} NPK and 250 kg h^{-1} NPK. The experiment was laid out in completely randomized design (CRD) and replicated five times. Data were collected on plant height, number of leaves, leaf length, bulb diameter, bulb length, bulb circumference, shoot weight, bulb weight, dry matter contents and distribution. The results of the analysis of variance showed that fertilizer rates significantly ($p < 0.05$) influenced plant height, number of leaves and leaf length of onion. Onion plants treated with 150 kg h^{-1} NPK had the tallest plants, more leaves and longest leaves across the sampling weeks. The result also indicated that fertilizer application rates positively impacted yield components and yield with 150 kg h^{-1} NPK taking the lead. Application of 150 kg h^{-1} NPK had similar effect with 100 kg h^{-1} NPK regarding growth and yield traits accessed. For cost effectiveness, application of 100 kg h^{-1} NPK is suitable for pot onion production in homes.
Keywords: *Onion; Fertilizer; Application rates; Growth and yield; Food security*

INTRODUCTION
The onion (*Allium cepa* L.) is an herbaceous biennial plant of the family Alliaceae (Ghaffoor *et al.,* 2003). Onion is one of the most important vegetable crops cultivated in different parts of the world commercially. Hussaini *et al.* (2000) reported that the crop ranks second in importance after tomatoes among the vegetables in Nigeria. Bulbs are formed from the seeds in the first season of growth. Seeds are formed from the flowers in the second season. According to variety, the onion bulbs differ in sizes such as small, medium and large. It also produces bulbs with different colours like white, yellow, or red. Various shapes such as flattened, round or globular and texture like fine, or coarse has been documented (Ghaffoor *et al.,* 2003). It is cherished for having flavour and pungent properties, due to the presence of a volatile oil – allyl-propyl-disulphide. Onion is a high value and high income generating vegetable crop for farmers (Dapaah *et al.,* 2014). Onion is important in the daily Nigerian diet, the mature bulbs and green shoots are widely used as a seasoning or a vegetable in various dishes (Abdissa *et al.,* 2011). Being a rich source of flavonoids, its consumption has been linked to reducing the risk of developing cancer, heart disease and diabetes (Renbomo and Kanti, 2017). In addition, its anti-bacterial, antiviral, anti-allergenic and anti-inflammatory potential are noteworthy. Onion contains vitamins A and C, and a good amount of mineral elements for human nourishment (United States Dietary Allowance, 2008; Paul, 2006).
In Nigeria, onion is produced in the Sudan Savanna zones especially Gombe, Kano, Sokoto, Kaduna, Bornu and Plateau States (Falodun *et al.,* 2015). Other zones in Nigeria rely on the onion supply from these parts of the country because they are ignorant of the possibility of onion cultivation in other agro-ecological zones of Nigeria. Another constraint to sustained increased onion production include inadequate information on fertilizer recommendation at optimum level. Onions are sensitive to nutrient deficiencies compared to other crop plants due to their shallow and unbranched root system. Hence, they require and often respond well to addition of fertilizers. The application of NPK fertilizer improves the

growth and yield of onion. The application of balanced macro nutrients (Nitrogen, Phosphorus and Potassium) can enhance plant growth, development and yield (Maisura *et al.,* 2019). Generally, excessive amounts of inorganic fertilizers are applied to vegetables in order to achieve a higher yield (Seran *et al.,* 2010; Stewart *et al.,* 2005) which is uneconomical. There is limited information in the guinea savanna zone of Kogi State on the effects of fertilizer application rates on onion performance. Determining the appropriate fertilizer rate for onion will help to increase onion production, improve the diet of the people and generate income to the farmers. The objective of this study therefore was to investigate the optimum level of fertilizer application for the growth and yield of onion in Kabba, Kogi State.

MATERIALS AND METHODS

Experimental site: The experiment was conducted at Horticulture section, College of Agriculture, Kabba (7.8231˚N, 6.0732˚E and 400 m above sea level), in Southern Guinea Savanna Zone of Nigeria. The monoidal rainfall spans April to November with peak in June and dry season extends from December to March. The mean annual rainfall is 1570 mm per annum with an annual temperature range of 18-32˚C. The mean relative humidity is 60%.

Nursery preparation and seedling transplanting: Onion seeds were sourced from a local market in Gombe State and nursery bed was prepared in late February 2022 to raise the seedlings for six weeks before transplanting into the pots. The seedlings were transplanted into the pots in March 2022. The soil was potted in polyethylene bags of size 48 x 38.5 cm.

Experimental design: The experiment was laid out in a Completely Randomized Design (CRD) and replicated five times. The treatments were no fertilizer (control), 50 kg h^{-1} NPK, 100 kg h^{-1} NPK, 150 kg h^{-1} NPK, 200 kg h^{-1} NPK and 250 kg h^{-1} NPK. Each pot contained one plant.

Fertilizer application: The NPK fertilizer (20:10:10) was applied in split doses, 40% of the required quantity was applied at 2 weeks after transplanting while the remaining 60% was applied at 6 weeks after transplanting. The pots were arranged 40 cm apart.

Irrigation: Irrigation was done when required especially during the dry season when the seedlings were transplanted. This is done to conserve the optimum moisture level of the soil.

Data collection: Data was collected from the five plants that received similar treatment.

The following parameters were recorded from the plants.

Plant height (cm): Plant height was measured in centimeter from the ground level to the tip of the leaf using measuring tape.

Number of leaves per plant: Number of leaves produced by each plant were counted and the average recorded.

Leaf length (cm): The length of leaves was measured in centimeter with a measuring tape and the average leaf length taken.

Bulb diameter (cm): Bulb diameter at harvest was measured at right angles to the longitudinal axis at the widest circumference of the bulb from each plant.

Bulb circumference (cm): The circumference of bulb at harvest was measured at the middle portion of bulb and the average taken.

Bulb length (cm): The height of the bulb was measured using Vernier caliper.

Bulb weight (g): The top of each bulb was removed by cutting the pseudo-stem at 1 cm from the bulb, then weighed using electronic balance.

Harvesting: The crop was harvested in early July when more than 70 per cent of the tops had fallen over. Oven dry weights of the shoot and bulb were also taken from which dry matter content and distribution were estimated. The various plant parts were oven dried at a temperature of 80°C to a constant weight.

Total dry weight: It was calculated by adding dry shoot weight with dry bulb weight.

Shoot/bulb ratio: This was calculated by dividing shoot weight by the bulb weight.

Dry matter accumulation to the shoot: This was calculated as follows: $\frac{\text{Dry weight of shoot}}{\text{total dry weight}} \times 100$

Dry matter accumulation to the bulb: This was calculated as follows: $\frac{\text{Dry weight of bulb}}{\text{total dry weight}} \times 100$

Statistical analysis: Data were subjected to analysis of variance (ANOVA) in completely randomized design (CRD) using the GenStat statistical package (GenStat, 2007). Means were separated using the least significant difference (LSD) at 5% probability level.

RESULTS

Physicochemical properties of the experimental soil used

The physicochemical properties of the soil used for the experimental is shown in Table 1. The soil is characterized as sandy loam. The total nitrogen was very low (0.398%) and the available phosphorus (12.20 ppm) was medium. The potassium content was 0.16 cmol/kg. The cation exchange capacity was 22.70 cmol/kg, the base saturation was 30.89%. Organic carbon and organic matter were 2.212 and 2.932%, respectively, indicating that the soil was low in fertility.

Table 1: Physicochemical properties of the soil used in the study

Mechanical properties	Soil Particle size
Clay (%)	17
Silt (%)	9
Fine sand (%)	38
Coarse sand (%)	37
Textural class	Sandy loam
Chemical properties	
pH in water	6.1
pH in KCl	5.1
Organic carbon (%)	2.212
Organic matter (%)	2.932
Total nitrogen (%)	0.398
Phosphorus (ppm)	12.20
Exchangeable base	
Sodium (Na+) cmol/kg	0.08
Calcium (Ca^2+) cmol/kg	3.83
Potassium (K+) cmol/kg	0.16
Magnesium (mg^2+) cmol/kg	3.04
CEC	22.70
Base saturation (%)	30.89
Exchangeable acidity in me/ 100 g soil	
Aluminium (Al3+)	0.11
Hydrogen (H+)	1.39

Source: Faculty of Agriculture, University of Nigeria, Nsukka, laboratory.

Growth parameters

Effect of NPK fertilizer application rates on plant height of onion in weeks after transplanting (WAT) is shown in Table 2. Fertilizer application rates significantly ($p < 0.05$) influenced height of onion plants at 4, 6, 8 and 10 WAT. Application of 150 kg h^{-1} of NPK increased plant height across the weeks with respective values of 30.63, 51.00, 56.90 and 61.00 cm. The value recorded at 4 WAT was not statistically different from 28.33 and 26.70 cm obtained when onion plants were treated with 100 kg h^{-1} and 200 kg h^{-1}, respectively. Similarly, the values obtained at 6, 8 and 10 WAT did not vary from 44.00, 49.22 and 55.33 noticed in plants that received 100 kg h^{-1} NPK, respectively. However, plants fertilized with 250 kg h^{-1} produced the shortest plants (16.73, 20.33, 24.17 and 27.73 cm) at 4, 6, 8 and 10 WAT, respectively.

Table 2: Effect of NPK fertilizer application rates on plant height (cm) of onion at 4, 6, 8 and 10 weeks after transplanting

Fertilizer	Plant height in weeks after transplanting			
	4	6	8	10
0 kg h^{-1}	18.00	23.83	30.33	34.67
50 kg h^{-1}	20.67	38.43	43.33	49.00
100 kg h^{-1}	28.33	44.00	49.33	55.33
150 kg h^{-1}	30.63	51.00	56.90	61.00
200 kg h^{-1}	26.70	33.67	38.67	44.67
250 kg h^{-1}	16.73	20.33	24.17	27.73
LSD (0.05)	7.75	10.47	9.85	9.87

Table 3 presents the effect of NPK fertilizer application rates on number of leaves of onion in weeks after transplanting. Number of leaves was significantly ($p < 0.05$) affected by the application of NPK fertilizer rates across the months. More number of leaves (5.67, 9.67, 11.33 and 13.67) was attributed to 150 kg h^{-1} NPK at 4, 6, 8 and 10 WAT, respectively. Although the values were statistically similar to 5.00 and 9.00 recorded when 100 kg h^{-1} NPK was applied at 4 and 6 WAT, respectively. Similarly, at 8 and 10 WAT, the values were not statistically the same with 9.33 and 10.67 and 11.67 and 12.33 recorded when plants were grown with 50 kg h^{-1} and 100 kg h^{-1}. Soil amended with 250 kg h^{-1} of NPK produced the least number of leaves of 2.67, 4.00, 5.67 and 7.00 at 4, 6, 8 and 10 WAT.

Table 3: Effect of NPK fertilizer application rates on number of leaves of onion at 4, 6, 8 and 10 weeks after transplanting

Fertilizer	Number of leaves in weeks after transplanting			
	4	6	8	10
0 kg h^{-1}	3.67	5.333	6.00	7.67
50 kg h^{-1}	4.33	7.67	9.33	11.67
100 kg h^{-1}	5.00	9.00	10.67	12.33
150 kg h^{-1}	5.67	9.67	11.33	13.67
200 kg h^{-1}	4.33	7.33	9.00	11.00
250 kg h^{-1}	2.67	4.00	5.67	7.00
LSD (0.05)	1.13	1.88	1.93	1.92

Effect of NPK fertilizer application rates on leaf length of onion in weeks after transplanting is presented in Table 4. Influence of fertilizer application rates is in this order with respect to number of leaves: 150 kg h^{-1} > 100 kg h^{-1} > 50 kg h^{-1} > 200 kg h^{-1} > 0 kg h^{-1} > 250 kg h^{-1}.

Table 4: Effect of NPK fertilizer application rates on leaf length (cm) of onion at 4, 6, 8 and 10 weeks after transplanting

Fertilizer	Leaf length in weeks after transplanting			
	4	6	8	10
0 kg h^{-1}	8.69	19.30	23.87	29.00
50 kg h^{-1}	11.17	29.90	36.00	44.00
100 kg h^{-1}	16.71	33.95	42.40	52.00

150 kg h^{-1}	18.47	39.25	43.31	53.67
200 kg h^{-1}	13.60	28.14	31.44	37.27
250 kg h^{-1}	7.72	17.63	21.20	26.33
LSD (0.05)	5.24	6.39	7.48	4.15

Yield attributes and yield

Effect of NPK fertilizer application rates on bulb circumference, bulb diameter, bulb length, bulb weight, shoot weight and total weight of onion is presented in Table 5. Fertilizer application rates had positive impact on bulb circumference, bulb diameter, bulb length, bulb weight and total weight of onion. It is important to note that, plants grown with 150 kg h^{-1} of NPK had the widest bulb (18.23 cm), heaviest bulb (71.00 g) and total weight of 99.67 g than others. The least value for bulb circumference (12.10 cm), bulb weight (27.00 g) and total weight (42.67 g) was associated with the application of 250 kg h^{-1} of NPK.

Table 5: Effect of NPK fertilizer application rates on bulb circumference, bulb diameter, bulb length, bulb weight, shoot weight and total weight of onion

Fertilizer	Bulb circumference (cm)	Bulb diameter (cm)	Bulb length (cm)	Bulb weight (g)	Shoot weight (g)	Total weight (g)
0 kg h^{-1}	13.67	13.40	8.00	29.33	20.33	49.67
50 kg h^{-1}	13.60	13.70	7.63	31.00	21.33	52.33
100 kg h^{-1}	16.50	17.20	9.03	59.33	26.67	86.00
150 kg h^{-1}	18.23	18.03	9.70	71.00	28.67	99.67
200 kg h^{-1}	12.40	11.67	8.83	33.00	16.67	49.67
250 kg h^{-1}	12.10	12.20	7.80	27.00	15.67	42.67
LSD (0.05)	3.74	NS	NS	23.33	NS	28.74

NS-Non-significant

Dry matter attributes

Effect of fertilizer application rates on dry matter attributes of onion is shown in Table 6. Dry matter attributes of onion plant evaluated indicated non-significant influence of fertilizer application rates on all the traits.

Table 6: Dry matter attributes of onion plants grown under different fertilizer application rates

Fertilizer	Dry shoot weight (g)	Dry bulb weight (g)	Total dry weight (g)	Shoot /bulb ratio	% DMDS	% DMDB
0 kg h^{-1}	2.36	7.15	9.52	0.31	23.57	76.43
50 kg h^{-1}	2.77	7.38	10.15	0.46	30.42	69.58
100 kg h^{-1}	3.17	9.72	12.89	0.34	24.87	75.13
150 kg h^{-1}	3.11	14.02	17.14	0.22	17.86	82.14
200 kg h^{-1}	2.33	6.72	9.06	0.41	28.70	71.30
250 kg h^{-1}	2.09	6.00	8.09	0.49	28.22	71.78
LSD (0.05)	NS	NS	NS	NS	NS	NS

% DMDS- Percent dry matter distribution to the shoot; % DMDB- Percent dry matter distribution to the bulb. NS-Non-significant

DISCUSSION

Growth

The effect of fertilizer application rates on growth attributes of onion differed significantly. Plant height, number of leaves and leaf length significantly increased with the application of 150 kg h^{-1} of NPK. This observation indicated that this rate is optimum thereby releasing sufficient amount of nutrient element to complement the inherent nutrient in the soil. Adebayo *et al.* (2011) reported that when fertilizer is available in adequate quantity, plants tend to grow at their optimal potential. Earlier reports from Cann (1965); Baiyeri (2002); Abubakari *et al.* (2015) reported that the number of fruits per bunch of plantain is impacted by plant nutrition. Further application of fertilizer above 150 kg ha^{-1} of NPK led to a decrease in growth attributes when compared with the plants treated without fertilizer application. The result implied that onion plants may thrive well on marginal soils but addition of fertilizer could enhance the growth of this plant. The decline in growth parameters obtained above 150 kg h^{-1} could be attributed to acidification. This result corroborates Olajide and Baiyeri (2021) who found that NPK decreased growth of *Ceiba pentandra* which was attributed to acidification of the rhizosphere.

Yield and dry matter attributes

The variability observed in yield and some dry matter attributes of onion in this study is linked to varying rates of fertilizer application. Application of 150 kg h^{-1} positively enhanced yield and some dry matter parameters accessed. This finding could be as a result of sufficient nutrient supplied to onion by this rate that resulted to increased yield. When nutrients are supplied in optimal quantity, high quality and better nutritious plants are produced (Rice *et al.,* 1994; Baiyeri *et al.,* 2009). The result of this finding contradicts the work of Falodun *et al.* (2015) who reported increase in yield characters of onion plants treated with higher rate of inorganic fertilizer over the control. The result also disagrees with those of Abdelrazzag (2002) in onion and Togun and Akanbi (2003) in tomato who found that the yield characters of the crops improved with increased application of inorganic fertilizer. Generally, reduction in yield parameters was obtained when fertilizer was applied beyond 150 kg h^{-1} which may be linked to rising level of soil acidity. Application of NPK decreased soil pH and boosted soil acidification (Qaswar *et al.,* 2020).

The pattern of dry matter distribution of onion plants in which 69.58 – 82.14% of photo-assimilates went to the bulb corroborates Ugese *et al.* (2008) who recorded dry matter allocation to the root of more than 70% in shea tree seedlings. This finding contradicts the report of Baiyeri (2003) in cashew and African breadfruit where dry matter allocation to the root was less than 20%. Ugese (2010) reported that dry matter distribution pattern of tamarind seedlings ranged from 38.9 – 45.3% which seem to be contrary to the findings of this present study.

CONCLUSION

Varying rates of NPK influenced growth, yield and some dry matter traits of onion as obtained in this present study. Although application of NPK fertilizer at 150 kg h^{-1} improved growth and yield of onion, however when compared with plants that received 100 kg h^{-1} of NPK, there was no significant difference in growth and yield parameters measured. Hence, for cost effectiveness, 100 kg h^{-1} of NPK is recommended for onion production in the study area.

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OPTIMISATION OF PROTOCOL FOR THE MICRO-PROPAGATION OF FLUTED PUMPKIN USING DIFFERENT CONCENTRATION OF HORMONES

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ABSTRACT
The optimized protocol for tissue culture will facilitate large-scale production of high-quality planting materials, ensuring a stable supply for commercial cultivation. It also supports genetic research, conservation, and mass multiplication of fluted pumpkin varieties. Ultimately, this research seeks to develop a robust and efficient protocol, enhancing the rapid multiplication of this nutritious vegetable. The application of plant growth hormones had varying effect on the cultivated tissue culture plantlets. In the absence of hormone (plant growth regulator), the plantlets survived, but did not proliferate. Varying the concentrations of the hormones showed varying growth patterns.
Keywords: *Tissue culture, plant growth regulators, fluted pumpkin, plantlets and protocol*

INTRODUCTION

Fluted pumpkin (*Telfairia occidentalis* Hook f.) is a prized leafy vegetable in West Africa due to its nutritional value and versatility (Fajinmi *et al*., 2022). However, conventional propagation faces challenges like limited access to quality planting materials and slow multiplication rates (Ajayi, 2007). Micro-propagation, a controlled environment technique, offers a solution. This study focuses on optimizing the micro-propagation protocol using different hormone concentrations. Hormones are critical for plant growth and can significantly impact micro-propagation success (Harahap *et al*., 2020). Fluted pumpkin, a vital West African leafy vegetable, faces challenges in traditional propagation. Micro-propagation shows promise for rapid multiplication, but optimized protocols are lacking. Hormone concentration optimization is crucial for improving shoot multiplication, elongation, rooting, and plantlet vigor. Research is needed to develop a reliable protocol for high-quality planting materials in commercial cultivation. This research aims to improve conventional fluted pumpkin propagation methods by optimizing micro-propagation. It will increase access to quality planting materials, boost agricultural productivity, and promote sustainability. Additionally, it supports genetic research, contributes to economic development, and addresses various limitations, offering substantial benefits to the fluted pumpkin sector. The aim of the study was to find the ideal hormone mix and concentration for promoting shoot multiplication, elongation, and root formation while minimizing callus formation.

MATERIALS AND METHODS

Healthy fluted pumpkin explants will be cultured on a nutrient medium with varying concentrations of plant growth regulators like auxins and cytokinins.

Media Composition

Table 1: Table showing media composition and concentrations

	Zero Hormone	**BAP + IBA (0.1mg/ml)**	**BAP + IBA(0.2mg/ml)**	**Kin +GA3+**	**BAP + NAA(0.1mg/ml)**	**BAP + NAA(0.2mg/ml)**
Murashige & Skoog (MS)	4.43g	4.43g	4.43g	4.43g	4.43g	4.43g
Sucrose	30g	30g	30g	30g	30g	30g
Mio Inositol	100mg	100mg	100mg	100mg	100mg	100mg
Kinetin	-	-	-	1.0/2.0/5.0	-	-
GA3+	-	-	-	1.0/2.0/5.0	-	-

BAP	-	0.5/0.1/0.05/ 1.0/2.0	0.5/0.1/0.05/ 1.0/2.0	-	0.5/0.1/0.05/ 1.0/2.0	0.5/0.1/0.05/ 1.0/2.0
NAA	-	-	-	-	0.1	0.2
IBA	-	0.1	0.2	-	-	-

Preparation of plant material

Surface Sterilisation

The seeds of fluted pumpkin will be extracted from its pod and washed thoroughly under running water, and then sterilized with 20% Clorox (Sodium Hypochlorite 3,5 v/v) for 15min and 10% Clorox (Sodium Hypochlorite 3,5 v/v)for 15min. Explants will be rinsed thrice with sterile distilled water

Initiation

Explants will be initiated using Nelson and Somogi medium as reported by Nagata *et al*, 2007. This medium contained mineral salts of Murashige and Skoog (1962) medium, Sucrose (30 g/l) and Phytagel (2.5 g/l). Sterilized ugwu seeds will be transferred to the MS initiation media under sterile conditions using a Labconco laminar flow hood (Murashige and Skoog 1962).

Multiplication

Upon establishment, approximately 6 weeks after initiation, the plantlets will be transferred to a multiplication medium in 200 mL glass food jars. The multiplication medium will be made up of Murashige and Skoog (1962) medium, IBA (2.0 mg/l), NAA (1.8 mg/l), Kinetin (2.0 mg/l), Sucrose (30 g/l) and Phytagel (2.5 g/l). Further sub-culturing will be done every 6 weeks to increase plantlet numbers. Mature rooting systems will be established after the plantlets are placed on a rooting medium containing mg NAA.

Fig 1: Measurement of root length after 4 weeks of cultivation under optimum temperature and humidity

Fig 2: Test tube containing cultivated fluted pumpkin using Kinetin and GA3+ (2:2) at 4 weeks

Fig 3: Test tube containing cultivated fluted pumpkin using BAP and NAA (0.1:0.1) at 4 weeks

RESULTS AND DISCUSSION

The results show the effect of increasing concentrations of each of the hormones on the growth parameters.

Number of Roots and Root length:

The model is highly significant ($p < 0.01$), indicating that the various hormone combinations collectively influence the number of roots.BAP and BAP + NAA are highly significant individual factors ($p < 0.01$), suggesting their strong influence on the number of roots.IBA, NAA, KIN, and GA3 do not significantly affect the number of roots. This report tallies with the observations of Vanhala *et al*., (1998). However, hormone combinations of BAP + IBA, BAP + NAA and increasing concentrations of BAP are also significant ($p < 0.05$), indicating their combined impact on root multiplication. This report tallies with the finding of Padmaja *et al*., (2012) who reported that increasing the concentration of IBA and NAA in combination with BAP had an additive effect on root number and root length.

Number of Shoots and Shoot Length:

The overall model is highly significant ($p < 0.01$), showing that the hormone combinations collectively influence the number of shoots. Among the individual hormones, BAP, IBA, NAAare highly significant ($p < 0.05$) and contributed significantly to the number of shoots, while increasing concentration of BAP leads to increase in the proliferation of shoots and shoot length. This report conforms with the findings of Mohapatra and Batra, (2017) concerning increasing the concentration of BAP to enhance shoot proliferation. Other hormone combinations like KIN + GA3+ do not individually affect the number of shoots significantly, while IBA, NAA, KIN, and GA3+ do not affect the shoot length significantly. Interaction factors BAP + IBA and BAP + NAA are also significant ($p < 0.05$), indicating their combined influence on the number of shoots and length of shoots. This is similar with the effects of PGR on tissue culture plantlets of khinjuk pistachio measured after 28 days of planting, (Tilkat *et al*., 2005).

Percentage Survival:

The overall model is highly significant ($p < 0.01$), indicating that the various hormone combinations collectively have a significant impact on percentage Survival of tissue culture of *Telfairia occidentalis*.

Among the individual hormones, BAP is highly significant ($p < 0.0001$) and contributes significantly to percentage survival of the plantlet. Increasing concentrations of IBA, NAA, KIN, and GA3 do not individually have a significant impact on the percentage survival of the plantlet ($p > 0.05$). Hormonal combinations of BAP + IBA and BAP + NAA are also significant ($p < 0.05$), suggesting that the combination of these factors affects percentage Survival. The best % survival was noticed in BAP + NAA (0.05/0.1 mg/1) with 97% survival rate.

In conclusion, the BAP treatments gave better shoot proliferation than the KIN treatments. The best multiple shoot initiation was obtained on MS medium with BAP+NAA at 0.05/ 0.1 mg l-1. All microshoots initiated by BAP hormone combinations showed further growth and proliferation upon transfer onto MS medium supplemented with 0.05- 0.1mg/1 BAP + NAA. Some treatments caused considerable callusing at the base of the explant.

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Table 2: Concentrations of Plant Growth Hormones in the various test tubes

	BAP (mg/L)	NAA(mg/L)		BAP (mg/L)	NAA(mg/L)
Group 1	0	0	**Group 2**	0.05	0.10
	0	0		0.10	0.10
	0	0		0.50	0.10
	0	0		1.00	0.10
	0	0		2.00	0.10
	BAP(mg/L)	**NAA(mg/L)**		**BAP(mg/L)**	**IBA(mg/L)**
Group 3	0.05	0.20	**Group 4**	0.05	0.10
	0.10	0.20		0.10	0.10
	0.50	0.20		0.50	0.10
	1.00	0.20		1.00	0.10
	2.00	0.20		2.00	0.10
	BAP(mg/L)	**IBA(mg/L)**		**KIN(mg/L)**	**GA3(mg/L)**
Group 5	0.05	0.20	**Group 6**	1.00	1.00
	0.10	0.20		1.00	2.00
	0.50	0.20		2.00	2.00
	1.00	0.20		2.00	5.00
	2.00	0.20		5.00	5.00

Table 3: ANOVA Table

Source	Sum of Squares	df	Mean Square	F-value	p-value	Significance	Coefficient of determination (R^2)

			% Survival				
Hormone Concentrations	670.87	12	55.91	49.46	< 0.0001	significant	0.9013
A-BAP	147.87	1	147.87	130.82	< 0.0001	significant	
B-IBA	2.45	1	2.45	2.17	0.1457		
C-NAA	1.87	1	1.87	1.65	0.2029		
D-KIN	0.0045	1	0.0045	0.0040	0.9498		
E-GA^{3+}	0.0048	1	0.0048	0.0042	0.9484		
AB (BAP+IBA)	5.71	1	5.71	5.05	0.0280	significant	
AC (BAP + KIN)	6.86	1	6.86	6.07	0.0164	significant	
DE (KIN + GA^{3+})	0.0694	1	0.0694	0.0614	0.8051		
			No of Roots				
Hormone Concentrations	608.71	12	50.73	31.49	< 0.0001	significant	0.8532
A-BAP	29.74	1	29.74	18.46	< 0.0001	significant	
B-IBA	1.65	1	1.65	1.03	0.3146		
C-NAA	0.0282	1	0.0282	0.0175	0.8952		
D-KIN	0.3435	1	0.3435	0.2133	0.6458		
E-GA3	0.0475	1	0.0475	0.0295	0.8642		
AB (BAP+IBA)	2.71	1	2.71	1.69	0.1988		
AC (BAP + KIN)	32.34	1	32.34	20.07	< 0.0001	significant	
DE (KIN + GA^{3+})	0.1453	1	0.1453	0.0902	0.7649		
			No of Shoots				
Hormone Concentrations	524.48	12	43.71	34.91	< 0.0001	significant	0.8657
A-BAP	141.17	1	141.17	112.75	< 0.0001	significant	
B-IBA	6.96	1	6.96	5.56	0.0214	significant	
C-NAA	6.29	1	6.29	5.02	0.0284	significant	
D-KIN	0.1660	1	0.1660	0.1326	0.7170		
E-GA3	0.1018	1	0.1018	0.0813	0.7764		
AB (BAP+IBA)	4.23	1	4.23	3.38	0.0705		
AC (BAP + KIN)	3.66	1	3.66	2.92	0.0921		
DE (KIN + GA^{3+})	0.0003	1	0.0003	0.0002	0.9886		
			Root length				
Hormone Concentrations	624.62	12	52.05	31.08	< 0.0001	significant	0.8516
A-BAP	33.26	1	33.26	19.86	< 0.0001	significant	
B-IBA	0.0165	1	0.0165	0.0098	0.9213		
C-NAA	2.84	1	2.84	1.70	0.1974		
D-KIN	1.86	1	1.86	1.11	0.2963		
E-GA3	1.89	1	1.89	1.13	0.2924		
AB (BAP+IBA)	2.33	1	2.33	1.39	0.2424		

AC (BAP + KIN)	32.51	1	32.51	19.41	< 0.0001	significant	
DE (KIN + GA^{3+})	0.2513	1	0.2513	0.1501	0.6997		
			Shoot Length				
Hormone Concentrations	570.79	12	47.57	37.02	< 0.0001	significant	0.8724
A-BAP	172.54	1	172.54	134.28	< 0.0001	significant	
B-IBA	1.03	1	1.03	0.7980	0.3750		
C-NAA	1.32	1	1.32	1.03	0.3143		
D-KIN	0.3286	1	0.3286	0.2557	0.6148		
E-GA3	0.1524	1	0.1524	0.1186	0.7316		
AB (BAP+IBA)	0.9898	1	0.9898	0.7704	0.3833		
AC (BAP + KIN)	0.7350	1	0.7350	0.5720	0.4522		
DE (KIN + GA^{3+})	0.1043	1	0.1043	0.0812	0.7766		

EFFECT OF FEEDING DIET CONTAINING GRADED LEVELS OF BOILED COFFEE PULPS MEAL ON HAEMATOLOGICAL PARAMETERS OF WEANER RABBITS.

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ABSTRACT
The effects of feeding diet containing boiled coffee pulp meal on haematological parameters in rabbit were studied. A total of thirty six (36) mixed breed weaner rabbits (average weight, 550 g) were randomly allocated to four dietary treatments containing 0, 4, 8 and 12% boiled coffee pulp meal (BCPM). Diet 1 (0% BCPM)) served as the control diet. Each of the four treatments was replicated thrice and each replicate had three rabbits arranged in a Completely Randomized Design. The rabbits were fed with the experimental diets for 12 weeks. The results showed that pack cell volume, haemoglobin, mean corpuscular haemoglobin, mean cell volume and red blood cell were significantly affected by the treatments while white blood cell count, neutrophil, lymphocytes, eusnophils, basophils and monocytes showed no significant difference. It was concluded that inclusion of boiled coffee pulp meal in rabbit diets was well tolerated by weaner rabbits without any adverse health condition.
Keyword*: coffee pulp meal, rabbits, anti-nutritional factors, boiling, haemoglobin*

INTRODUCTION

The inability of livestock farmers to supply their animals with high quality feed has been recognized as one of the technical constraints limiting livestock production in the developing countries (Okoruwa, 2015). The livestock are exposed to severe nutritional stress especially in recent time that the prices of conventional feedstuffs such as soybeans, maize and groundnut have been increasing at the same time that the availability is often a problem (Babayemi *et al*., 2006). The case has been worsened during the dry season when fodders are rare and of low nutritive value. To salvage this problem, it is necessary for the livestock farmers to explore the cheapest and readily available agricultural waste products that have high nutritive value as feed ingredient in the diet of their animals. Typical among such feed ingredients is coffee pulp. The presence of essential nutrients such as proteins, carbohydrates fibre and some minerals especially potassium in coffee pulp suggest that it could be used as livestock feed ingredient (Barcelos *et al*., 2001), nonetheless high content of anti-nutritional factors in this by-product has restricted its use as an animal feed to a large extent (Padmapriya *et al*., 2013). Therefore, total elimination or reduction of anti-nutritional factors in coffee pulp through physical, chemical or biological processing technique is of paramount important. The major limitations of these anti-nutrients are related to its physiological effects on the central nervous system and its influence can alter the constituents of the animal blood (Mazzafera 2002). The aim of this study was to determine the effect of feeding boiled coffee pulps meal on the haematological parameters of weaner rabbits.

MATERIALS AND METHODS

About 25kg of coffee pulps were collected from the coffee pulping centre, Cocoa Research Institute of Nigeria, Ibadan. The pulps were subjected to boiling process. The process involves putting sterilized coffee pulp into heat water at 100^0C at a pulp: water of 1:5 for 30 minutes. At this temperature, majority of hard pulps were expected to be softened, After which the boiled pulps were removed, put into sieve to drain the water, later sun dried and stored in jute bags until it was used. Thirty-six (36) mixed breed weaner rabbits were purchased from Adeeko Farm, Ibadan, Oyo State. Before the commencement of the experiment, the rabbits were acclimatized for seven days. During this period, rabbits were all fed control diets and were also treated against endo and ecto-parasites using sodex (dewormer) and ivomectin respectively. The animals were randomly divided into four treatment groups andach group comprised of nine rabbits. Each group was further sub-divided into three, such that replicate groups of three rabbits were obtained for each sub-group with three rabbits per replicate. The boiled coffee pulp was mixed into rabbits ration at 0, 4, 8 and 12% inclusion level designated T_1, T_2, T_3 and T_4 respectively (Table 1). All diets were formulated to meet the nutritional requirements of weaner rabbits based on NRC (2007) recommendations and the experimental diets were offered to rabbits twice in a day at about 7:00 am and 4:30 pm. The animals were allowed *ad libitum* access to feed and water throughout the trial. On the last day of the feeding trial, two sets of blood samples were collected from each rabbit via jugular vein puncture using a 5 ml needle fitted syringe. About 5 ml blood sample each was collected into labeled sterile bottles containing anticoagulant for the determination of hematological parameters while the blood samples for serum analysis were taken with sterile bottles without anticoagulant, so as to allow the blood to coagulate at room temperature. The supernatant was then collected and stored in a freezer for subsequent biochemical analysis. The blood samples were analyzed using the procedure described by AOAC (2001). Data collected from this study were subjected to statistical analysis (SAS, 2008 version 9.2) and significant means were separated using Duncan multiple range test (Duncan, 1955). The trial lasted for 84 days.

Table 1: Feed composition and calculated nutrient values of the experimental diets

Parameters	**T_1 (0%CPM)**	**T_2 (4%CPM)**	**T_3(8%CPM)**	**T_4 (12%CPM)**
Maize	38.00	37.00	36.00	36.00
Soybean meal	27.00	26.55	25.85	25.00
Fish meal	3.35	2.80	2.50	2.50
CPM	0.00	4.00	8.00	12.00
Rice bran	28.00	26.00	24.00	20.85
Bone meal	2.50	2.50	2.50	2.50
Premix	0.25	0.25	0.25	0.25
Salt	0.50	0.50	0.50	0.50
Methionine	0.20	0.20	0.20	0.20
Lysine	0.20	0.20	0.20	0.20
Total	100.00	100.00	100.00	100.00
Calculated analysis				
Crude protein	18.06	18.03	18.05	18.01
Gross energy	3003.05	3001.00	3000.55	2999.85
Crude fibre	10.95	11.05	11.10	11.25

CPM: Coffee Pulp Meal

Table 2: Effect of Feeding Diet Containing Graded Levels of Boiled Coffee Pulps Meal on Haematological Parameters of Weaner Rabbits.

Parameters	**T_1**	**T_2**	**T_3**	**T_4**	**SEM**
Pack cell volume (PCV)	24.06^{c}	26.05^{b}	28.72^{a}	28.84^{a}	0.87
Haemoglobin	7.04^{b}	8.65^{a}	8.70^{a}	8.50^{a}	0.76
Mean corpuscular haemoglobin	30.36^{b}	34.25^{a}	34.82^{a}	34.85^{a}	0.82
Mean cell volume	86.47^{b}	88.35^{a}	90.11^{a}	92.77^{a}	2.15
Red blood cell	5.50^{b}	5.62^{b}	7.00^{a}	7.55^{a}	0.77
White blood cell	5.97^{a}	6.05^{a}	6.12^{a}	5.95^{a}	0.89
Neutrophils	63.11^{a}	60.68^{ab}	64.75a	58.00^{b}	3.05
Lymphocytes	48.20^{a}	43.86^{ab}	46.10^{a}	38.25^{b}	0.81
Eusnophils	3.80^{a}	3.61^{a}	3.50^{a}	3.10^{ab}	0.28
Basophils	2.25^{a}	2.00^{a}	1.85^{ab}	1.70^{b}	0.34
Monocytes	$1,85^{a}$	1.70^{a}	1.62^{ab}	1.50^{b}	0.41

abc= mean with different superscripts on the same column are significantly different (P<0.05), SEM= Standard error of mean

RESULTS AND DISCUSSION

The results of haematological parameters of rabbits fed graded levels boiled coffee pulp are presented in Table 2. The results showed significant (P<0.05) differences in most of the haematological parameters investigated. The least packed cell volume (PCV) was recorded in rabbits fed control diet which increase progressively as the level of boiled coffee pulp increase in the diets. The increase in the PCV concentration in the blood of rabbits in this experiment indicated the good health status as low PCV values are taken as an index of anaemia. This is in agreement with the finding of (Abdelati *et al*., 2008) who reported reduction in the PVC of broiler chickens fed roasted *Leucaena leucocephala* at various levels and attributed it to toxic factor (anti-nutritional factor) in the diet. PCV is a symbol of toxicity (Ahamefule *et al*., 2008). Haemoglobin (Hb), mean corpuscular haemoglobin (MCH), mean cell volume (MCV) and red blood cell (RBC) counts were also significantly (P<0.05) affected by the dietary inclusion of boiled coffee pulp which increase progressively as the level of inclusion is increased in the diet. The increase in Hb, MCH, MCV and RBC denotes that coffee pulp meal positively contributed to the synthesis of blood forming metabolites such as copper, iron and magnesium which augments effective transportation of oxygen and other nutrients in the body of animals (Oyebode, 2015). The white blood cell were not significantly (P>0.05) different. This shows that boiled coffee pulp meal neither enhanced nor impaired the ability of rabbit to ward off infection. There was also no significant (P>0.05) difference in the neutrophil, lymphocytes, eusnophils, basophils and monocytes, and their values fell within the normal range established by Research Animal Resource (2009) for growing rabbits.

CONCLUSION

It was concluded that inclusion of boiled coffee pulp meal in the rabbits diet was well tolerated by weaner rabbits without any adverse health condition.

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COMPARATIVE EFFECTS OF INORGANIC AND *Tithonia diversifolia-BASED* FOLIAR FERTILIZER ON THE VEGETATIVE GROWTH OF *Amaranthus hybridus L*

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ABSTRACT

A field experiment was conducted at the horticulture garden of the Federal College of Agriculture Ibadan to assess the effects of an aqueous extract of Tithonia diversifolia and a synthetic foliar fertilizer on the vegetative growth parameters of Amaranthus hybridus. The experiment was laid out in a randomized complete block design (RCBD) with eleven treatments replicated three times. The treatments were Tithonia diversifolia extract at 1kg/L, 1.5kg/L, and 2kg/L with a soaking duration of 1, 2, and 3 days, synthetic foliar fertilizer (positive control) and negative control (no fertilizer). Data were collected on plant height, number of leaves, stem girth and leaf area. The result revealed that Tithonia diversifolia-based foliar fertilizer had a significant effect on the vegetative parameters of Amaranthus hybridus. Tithonia diversifolia of 1kg/L with a soaking duration of 1 and 3 days at 4 weeks after transplanting had the highest plant heights (54.90 cm and 54.10 cm respectively) which were significantly higher than the negative control (no fertilizer) which had the lowest plant height (42.30 cm). The use of Tithonia diversifolia-based foliar fertilizer could therefore be recommended as an alternative to synthetic foliar fertilizer for the sustainable production of Amaranthus hybridus.

***Keywords**: Amaranthus hybridus**,** Tithonia diversifolia, foliar fertilizer, synthetic foliar fertilizer*

INTRODUCTION

Fertilizers are indispensable components of modern agriculture, playing a pivotal role in augmenting crop yields and addressing global food security challenges. Depending on how crops absorb nutrients, fertilization techniques can be categorized as either root fertilization or foliar fertilization (Niu *et al*., 2021). Numerous variables, including soil temperature, humidity, salinity, and microbiota, have an impact on how well soil fertilizer nutrients are utilized (Li *et al*., 2009); however, foliar fertilization has emerged as an effective means of delivering essential nutrients directly to plants through aerial parts, thereby reducing the negative impacts on the soil such as nutrient fixation, toxicity and antagonism (Bindraban *et al*., 2015). It is also characterized by rapid nutrient absorption and the ability to rectify nutrient deficiencies promptly, thus contributing to improve crop health and increased agricultural productivity. Foliar fertilizers exist in both organic and synthetic forms. Organic-based foliar fertilizers, derived from natural sources and organic materials, embody a holistic approach to plant nourishment, addressing concerns related to soil health and environmental impact while synthetic foliar fertilizers are chemically manufactured to contain specific nutrient compositions, offer precise and readily available nutrients. This study explores the effects of organic-based and synthetic foliar fertilizers on the vegetative growth parameters of *Amaranthus hybridus.*

MATERIALS AND METHODS

The field experiment was conducted at the horticultural garden of the Federal College of Agriculture, Moor Plantation, Ibadan, Oyo state. The land was cleared manually and later ploughed and harrowed. *Amaranthus hybridus* seeds were obtained from the Institute of Agricultural Research and Training

(I.A.R&T) seed store. A seedbed of 2m x 2m was made for raising *Amaranthus hybridus* in the nursery. Thirty-three beds measuring 1m × 1.5m each with a 0.5m alleyway were constructed as permanent beds/sites onto which the *Amaranthus hybridus* seedlings were transplanted. The *Amaranthus hybridus* seedlings were transplanted 3 weeks after sowing using a ball of earth method at a spacing of 20cm x 20cm. Leaves of *Tithonia diversifolia* collected were chopped into small pieces and soaked in water; 1kg/L, 1.5kg/L and 2kg/L. The soaking durations were 1 day, 2 days and 3 days. The synthetic foliar fertilizer was diluted according to the specification of 3kg/ha and applied at 2-week intervals while 250 ml of *Tithonia diversifolia* extract was applied per plot at 5-day intervals. The foliar fertilizer application regime started one week after transplanting. Vegetative data were taken on number of leaves, plant height, stem girth and leaf area at 4 Weeks After Transplanting (WAT) using standard procedure. The data generated were subjected to analysis of variance (ANOVA) and the treatment means were separated using DMRT at a 5% probability level.

RESULTS

Table 1 shows the result of the soil physical and chemical analysis of the study area with a pH (H_2O) of 6.21, texturally sandy loam with a composition of 888 g/kg sand, 32 g/kg silt, and 80 g/kg clay (Table 1). *Tithonia diversifolia* (1kg /L) with a soaking duration of 1 and 3 days at 4WAT had the highest plant heights (54.90 cm and 54.10 cm respectively) which were significantly higher than the negative control (no fertilizer) which had the lowest plant height (42.30 cm) (Table 2). However, there were no significant differences in plant height treated with the same concentration (4WAT) soaked for different durations (1 day and 3 days). These heights were also comparable to the plant height of the positive control, which implies that the soaking duration did not significantly affect plant height (Table 2). *Tithonia diversifolia* (2kg/L) with a soaking duration of 2 days had the highest number of leaves (37.00) which was significantly higher than *Tithonia diversifolia* (2kg /L) with a soaking duration of 1 day that had the least number of leaves (24.90). The number of leaves under *Tithonia diversifolia* (1kg/L) and 1.5kg/L did not differ significantly with respect to the duration of soaking. *Tithonia diversifolia* (2kg/L) with 2 days soaking duration gave the highest number of leaves (37.00) which was significantly higher than 1 and 3 days soaking durations, respectively (Table 2). *Tithonia diversifolia* (2kg/L) with a soaking duration of 2 days had the highest stem girth (4.17) which was significantly higher than the negative control (No treatment) and some of the other treatments. With *Tithonia diversifolia* (1kg/L), the stem girth decreased as the days for soaking increased. *Tithonia diversifolia* (1.5 kg/L) with a soaking duration of 2 days gave the highest stem girth and for *Tithonia diversifolia* (2kg /L) the stem girth decreased as the days for soaking increased and these were also comparable to the stem girth of the positive and negative control (Table 2).

T1(1kg sunflower/L soaked for 1 day); T2 (1kg sunflower/L soaked for 2 days); T3 (1kg sunflower /L soaked for 3 days); T4 (1.5kg sunflower /L soaked for 1 day); T5 (1.5kg sunflower /L soaked for 2 days); T6 (1.5kg sunflower /L soaked for 3 days); T7 (2kg sunflower /L soaked for 1 day); T8 (2kg sunflower /L soaked for 2 days), T9 (2kg sunflower /L soaked for 3 days); T10 (Synthetic foliar fertilizer); T11 (Control)

Table 1: Chemical and physical properties of the soil

Parameters	Value
pH (H_2O)	6.21
Available Phosphorus(mg/kg)	9.13
Organic Carbon (g/kg)	9.3
Organic matter (g/kg)	16.1
Total N (g/kg)	1.6
Exchangeable cations (cmolkg^{-1})	
Ca^{2+}	0.71
Mg^{2+}	1.55
K^+	0.21

Na^+	0.27
H^+	0.10
ECEC	2.84
Particle sizes(g/kg)	
Sand	888
Silt	32
Clay	80
Texture class	Sandy loam

Table 2: Effect of *Tithonia diversifolia* on the growth parameters of *Amaranthus hybridus* L

	Plant Height (cm)	Number of leaves	Stem girth	Leaf area (cm^2)
Treatments	4 Weeks after planting			
1	54.90a	34.80ab	3.97a	66.96ab
2	49.53ab	30.77b	3.83ab	96.00ab
3	54.10a	28.33bc	3.77b	92.23ab
4	48.80b	33.23ab	3.67c	87.72ab
5	52.87ab	28.57bc	3.93a	113.90a
6	48.30b	31.10ab	3.83ab	96.69ab
7	49.63ab	24.90c	3.80ab	83.55ab
8	50.30ab	37.00a	4.17a	85.27ab
9	43.90bc	29.10bc	3.73bc	49.87b
10	45.03b	31.90ab	3.70bc	58.18b
11	42.30bc	30.00b	3.67c	48.42b

DISCUSSION

The result from the experiment revealed the positive effect of the *Tithonia diversifolia-based* foliar fertilizer on the vegetative growth parameters of *Amaranthus hybridus* L. Several studies have reported the potential of *Tithonia diversifolia* to enhance vegetative growth parameters of crops which is an indicator of overall plant health and vigor (Ademiluyi and Omotosho, 2007; Liasu and Achakzai, 2007). On the other hand, the soaking duration did not seem to have a significant impact on the vegetative parameters during the period of growth. This finding implies that for the recommended concentration, there is no added benefit to extending the soaking duration from 1 day to 3 days. This suggests that *Tithonia diversifolia* when soaked quickly releases its components into solution to be taken up by the plants or reaches its maximum effectiveness within the first day of soaking.

CONCLUSION

This study showed that the application of *Tithonia diversifolia-based* foliar fertilizer had significant effects on the vegetative growth of *Amaranthus hybridus.* However, the soaking duration of *Tithonia diversifolia* did not have significant effects on the vegetative parameters of *Amaranthus hybridus*. Therefore, in order to promote organic agriculture, *Tithonia diversifolia* can be used as an alternative to synthetic foliar fertilizer.

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RESPONSE OF ORGANIC MULCHES TO THE SPROUTING AND SEEDLING EMERGENCE OF TURMERIC (*Curcuma longa* L.) RHIZOMES

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ABSTRACT
Organic mulches as one of the agronomic practices used at different rates and types could increase the yield of turmeric grown all over the world for its spice and medicinal values. The use of locally available mulches like cassava peel and sawdust enhanced the sprouting, emergence and establishment of turmeric rhizomes. A field experiment was carried out on the field of National Horticultural Research Institute, Ibadan, Oyo State, Nigeria (Lat. 7^0 30' N; Long. 3^0 50'E) between 2017 and 2018 rainy seasons on the emergence of turmeric rhizomes on a 2 x3 factorial arranged in Randomized Complete Block design, the first factor is two types of mulches (sawdust and cassava peel) and the second factor is the three rates of mulch (No mulch (control), 5t/ha and 10t/ha. The results showed that 10t/ha cassava peel mulch produced the highest rhizome emergence of 99.20% in 2017 and 100. 0% in 2018 after 30 days of planting followed by 10t/ha sawdust with 94.44% in 2017 and 94.43% in 2018 and the least of 20.64% in 2017 and 21.43% in 2018 with no mulch. The yield of the rhizome varied with the type and rate of mulch used with 10t/ha cassava peel having the yield of 8179kg/ha in 2017 and 8183.6kg/ha in 2018, followed by 10t/ha sawdust mulch with 5956kg/ha in 2017 and 5964kg/ha in 2018 and the least yield of 1401kg/ha in 2017 and 2209.5kg/ha in 2018 with the control.
***Keywords**: Cassava peel, sawdust, organic waste, mulch, seedling, emergence*

INTRODUCTION
Turmeric (*Curcuma longa* L.) is an herbaceous plant belonging to the family Zingiberaceae. The consumption is multidisciplinary as food, cosmetics and medicine (Uchechukwu, 2020). India is the leading producer of turmeric in the world; it produced about 75% of the total world supply (Prahakaran, 2013). India occupies the first position in production area with 195.10 thousand hectares (78 %) followed by China with 16.61 thousand hectares (8 %), Myanmar with 8.80 thousand hectares (4 %) and Nigeria and Bangladesh together contributing 12.71 thousand hectares (6 %) of the global production (Anonymous, 2012). The climatic condition in Nigeria favours turmeric production and makes its intensive cropping more common especially in the rainforest transition (Ihenacho *et al.*, 2017). In Nigeria, productions of turmeric are prominent in 19 states depending on the locality where it assumes different names. Meanwhile, other minor crops such as rizga and Hausa potato play significant roles as turmeric in the food chain in Nigeria (Olojede *et al.,* 2005). Mulching is an application of any plant residues or other materials for covering top soil surface for conserving soil moisture, reducing the runoff and manages soil erosion, checking weed control, improving soil temperature, modifying the micro environment of soil to meet the needs of seeds for their good germination and better growth of seedlings (Chavan *et al.,* 2010).
Different materials may be use for mulching including crop residues and organic mulches (Masarirambi *et al.,* 2013). Organic mulches derived from plant material, will decompose in time and develop the soil. It also reflected positively on the cultivated crops in influences the growth and improvement of plants and increases the yield (Majkowska- Gadomska, 2010). A lot of organic materials litter our environment resulting in environmental hazards. Some of these organic materials such as cassava peel and sawdust could be utilized as a source of mulch as reported by various researchers (Shiyam *et al.,* 2011; Ewere *et al.,* 2017; Amenkhienan *et al.,* 2018; Angus *et al.,* 2019). Information on the use of cassava peels or sawdust as a source of mulch on turmeric is lacking. It is therefore pertinent to examine the use of both

cassava peels and sawdust as a source of mulching materials in turmeric cultivation in order to obtain a uniform seedling emergence.

MATERIALS AND METHODS

A field experiment was carried out at National Horticultural Research Institute, Ibadan (Lat. 7^0 30' N; Long. 3^0 50'E; in an altitude of 234m above sea level) between 2017 and 2018 rainy seasons on the emergence of turmeric rhizomes on a 2 x3 factorial arranged in Randomized Complete Block design, the first factor is two types of mulches (sawdust and cassava peel) and the second factor is the three rates of mulch (No mulch (control), 5t/ha and 10t/ha with turmeric planted at a spacing of 50cm x 40cm and the treatments combinations were replicated three times. Planting was done on the same day for all the treatments. Data collected includes sprouted turmeric which was manually counted at 20, 25 and 30 days after planting. This was expressed as the number of sprouted to the total number of rhizome planted as a percentage. Data were subjected to analysis of variance using linear model procedure of Statistical Analysis software Gen-Stat Discovery Edition 4 (2013). Significant means was separated where appropriate using the least significant difference at 5% probability level ($LSD_{0.05}$).

RESULTS AND DISCUSSION

Sprouting is the natural process, by which seeds, spores and rhizomes germinate and put out shoots, and already established plants produce new leaves or buds or other structures experience further growth (Wikipedia, 2022). Sprouting and emergence of the turmeric rhizome seedlings did not start until 20 days after planting on the field. The percentage sprouting in 2017 was statistically different among the treatments. In 2018, there were also significant differences ($P< 0.05$) in sprouting 30DAP (Table 1). The use of 10t/ha dried cassava peels as mulch produced the highest sprouted rhizome emergence of 99.20% in 2017 and 100% in 2018 after 30 days of planting. The higher sprouting and emergence percentage obtained from 10t/ha cassava peels mulch is an indication that heavy coverage with mulch encouraged higher sprouting and emergence according to Akinwumi *et al*., (2013). Fariyike *et al*., (2020) also attributed higher rhizome emergence as the key to good crop stand establishment. Next to cassava peel was closely followed by 10t/ha sawdust as mulch with 94.44% in 2017 and 94.43% in 2018 also after 30 days of planting. The least sprouted and seedling emergence was noticed with the un- mulched plots having the lowest percentage of sprouting of 20.64% in 2017 and 21.43% in 2018(Table 1).

This is in agreement with the findings of Islam *et al*., (2015) who observed higher percentage emergence from mulched ginger and the least percentage emergence from the control. The results also buttressed the importance of mulching in turmeric production and supported by Ahaiwe *et al*., (2016) who reported that mulching enhanced early sprouting of ginger rhizome which is in thesame family with turmeric. Ohiri and Njoku, (1997) also emphasized that mulching enhanced early sprouting in ginger rhizome. Kaya and Coskun, (2020) on the other hand referred mulch as a good soil conditioner, its use as organic extracts (fertilization, plant growth regulators, mulch etc.) has also proven effective in improving sprouting and early seedling emergence under abiotic stress conditions.

The yield of the rhizome varied with the type and rates of organic mulch used with 10t/ha dried cassava peels having the yield of 8179kg/ha in 2017 and 8183.6kg/ha in 2018 (Table 2). The highest yield with 10t/ha cassava peel revealed that turmeric requires heavy mulching to obtain high yield according to Akinwumi *et al*., (2013) which was closely followed by 10t/ha sawdust with 5956kg/ha in 2017 and 5964kg/ha in 2018. The lowest of the yields was obtained with the control in 2017 with 1401kg/ha and also with 2209.51kg/ha in 2018. Manhas *et al*., (2011) and Satyareddi and Angadi, (2014) improved the yield of fresh rhizomes of turmeric with mulching. Irene *et al*., (2015) also used different types and rates of organic mulches to obtain sustainable production and yield of waterleaf (Table 2).

CONCLUSION

The study revealed that both sawdust and cassava peels are very good as mulching materials to enhance sprouting and rhizome establishment, but sprouting percentage was higher with cassava peels establishing its superiority over sawdust in both years under study in Ibadan, Oyo state, Nigeria.

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Table 1: Effect of organic mulches on the sprouting percentage and emergence of turmeric

		2017			2018		
		20DAP	25DAP	30DAP	20DAP	25DAP	30DAP
Sawdust	0t/ha	15.08	16.67	20.64	16.70	18.30	21.43
Sawdust	5t/ha	73.02	74.60	84.13	75.40	79.37	85.70
Sawdust	10t/ha	82.54	85.71	94.44	83.33	86.50	94.43
Cassava peel	0t/ha	23.02	23.81	28.60	24.60	25.40	30.93
Cassava peel	5t/ha	77.78	78.57	89.68	80.13	80.93	90.47
Cassava peel	10t/ha	88.09	95.23	99.20	88.90	96.00	100.0
LSD(0.05)		3.18	3.89	3.58	4.64	3.65	3.21

Table 2: Effect of organic mulches on the yield of turmeric

		2017	2018
		Yield Kg/ha	Yield Kg/ha
Sawdust	0t/ha	1401	2209.5
Sawdust	5t/ha	5584	5593.8
Sawdust	10t/ha	5956	5964.9
LSD(0.05)			
Cassava peel	0t/ha	4120	4126
Cassava peel	5t/ha	6567	6579.0
Cassava peel	10t/ha	8179	8183.6
LSD (0.05)		30.19	22.82

TOTAL ANTIOXIDANT CAPACITY AND HYDROGEN PEROXIDE SCAVENGING ACTIVITY OF SOME SELECTED SPICES SOLD IN ILORIN

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ABSTRACT
Compounds that prevent or slow down the oxidation of lipids or other molecules like free radicals are known as antioxidants. This study evaluates the total antioxidant capacity and hydrogen peroxide scavenging capacity of four spices (fenugreek, Star anise, Cinnamon and black Cardamom). Dry samples of the spices were extracted in distilled water and analyzed using spectrophotometric and titrimetric methods to determine total antioxidant capacity (TAC) and Hydrogen peroxide (H_2O_2) scavenging activity. TAC results ranged from 232.79 - 64.32 mg/100g, with cinnamon and black cardamom exhibiting the highest and lowest antioxidant activity respectively. The spice extracts showed H_2O_2 scavenging activities with fenugreek having the highest scavenging activity with an inhibition of 92.04%. Black cardamom had the least H_2O_2 scavenging activity with 40.41% inhibition. The results showed that black cardamom had the lowest values for both TAC and H_2O_2 scavenging activity. Spices could be substituted for synthetic antioxidants in the food industry and also as dietary source of natural antioxidants.
***Keywords**: spices, antioxidant capacity, star anise, cinnamon, black cardamom, fenugreek*

INTRODUCTION
Spices have long been utilized as aromatic and pungent food components that are used in a variety of dishes to enhance their flavor. They are made from many plant components including bark (cinnamon), flower buds (clove), roots (ginger), fruits (pimento), completely ripe berries (white pepper), and other dried, edible, aromatic plants (Przygodzka *et al*., 2014). Majority of these spices are known to have a wide range of potential medical benefits, including their favourable effects on lipid metabolism, effectiveness as anti-diabetics, capacity to stimulate digestion, potential as anti-inflammators, and antioxidant qualities (Strabbiol and Murcia, 2001). When used in various food applications, natural antioxidants extracted from herbs and spices show varying degrees of efficacy. They not only add specific antioxidant vitamins like vitamin C, vitamin E, and pro-vitamin A to the human diet, but also a complex mixture of other naturally occurring compounds with antioxidant capacity. Aromatic plants have also been studied as sources of different classes of natural antioxidants (Bowser *et al.*, 2014; Ozcan *et al*., 2009).
Antioxidants are compounds that can delay or inhibit the oxidation of lipids or other molecules by inhibiting the initiation or propagation of oxidative chain reactions. As a result, antioxidants can prevent or repair damage caused to the body's cells by oxygen due to the redox potential of phenolic moieties (Choudhary *et al*., 2017; Suhartono *et al*., 2012). They exert their effects by one or more of the following mechanisms: by acting as reducing agents, scavenging free radicals, potentially complexing pro-oxidant metals, and quenching singlet oxygen (Bowser *et al.*, 2014; Suhartono *et al*., 2012). The most frequent type of food product deterioration is oxidative rancidity, which results in significant flavour changes and structural damage to proteins that reduces freshness and deters consumers from making more purchases. (Saini *et al*., 2019). Integrating antioxidants into formulations is the most efficient way to prevent oxidative deterioration in food items, and herbs and spices are a rich natural source of antioxidants (Saini *et al*., 2020; Choudhary *et al*., 2017). The present study was undertaken to explore the total antioxidant capacity and Hydrogen peroxide scavenging activity of some spices (fenugreek, Star Anise, Cinnamon and black Cardamom) sold in Ilorin, Kwara State, Nigeria.

MATERIALS AND METHODS

Collection of materials

All sample materials (fenugreek, Star anise, Cinnamon and black Cardamom) were purchased from Yoruba road market, Ilorin, Kwara State, Nigeria.

Sample preparation

The purchased samples were ground to fine powder by a high speed blender machine and stored in airtight containers until analyses was done. A portion of 20 g of each sample was weighed separately and extracted with 100 mL distilled water at 60°C for 1 hour. The sample solutions were filtered and the filtrate collected in amber bottles and kept airtight for further use.

Determination of total antioxidant capacity (TAC)

The total antioxidant capacity was determined spectrophotometrically by the phosphomolybdenum assay. One (1) mL of each extract was mixed with 3mL reagent solution of 0.6M H_2SO_4, 28nM Sodium Phosphate and 4 mM Ammonium molybdate. The blank contained 4mL of reagent solution only. The mixtures were incubated at 95°C for 150 min and then cooled to room temperature. A set of varying concentrations of ascorbic acid as standard were prepared and treated as test samples. The absorbance of both test samples and standards were taken 695 nm. TAC was expressed as Ascorbic Acid equivalent.

Hydrogen peroxide scavenging assay

This was determined using replacement titrimetric method explained by Zhang (2000). A portion of 2 mL of 1mM H_2O_2 and 1 mL of each extract were separately mixed, followed by 2 drops of 3% ammonium molybdate, 10 mL of 0.2 M Sulphuric acid, 7 mL of 1.8 mM Potassium Iodide and 2 drops of starch indication. The reaction mixture was titrated against 0.5 mM Sodium thiosulphate until blue colour disappeared. Percentage of scavenging of H_2O_2 was calculated as:

$$Inhibition\,(\%) = \frac{Vo - V1}{V1} X100$$

Where V_o and V_1 are volume of thiosulphate used for blank and samples respectively.

Statistical analysis

All experiments were carried out in triplicate. Results were expressed as mean ± SE (Standard Error). Analysis of variance (ANOVA) was carried out to determine any significant differences of measurements by the SPSS statistical software (Version 20.0, SPSS Inc., USA). The significance of the difference was checked by the Duncan test and the differences were considered as significant with $P<0.05$

RESULTS AND DISCUSSION

Scavenging of different types of reactive oxygen species, mostly free radicals is thought to be one of the main mechanisms of antioxidant action exhibited by phenolic phytochemicals (Shan *et al*., 2005). The results of TAC and H_2O_2 scavenging activity are expressed in Table 1. Cinnamon had the highest total antioxidant activity (232.79 mg/100g) while black cardamom gave the lowest activity (64.32 mg/100g). Star anise and fenugreek also had relatively moderate antioxidant activities of 122.46 and 153.37 mg/100g respectively. The strong antioxidant activity of cinnamon might be attributed to its high cinnamaldehyde content in addition to eugenol (Hossain *et al*., 2008). This result is similar to the findings of Lu *et al*. (2011) where cinnamon showed a strong total antioxidant activity. Shan *et al*. (2005), also reported results where cinnamon of two different species and origins exhibited high antioxidant activities that were significantly different from each other. The different result observed in the two species were attributed to genetic and environmental factors.

All the spice extracts had effective H_2O_2 scavenging activity. The inhibitory percentages varied from 40.41 % for Black cardamom to 92.04 % for fenugreek. Fenugreek showed the strongest H_2O_2 scavenging activity, this was followed by cinnamon and star anise with H_2O_2 scavenging activity inhibitions of 85.76 and 48.59 % respectively. According to Shan *et al*. (2005), the presence of phenolic compounds in plants and plant parts and their redox properties accounts for their antioxidant effect. This could be a justification for the scavenging strength of the spice extracts analyzed.

Table 1: Total Antioxidant Capacity and H_2O_2 Scavenging Activity of Selected Spices

Spices	**Total Antioxidant capacity (mg/100g)**	**H_2O_2 scavenging activity (% inhibition)**
Fenugreek	$153.37^{c}\pm0.03$	$92.04^{d}\pm0.04$
Star anise	$122.46^{b}\pm0.00$	$48.59^{b}\pm0.16$
Cinnamon	$232.79^{d}\pm0.05$	$85.76^{c}\pm0.10$
Black cardamom	$64.32^{a}\pm0.02$	$40.41^{a}\pm0.05$

Result shows mean ± Standard Error of triplicate values. Means on the same column with unshared superscripts are significantly different ($p<0.05$)

CONCLUSION

In the study, most of the spices were found to possess high levels of total antioxidant capacity and H_2O_2 scavenging activities. These natural spices have good potentials as substitute to synthetic ones being used in food industry in processing and storage, in order to prevent oxidative deterioration of foods and would also be a promising and economic dietary source of natural antioxidants for improving human nutrition and health.

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EFFECT OF CURRENCY REDESIGN ON VEGETABLE FARMERS PRODUCTION ACTIVITIES IN IBADAN NORTH WEST LOCAL GOVERNMENT AREA OF OYO STATE

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ABSTRACT
*Redesign of a nation's currency is done through appropriate policy implementation, however it can bring untold hardship if not appropriately implemented. This study examined effect of currency redesign on vegetable farmers' production activities in Ibadan North West Local government area of Oyo State. Multistage sampling techniques which involves purposive selection of local government area and prominent farmers association in the LGA was used. This was followed by random selection of forty farmers that were present at the association's monthly meetings. Data were collected using questionnaire and analyzed using descriptive statistics. Major occupation of respondents was farming (40%), **p**rominent fruits planted are Sweet orange (23.3%) and plantain/banana (13.4%). Vegetables mostly planted are Corchorus (26.6%), Amaranth (23.3%) and okra (16.7%). Most (56.7%) respondents strongly agreed reduced attendance in family function, reduced sales (50.0%), loss made through online cash transfer (46.7%) and transportation problem (46.7%). Reduction in unnecessary spending (40.0%), feeding (36.7%) and adjustment of family food budget (33.3%), reduced spending on family and friends (33.3) were observed. Most (50%) respondents disagreed with increase in number of customers, family association (36.7%) and more profit through online cash transaction (36.7%). Majority agreed that land clearing (83.3%), weeding (80.0%) and marketing of produce (80.0%) were affected, 76.7% was of the opinion that transportation of goods, purchase of inputs and payment of labourers were affected. The currency redesign brought more harm to the vegetable farmers in the LGA, subsequent policy involving currency redesign must be done appropriately using people oriented approach.*
***Key words**: Currency redesign, Farming activities, Fruits and vegetables*

INTRODUCTION

Cashless economy is an economy where transaction can be done without necessarily carrying physical cash as a means of exchange of transaction but rather with the use of credit or debit card payment for goods and services (Omotunde et al 2013). The cashless economy policy initiative of the Central Bank of Nigeria (CBN) is a move to improve the financial terrain but in the long run sustainability of the policy will be a function of endorsement and compliance by end-users (Ejiro, 2012). Studies have further shown that the crucial role played by financial inclusion to strengthen the growth and development of any economy in the world cannot be over emphasized. In fact to achieve its desired development, there must be easy access to mobilization and fund circulation within all strata of the economy (Huseni and Abdurrauf 2023). This in turn propelled the Central Bank of Nigeria (CBN) in 2012 led by Sanusi Lamido to introduce the cashless policy with the aim of reducing the bulk of cash being carried about and to track the amount of money in circulation and it was finally implemented in February 2023. The introduction of the cashless policy / currency redesign affected a lot of business in which the agricultural sector was not exempted. The agriculture sector, which contributes significantly to the economy, suffered from depressed spending, affecting farmers' ability to pay for labor and resulting in reduced production as stated by the SBM report. Coincidentally the currency redesign clashed with the emergence of planting season in the country, which has further in turn has its weight on the food productivity hence causing shortage of food in the country presently. The study assessed the effect of currency redesign on farmer's production activities in Ibadan North West Local government area of Oyo State

The specific objectives are to:

1. Determine the socio-economic and enterprise activities of respondents
2. Ascertain farmers' perception about cash withdrawal and currency redesign
3. Assess the effect of currency re-design on farming activities among farmers in

METHODOLOGY

The study area was Ibadan Northwest local government area, Oyo State Nigeria. The study area was Ibadan Northwest local government area, Oyo State Nigeria, which belongs to the Yoruba ethnic group. The target population were Vegetable Farmers in Ibadan Northwest Local Government Area, Oyo State. Multistage sampling techniques was used, the first stage was the selection of local government area which is Ibadan Northwest Local Government Area. The second stage was purposive selection of vegetable farmers group from the selected local government and this was followed by random selection of farmers during the association's monthly meeting. Data were collected using questionnaire. A total of forty farmers were interviewed. The data collected were analyzed using descriptive statistics such as frequencies, percentages.

Socio-economic characteristics of farmers

Table 1 reveals that sizeable proportion (70%) of the respondents are male, an indication that more male participates in agricultural practices among the respondents, but was argued by (Opio 2003) that in most parts of Africa, women have traditionally been responsible for producing food for the family on land to which they gain access upon marriage but do not necessarily control. Their fundamental role is in securing food for the family and therefore their role in national food security must be stressed. While men have generally been responsible for bush clearing and land preparation. 80% married and 63.3% has number of children ranging from 0-4 and 56.7% has a total household size of 5-7 while majority 50% of the respondents had secondary school leaving certificate as their highest level of education. Major occupation of 40% of the respondents is farming, others generate income through civil service (13.3%), trading (23.3%), share investors (3.3%), animal production (13.3%) and technical services (6.7%)

Table 1: Frequency distribution of the Socio-economic characteristics of farmers

	Variables	Frequency	Percentage
Sex	Male	21	70.0
	Female	9	30.0
Marital Status	Single	1	3.3
	Married	24	80.0
	Widowed	5	16.7
Number of Children	0-4	19	63.3
	5-9	10	33.3
	>9	1	3.3
House hold size	0-4	11	36.7
	5-9	17	56.7
	>9	2	6.6
Education	Primary	7	23.3
	Secondary	15	50.0
	Tertiary	7	23.3
	Quran school.	1	3.3
Other income generating activities	Civil servant	4	13.3
	Trading	7	23.3
	Share investor	1	3.3
	Animal production	4	13.3
	Technician	2	6.7

Enterprise characteristics of farmers

Prominent fruits planted by the farmers are Sweet orange and plantain/banana planted by 23.3% and 13.4% respectively. Vegetables mostly planted are Corchorus, Amaranth and okra cultivated by 26.6%, 23.3% and 16.7% respectively. Arable crops planted by few of the respondents were cassava (16.7%) and maize (13.3%) (Table 2).

Table 2: Crops grown by selected farmers

S/N	Crops planted		
A	**Horticultural crops**		
	Fruits	**Yes (%)**	**No (%)**
1	Lemon	1(3.3)	29(96.7)
2	Sweet orange	7 (23.3)	23(76.7)
3	Plantain/banana	4 (13.4)	26(86.7)
4	Mango	2 (6.7)	28(93.3)
5	Sour sop	2 (6.7)	28(93.3)
6	Cashew	1 (3.3)	29(96.7)
7	Sugar apple	1(3.3)	29(96.7)
8	Avocado	1(3.3)	29(96.7)
9	Noni	1(3.3)	29(96.7)
10	Pawpaw	2 (6.7)	28(93.3)
11	Water melon	1 (3.3)	29(96.7)
ii.	**Vegetables**		
1	Tomato	4(13.3)	26(86.7)
2	Garden egg	1(3.3)	29(96.7)
3	Okra	5(16.7)	25(83.3)
4	*Corcorhrus*	8 (26.6)	22(73.3)
5	*Celosia*	2(6.7)	28(93.3)
6	*Amaranth*	7(23.3)	23(76.7)
7	Hibiscus	1(3.3)	29(96.7)
8	*Pepper*	2(6.7)	28(93.3)
B	**Arable crops**		
1	Maize	4(13.3)	26(86.7)
2	Cassava	5 (16.7)	25(83.3)
3	Yam	3(10.0)	27(90.0)
4	Potatoes	1(3.3)	29(96.7)

Perception of farmers about cash withdrawal and currency redesign

Table 7 shows that most (56.7%) respondents strongly agreed reduced attendance in family function, less was sold due to lack of cash (50.0%), loss made to online cash transfer (46.7%), Transportation problem encountered (46.7%) and that goods were expensive (33.3%). Some respondents also agreed on reduction in unnecessary spending (40.0%), Reduction in feeding (36.7%), Adjustment of family food budget (33.3%), reduced spending on family and friends (33.3%), goods were expensive (30.0%). Most respondents disagreed with increase in number of customers (50%), increase in family conflict (33.3%), increase in family association (36.7%) and more profit made through online transaction/transfer of cash (36.7%).

Table 3: Perception of farmers about cashless policy implementation

Variables	Missing	Strongly agreed	Agreed	Undecided	Disagreed	Strongly disagreed
Increase in family conflict	5(16.7)	10(33.3)	8(26.7)	4(13.3)	10(33.3)	_
Increase in family association	4(13.3)	5(16.7)	4(13.3)	6(20.2)	11(36.7)	_
Reduction in feeding	4(13.3)	10(33.3)	11(36.7)	1(3.3)	4(13.3)	_
Adjustment of family food budget	4(13.3)	14(46.7)	10(33.3)	-	2(6.7)	_
Reduced attendance of family function	4(13.3)	17(56.7)	4(13.3)	1(3.3)	4(13.3)	_
Reduced spending on family and friends	4(13.3)	13(43.3)	11(33.3)	-	3(10)	_
More profit made through online transfer	4(13.3)	4(13.3)	6(20)	4(13.3)	11(36.7)	1(3.3)
Increased number of customers	4(13.3)	2(6.7)	3(10)	5(16.7)	15(50)	1(3.3)
Enhances savings	4(13.3)	4(13.3)	7(23.3)	10(3.3)	_	2(6.7)
Reduced unnecessary spending	4(13.3)	13(43.3)	12(40)	_	1(3.3)	_
Less sold due to lack of cash	4(13.3)	15(50)	7(23.3)	1(3.3)	1(3.3)	2(6.7)
Loss made to online transfer	4(13.3)	14(46.7)	8(26.7)	1(3.3)	3(10)	
Transportation problem encountered	4(13.3)	14(46.7)	8(26.7)	_	4(13.3)	_
Goods were expensive	4(13.3)	10(33.3)	9(30)	2(6.7)	5(16.7)	_
Reduction in hoarding of commodities	4(13.3)	6(20.0)	7(23.3)	10(33.3)	8(26.7)	_

Effect of currency redesign on vegetables farmers farming activities in Ibadan North West Local government area of Oyo State, Nigeria

Majority of the respondents representing 83.3%, 80.0% and 80.0% agreed that land clearing, weeding and marketing of produce were affected during the period. In addition, 76.7% of respondents was of the opinion that both transportation of goods, purchase of inputs and payment of labourers were affected during the period. A cursory observation on the level of difficulty revealed that 50%, 43.3%, 43.3% were of the opinion that payment of labour, land clearing and purchase of inputs very greatly affected. In addition weeding, marketing and transportation of produce were very greatly affected as testified by 40% respondents in each of the cases.

Table 4: Effect of cash withdrawal and currency redesign on farming activities

Variables	No	Yes	Slightly affected	Greatly affected	Very greatly affected

Land clearing	5(16.7)	25(83.3)	2(6.7)	10(33.3)	14(43.3)
Planting	7(23.3)	23(76.7)	7(23.3)	7(23.3)	9(30)
Weeding	6(20)	24(80)	4(13.3)	8(26.7)	12(40)
Fertilizer application	11(36.7)	19(63.3)	4(13.3)	5(16.7)	10(33.3)
Pesticides application	11(36.7)	19(63.3)	3(10)	8(26.7)	8(26.7)
Harvesting	8(26.7)	22(73.3)	6(20)	10(30)	6(20)
Marketing of produce	6(20)	24(80)	-	12(40)	12(40)
Transportation	7(23.3)	23(76.7)	1(3.3)	10(33.3)	12(40)
Purchase of input	7(23.3)	23(76.7)	3(10)	7(23.3)	13(43.3)
Payment of laborers	7(23.3)	23(76.7)	2(6.7)	6(20)	15(50)

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EFFECT OF *Parkia biglobosa* PULP EXTRACTS ON GROWTH, CARCASS AND SENSORY QUALITY OF BROILER

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ABSTRACT

This study was conducted to determine the effect of parkia pulp extract as vitamin/mineral source in broiler. A total of 204 'Ross 308' day old chicks were used for this study. At third week old, birds were randomly allotted into four treatments as follows; 1% PPE (1% Parkia Pulp Extract 10gm in 1litre of water), 2% PPE (2% Parkia Pulp Extract 20gm in 1litre of water), CMLT (Conventional Multi-Vitamin) and 0% PPE (0% Parkia Pulp Extract; only water). Treatment was added to their drinking water intake thrice in a week, there were fifty one birds per treatment; Seventeen (17) birds per replicate, each treatment was replicated thrice. The experiment lasted for nine weeks. Data on weight gain, carcass quality and sensory evaluation of cooked chickens were determine. Weight of broiler on CMLT were significantly higher at 3rd and 4th week of treatment administration but at 5th and 6th week of treatment there were no significant different ($p > 0.05$). The percentage of dressed to carcass weight was highly significant in 2% PPE (94.44%). There was no negative influence on all the parameter of sensory evaluation and the overall acceptance of chicken. Hence, addition of parkia pulp in broiler drinking water improved the percentage of dressed weight to live weight and carcass quality and does not have negative influence on the sensory attributes of the chicken.

***Keywords**: Parkia pulp, organic broiler production, sensory evaluation, organic vitamins/mineral, carcass quality*

INTRODUCTION

Parkia biglobosa is a non- timber forest products used as food, medicine, glazes, animal fodder, soil amendments, charcoal, and firewood. It is a horticultural crop that contain seeds that are used in preparation of spice called dawadawa, iru and ogiri in Hausa, Yoruba and Igbo respectively (Sadiku 2010). The spice is rich in protein and fat but bulk of the pulp covering the seed is usually washed off during processing of the seed to spices, in Nigeria few household process the pulp into drink by mixing it with water and fermented to fine refreshing drink (Akoma *et al.,* 2001). Locus bean pulp is high in vitamin C and carotenoids both important in the immune function of animals (Gernal *et al*., 2005). Poultry industry requires vitamins and mineral premix for optimal performance of birds which is usually derive from synthetic. Quest for organic products due to financial, environmental and health benefits has necessitated promotion of organic products. Hence, this study was conducted to determine the weight gain, carcass and sensory evaluation of broiler *on Parkia biglobosa* pulp drink extract.

MATERIALS AND METHODS

This experiment was carried out in Kensim Farm located at Aquatech College of Agriculture and Technology, Ibadan, Oyo State, Nigeria. Two hundred and four (204) 'Ross 308' day old chicks were purchased from Agrited hatchery in Ibadan and used for this study. The birds were raised in a deep litter system, at third week birds were randomly allotted into four treatments, there were fifty one birds per treatment; Seventeen (17) birds per replicate, each treatment is replicated thrice. The treatment was added to their drinking water thrice in a week as follows: 1% PPE (1% Parkia Pulp Extract 10gm in 1litre of water), 2% PPE (2% Parkia Pulp Extract 20gm in 1litre of water), CMLT (Conventional Multi-Vitamin) and 0% PPE (0% Parkia Pulp Extract; only water). Birds were supplied feed (commercially available feed) and water *ad libitum*. When the birds were three weeks old the initial weight of the birds was recorded, treatment was introduced into drinking and they were subsequently weighed weekly throughout the study by using Carmy digital scale. The average temperature and relative humidity of the pen were 29.8℃ and 72.71%. The experiment lasted for nine weeks. Data on weight gain, carcass quality and sensory evaluation were determine. The Sensory evaluation of cooked broiler without salt or seasoning on treatment was done through 30 consumers by 5 points hedonic scale to test, for smell, colour, juiciness, taste, tenderness, and overall acceptances. The data was analyzed by analysis of variance (ANOVA) using SAS package version and the significant treatment means were separated with Duncan option.

RESULT AND DISCUSSION

The effect of Parkia Pulp concentrate on weight of broilers is shown in table 1. There was significant difference ($p>0.05$) in the weight of the broilers at the 3rd and 4th week of administration of treatment on broiler with conventional multivitamin leading but at 5th and 6th week of administration of treatment, the weight of broiler across the treatments were not significantly different. The parkia pulp is known to contain antioxidants, vitamins and minerals which work synergy to prevent fat accumulation and good growth; muscle build up (Kenneth-Obosi *et al*., 2023). Parkia pulp is a horticultural crop that can sever as organic source of vitamins and minerals that can be used to replace synthetic vitamin and mineral premix that is commonly used. There were no significant preference ($p>0.05$) for all the sensory parameters of broiler on observed across the treatment (Table 3). However, chicken from broiler on 2% parkia pulp extract was evaluated to have highest juiciness and tenderness. This may be a reflection of the sweet and juicy taste of ripped parkia pulp (Campbell-Platt, 1990). The overall acceptances of the chicken from the treatments preference is 0%PPE (4.03). This was followed by chicken from broiler raised with 2% parkia pulp extract drink (3.86). Carcass evaluation of broiler on Parkia pulp extracts drink is shown in table 2.
There were no significant ($p>0.05$) differences in the percentages (%) of the traits measured across the treatment. As revealed in table 2, the utilization of parkia pulp as alternative vitamin/mineral premix in drink did not suppress the physiological development of the birds. This is an indication that Parkia Pulp has no detrimental effect. The ratio of dress weight to live weight of birds on supplements was significantly higher (Fig. 1) than bird on water (85.80%) with highest ratio from birds on 2% parki pulp extract (93.44%). This is an indication that broiler on mineral and vitamin supplement have more flesh than broiler on water. Abeke *et al*., 2013 reported that the prime cuts expressed as a percentage of live weight showed that the breast, thighs and drumsticks which are the most preferred and meaty parts of the chicken followed the weight pattern of the bird and decreased as the level of Parkia pulp increased in the diets. That may be due to the level of phytochemical present when high quantity of parkia pulp was used in replacement of maize in poultry diet but when small quantity is used as supplement the dress and live weight ratio of broiler on parkia pulp was encouraging (Kenneth-Obosi and Babayemi, 2017). Hence, bigger and meatier birds have better prime cuts than smaller and leaner birds.

Table 1: Weight gain of broiler on parkia pulp extract drink (Kg)

Treatment	Initial Wt	WK 1	WK 2	WK 3	WK 4	WK 5	WK6
1% PPE	0.61	0.99	1.59	1.89^{b}	2.43^{b}	2.70	2.96
2% PPE	0.59	1.04	1.60	1.92^{ab}	2.51^{ab}	2.73	3.08
CMLT	0.60	1.04	1.63	2.07^{a}	2.77^{a}	2.79	3.03
0% PPE	0.60	1.00	1.56	1.96^{ab}	2.53^{ab}	2.82	2.96
SEM	0.01	0.01	0.03	0.03	0.05	0.07	0.068

Result are mean of 3 replicates

PPE: Parkia Pulp Extract; CMLT: Conventional Multivitamin, SEM: Standard Error of Mean

Table 2: Carcass evaluation of broiler on Parkia pulp extract drink (Kg)

	Treatment				
Parameter	1% PPE	2% PPE	CMLT	0% PPE	SEM
Live weight	3.39	3.24	3.71	3.62	0.142
Dressed weight	3.13	3.06	3.46	3.08	0.141
Breast	0.88	0.83	1.01	0.9	0.047
Thigh	0.75	0.77	0.82	0.72	0.031
Drumstick	0.36	0.36	0.37	0.34	0.013
Back	0.42	0.42	0.51	0.52	0.035
Neck	0.15	0.27	0.15	0.12	0.043
Shank	0.15	0.13	0.13	0.12	0.007
Head	0.08	0.07	0.27	0.07	0.058
Wing	0.25	0.24	0.28	0.26	0.011
Eviscerated	0.4	0.56	0.44	0.3	0.064

Result are mean of 3 replicates
PPE: Parkia Pulp Extract; CMLT: Conventional Multivitamin, SEM: Standard Error of Mean

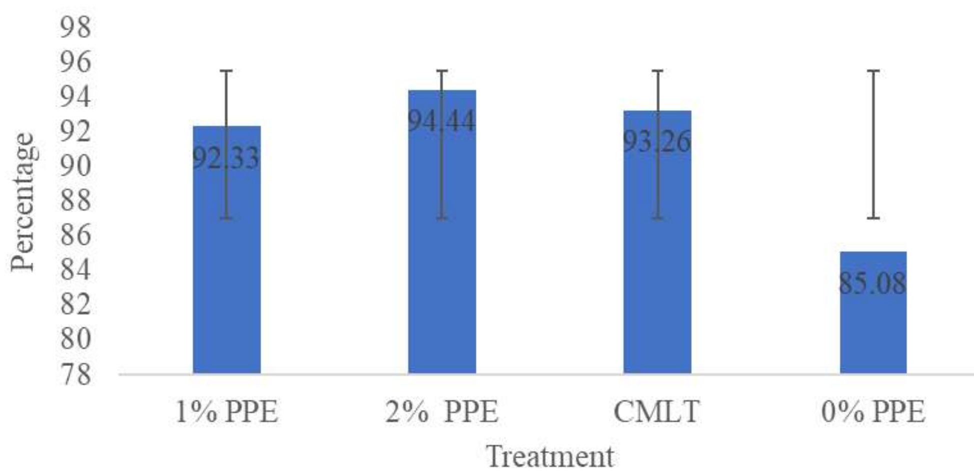

Fig 1: Percentage of dressed weight to live weight of broiler on parkia pulp drink

Table 3: Sensory Evaluation of Broiler on *Parkia Pulp* Extracts Drink

Parameter	1% PPE	2% PPE	0% PPE	CMLT	SEM
Smell	3.66	3.73	4.03	3.69	0.36
Colour	3.70	3.73	3.83	3.60	0.03
Juiciness	3.57	3.70	3.65	3.20	0.03
Taste	3.65	3.86	4.06	3.75	0.03
Tenderness	3.34	3.76	3.75	3.63	0.03
Over all acceptances	3.62	3.86	4.03	3.72	0.03

Result are mean of 30 replicates
PPE: Parkia Pulp Extract; CMLT: Conventional Multivitamin, SEM: Standard Error of Mean

CONCLUSION

African locust beans (*Parkia biglobosa*) pulp usually washed off can be put to used as source of organic vitamins and minerals in the drinking water of broilers for better growth response and carcass traits without any adverse effect on the sensory attributes of the broiler meat.

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CONSTRAINTS IN ORNAMENTAL PALMS PRODUCTION IN LAGOS STATE, NIGERIA

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ABSTRACT

This study examined the constraints and coping strategies in Lagos state by ornamental palms producers. Data for the study were obtained from different local government area in Lagos state. Snowballing sampling technique was used to select a total of 20 respondents for the study and the data collected were analysed using descriptive statistics. The result showed that majority (75.0%) of the respondents were male and all (100.0%) were married. Majority (60.0%) were within the age range 31-60 years. The result showed various constraints facing ornamental palms production in the study area which include pest and diseases, theft, land unavailability, and labour scarcity. Different coping strategies were adopted by the respondents in the study area. The respondents hire security agents to assist in safeguarding the garden and frequently choose to take expensive palm trees home to prevent theft. It was recommended that for the development of the ornamental palm industry in Lagos there is the need for improved research and development efforts to address the constraints facing florists in the region.

Keyword: *Constraints, Coping strategies, Ornamental palms*

INTRODUCTION

Ornamental palms have significant economic potential in Nigeria due to their aesthetic appeal, cultural significance, and various commercial applications (Market watch, 2020). Ornamental palms in Nigeria are used for landscape beautification, religious and cultural festivals, and as raw materials for crafts and furniture making (Udo *et al*. 2015). Additionally, ornamental palms such as the Royal Palm (*Roystonea regia*) and the Coconut Palm (*Cocos nucifera*) have commercial value as a source of edible oil, coconut water, and palm wine (IITA, 2019). According to a study by Imaobong *et al*. (2018), the production and profitability of ornamental palms can be influenced by various factors, such as the species of palm, the size of the plant, and the market demand for the product. The cultivation of ornamental palms for commercial purposes is a growing industry in Nigeria, with many farmers and entrepreneurs taking advantage of the high demand for ornamental plants (Folarami *et al*. 2020). Ornamental plants cultivation has the potential to generate income and create employment opportunities, especially in rural areas. Furthermore, the export market for ornamental palms is also significant. Nigeria is well positioned to develop its ornamental palms cultivation due to the favorable tropical climatic conditions in the country.

Previous studies on ornamental plants which includes Akintoye *et al* (2018), Muhammed-Lawal *et al*. (2012), Imaobong *et al*. (2018), Udo *et al*. (2015), and Adeduntan (2015). Akintoye *et al* (2018) examined the profitability of ornamental plants production in southwest, Nigeria and also prospects and challenges of floriculture business in Nigeria. While Mohammed Lawal *et al* (2012) examined economic analysis of floricultural plants production and Adeduntan (2014) contribution of some ornamental plants to the socio-economic development of urban household. The aforementioned studies did not focus specifically on ornamental palms. Therefore, in view of the economic benefits derived from ornamental palms production in other countries, it is important to examine constraints in ornamental palm production node in order to be able to come up with strategies that may improve efficiency of the production of the commodity.

MATERIALS AND METHODS

Study Area

Lagos state is a coastal state located in the southwestern part of Nigeria. It is the economic hub of Nigeria and one of the fastest-growing cities in Africa. Lagos state is bounded by Ogun state to the north and east, by Benin to the south, and by the Republic of Benin to the west. The state is mainly filled with the Yoruba tribe which has grown diverse with the migration of other Nigerians, West Africans and people for all other parts of the world. Lagos state has an estimated population of over 21 million people, making it the most populous state in Nigeria (National Bureau of Statistics, 2021). Lagos state is also known for its cultural diversity, vibrant nightlife, and beautiful scenery, which include beaches, parks, and gardens. Lagos state is comprised of thirty seven local government areas (LGAs), including Amuwo-Odofin, Ojo, Ajeromi-Ifelodun, Agege, Alimosho, Ifako-Ijaiye, Ikeja, Kosofe, Oshodi-Isolo, Somolu, Lagos Island, Apapa, Eti Osa, Lagos Mainland, Mushin, Surulere etc.

Sampling Technique and Data Collection

Snowball sampling technique which was used to locate florists in the study area. This method was used because of the population of florists is small. Primary data were collected through interview and the use of structured questionnaire administered to twenty respondents.

Data Analysis: Data generated in the survey were analyzed using descriptive statistics (frequency, percentage, and mean).

RESULTS AND DISCUSSIONS

Socio-economic characteristics of respondents

Table 1 presents the socio-economic characteristics of ornamental palms producers in the study area. The results showed that most of the respondents (75.0%) were male and married (100%), this is supported by Larinde and Santus (2014), who reported 68.4% married in a similar study. This shows that males are more involved in ornamental palms production than female. Most of the ornamental palms producers were within the age bracket of 31-40 years (30%). This clearly shows that most of the respondents were young adults. This agrees with Muhammed-Lawal *et al*. (2012) who reported the dominant age range of 26-40 years for a similar study in Kwara State, Nigeria. The results showed that 55.0% and 30.0% of the respondents has secondary and tertiary education respectively with average year of experience of 16 years in ornamental palms production. This shows that most of the respondent involved are highly literate and have experience in ornamental palms production. Similarly, Shalnim (2009) reported that 80% of the ornamental plant producers he interviewed had attended tertiary institutions. This high literacy level of the respondents could affect their choice of inputs and also their willingness to adopt improved technologies. On the basis of income distribution, most (45.0%) of the respondents realized less than 100,000 naira per month. In table 3, the respondents (50.0%) were visited by extension agents.

Resource use information

Table 2 reveals that 90.0% of the respondents operate on less than one acre of land with a mean land size of 0.38 acre and most of them (70.0%) obtain the land through leases. This agrees with Nelson and Jacob (2018) who reported that (90.48%) of the ornamental plants nursery operators were lease/rented lands. This is an indication that they are small scale producers. However, this might limit the expansion of their business. Half (50.0%) of the respondents used hired labour and 60.0% of the respondents make use of organic fertilizer. None of the respondents make use of growth regulator to enhance the performance of their palms. The use of PGRs for palm cultivation should be based on careful consideration of the potential benefits and risks, and should be done in accordance with local regulations and guidelines (Yasar *et al*. 2017).

Constraints to Ornamental palms production

Table 4 shows the constraints facing palms production in the study area which include pest and diseases (70.0%), theft (60.0%), land unavailability (50.0%), labour scarcity (45.0%), water scarcity (40.0%) and financial constraints (5.0%). Ornamental palms are susceptible to various pests and diseases, which can reduce their yield and quality. This agrees with Akintoye *et al* (2018) who also reported some challenges among which are water scarcity, lack of permanent site for production and inadequate fund. According to Ogbuehi et al. (2020), pest and disease management is a major challenge in ornamental palm production in Nigeria. According to Akinbile *et al*. (2017), poor infrastructure is a major constraint to the development of the horticulture industry in Nigeria. In conclusion, the production of ornamental palms in Nigeria faces several constraints that limit its growth and development.

Coping strategies adopted by the respondents to manage the identified constraints

The respondents were asked to state how they have been coping with the constraints identified. The respondents undertake palm fumigation on a monthly basis as a preventive measure against pest and disease attacks. This proactive measure helps maintain the health and vitality of their palms, ensuring their long-term well-being. Furthermore, regular fumigation assists in preserving the aesthetic appeal of the garden and promotes a thriving environment for other plants and vegetation. The garden owners hire security agents to assist in safeguarding the garden and frequently choose to take expensive palm trees home to prevent theft. In addition, they procure water from nearby sources as a solution to address water scarcity issues (Table 5).

CONCLUSION AND RECOMMENDATION

Ornamental palms have enormous economic potential in Nigeria, with their cultural significance, commercial applications, and export market value. The development of this industry has the potential to boost the country's economy and create employment opportunities in both rural and urban areas. However, several constraints such as pest and diseases, poor access to quality inputs, water scarcity, land unavailability and inadequate funding limit the growth of the industry. It is recommended that for the development of the ornamental palm industry in Lagos there is the need for improved research and development efforts to address the constraints facing florists in the region. Additionally, there is a need for the government to provide adequate support in terms of funding, training, and access to quality inputs for producers to ensure sustainable growth of the industry.

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Table 1: Socio-economic characteristics of respondents

Variable	Frequency	Percentage
Sex		
Male	15	75.00
Female	5	25.00
Total	20	100.00
Marital Status		
Single	-	-
Married	20	100.0
Total	20	100.0
Age		
<30	2	10.0
31-40	6	30.0
41-50	6	30.0
51-60	4	15.0
>60	2	10.0
Total	20	100.0
Mean	44.81	
Educational level		
Primary education	-	-
Secondary education	14	70.0
Tertiary education	6	30.0
Total	20	100.0
Years of experience		
1-10	5	25.0
11-20	10	50.0
21-30	2	10.0
31-40	2	10.0
41 and above	1	5.0
Total	20	100.0

Mean	16.26	
Income per Month (Naira)		
Less than 100,000	9	45.0
100,000 - 199,999	1	5.0
200,000 - 299,999	5	25.0
300,000 - 399,999	1	5.0
400,000 and above	4	20.0
Total	20	100.0
Extension agents visit		
Yes	10	50.0
No	10	50.0
Total	20	100.0
Have you received training on palms production		
Yes	14	70.0
No	6	30.0
Total	20	100.0

Source: Field survey, 2023.

Table 2: Resource profile of the respondents

Variable	Frequency	Percentage
Land size (acre)		
Less than 1	18	90.0
1-2	2	10.0
Total	20	100.0
Mean	0.38	
Type of labour		
Hired	10	50.0
Family	2	10.0
Both	8	40.0
Total	20	100.0
Source of land		
Community	1	5.0
Rented	4	20.0
Purchased	1	5.0
Leased	14	70.0
Total	20	100
Use of growth regulators		
Yes	-	-
No	20	100.0
Total	20	100.0
Type of fertilizer used		
Organic	12	60.0
Inorganic	2	10.0
Both	6	30.0
Total	20	100.0

Source: Field survey, 2023.

Table 4: Constraints to ornamental palm production

Constraints	Percentage	Rank
Financial constraints	5.0	7th
Water scarcity	40.0	5th
Pest and diseases	70.0	1st
Theft	60.0	2nd
Land Unavailability	50.0	3rd
Source of Seed/Seedlings	10.0	6th
Labour scarcity	45.0	4th

Source: Field survey, 2023. Multiple responses were allowed

Table 5: Coping strategies for the identified constraints by respondents

Strategy	Frequency	Percentage
Fumigation	12	60.0
Security	6	30.0
Importation of seeds	1	5.0
Buying for water from nearby sources	3	15.0
Funding from Government	1	5.0
Taking expensive plants home	3	15.0

Source: Field survey, 2023.

DETERMINATION OF PERCENTAGE GERMINATION OF TEN VARIETIES OF SWEET CORN (*Zea mays convar. saccharata var.rigosa*) UNDER VARIED SUCROSE CONCENTRATION

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ABSTRACT
The research experiment was conducted at crop science laboratory, University of science and technology, Wudil Kano State in 2015. The aim of the experiment was to identify the promising sweet corn genotypes with higher germination percentage in various sucrose concentration and to recommend the suitable genotypes of sweet corn to maize breeders for further development of drought tolerant varieties to farmers. The experiment was laid out in a randomized design and replicated three times. The results of the experimental findings indicated that, the proper germination percentage of sweet corn seeds tested shown that six genotypes were promising and found to have significant percentage germination and they include Jarobama white 96.6 %, Wari white 90 %, El-yellow local 83.3, Zaria E 76.3 %, Yar gangara yellow 75 % and Zaria D 73.3 % while Yar Ghana 26.67 and Yar tasau recorded the least germination percentage.
***Keywords**: Maize, Genotypes, Variety, Sucrose, Radicle, Plumule and Concentration.*

INTRODUCTION

Sweetcorn (*Zea mays* convar. saccharata var. rigosa) also called sugar corn or pole corn is a variety of maize with high sugar content (Erwin,1951). It is gradually becoming an important vegetable crop in Nigeria, since it forms a useful ingredient in both homes and hotels (Akintoye and Olaniyan,2012). it is an important source of fibre, mineral and certain vitamins (Leitrat and Pulam,2007). Germination is the process by which an organism grows from a seed or a spore. The most common forms of germination include a seed sprouting to form a seedling and the formation of spore ling from a spore. Thus, germination occurs primarily in a plant and fungal species. Sugar is a white odorless, crystalline powder with a sweet taste. It is best known for its role in food. The molecule disaccharide composed of the monosaccharide glucose and fructose with the molecular formula $C_{12}H_{22}O_{11}$.The word sucrose was coined in 1857 by the English chemists William Miller (John W. Parker, 1857) from the French ("sugar'') and the generic chemical suffix for sugar -ose. The effects of prolonged droughts such as those that have struck eastern and southern Africa in recent years, have been disastrous. With the aid of this practical, drought resistant varieties of sweetcorn can be used to contribute to a significant expansion in sweetcorn in many countries of west Africa, notably Benin republic, Burkina Faso, Cameroon, Niger republic and Nigeria.

Developing new sweetcorn Varieties, tolerant to drought stress will expand sweetcorn production not only in the eastern and southern Africa, but also in many countries in West Africa including Nigeria. Sweetcorn is an important crop which serves as a vital source of energy in human diet in developing Tropical countries. However, in a view of the vast important of sweetcorn, still it is affected by drought. This fact necessitates the development of more Varieties tolerant to moisture deficit that can be produced in various agro ecological zones. Therefore, the objective of this study is to determine the percentage germination and identify genotypes with higher germination percentages in sucrose solutions and also recommend the genotype to sweetcorn breeders for developing drought tolerant varieties.

MATERIALS AND METHODS

The experiment was conducted in crop science laboratory Kano science and technology wudil. The materials used were petri dishes, spoon, filter paper, masking tape, measuring tube and water. The maize samples tested for germination and their sources are represented in table1. Ten seeds from each sample were counted and planted in a labelled petri dish lined with filter paper in a complete randomized design (CRD) and replicated three times each germination test in water,5%and 10% sucrose solution. 5% was made by measuring 5ml of sucrose in measuring cylinder and filling the cylinder with distilled water to the level of 100ml.The same procedure was followed in preparation of 10% of 100ml.For germination test with water, filter paper in labelled petri dish was moistened and ten seeds were widely spread on it. The Petri dishes in three replicates for each sweetcorn sample were kept in a germinator, the procedure was followed when setting the germination test with 5% and 10% sucrose. The petri dishes were checked for germinants. Germination was considered to have taken place when radical and plumule emergence was noticed from a seed. Number of germinant with radicle and plumule were counted and recorded daily. They were considered as normal seeds (NS). Number of germinants with either radicle or plumule, considered as abnormal seedlings (AS) were also recorded daily on data sheet. Observation was stopped when the germinants counts in each replicate remains constant and no more seed was expected to germinate. Germination percentages in water and sucrose solutions were computed based on the number of seedlings only. The data was subjected to statistical analysis using SAS and the mean were Separated using Duncan ranking

RESULTS AND DISCUSSION

Table 1 indicated that Wari White, Zaria E, Yar Gangara yellow, Zaria D, El yellow local and Jorobama White had highest germination percentage in water of 90% and above in water, at 5% sucrose they have the highest percentage of 50% and above. The more the increase of sucrose concentration the percentage germination reduces. The least percentage germination was found at MI307-8, IITA variety. This might be that favorable environmental condition was created for germination of the above varieties as reported by (Miles and Brown 2007) Seeds generally "wake up" and germinate when soil moisture and temperature conditions are correct for them to grow. Also, the least germination percentage due to unfavorable environmental condition created which did not favour germination[7].

Table 2 shows that the highest mean of radicle length was found in 6 six varieties that have mean radicle length in water of 4cm and above, they include Wari White, Zaria E, yar Gangara Yellow, Zaria D, Jorobama White and Yar Tasau Yellow. The highest mean radicle length at 5% sucrose concentration of 1cm and above was found on the following varieties Wari White, Zaria E, Yar Gangara Yellow, zaria D, El yellow Local and Jorobama White. Similarly, the more concentration the lesser the mean radicle length. This might be that more concentration of sucrose retarded the germination and reduce the radicle length as reported by (stefanello *et al*.2020) if sucrose concentration is too high, the seed would be under stress and as a result the seed's growth rate would slow down or, in extreme cases, would end up in the seed dying. The least mean radicle length was found in MI307-8 variety and at 10% sucrose concentration. Table 3 shows the mean plumule length in water and sucrose concentration at different rate. The result indicated that four varieties have the highest mean plumule length of 2cm and above, they include Wari White, Yar Gangara Yellow, Jorobama White and Yar Tasau Yellow. The least variety was M1307-8 in 10% sucrose concentration. This is due to the highest concentration that affected the germination percentage.

CONCLUSION AND RECOMMENDATION

The present result showed that germination percentage of sweetcorn seeds was significantly reduced by increasing sucrose concentration. The study also showed reduction in radicle and plumule length with increase sucrose concentrations. The germination, root and shoot development were more arrested in 10% than in 5% sucrose solutions. Sweetcorn samples jarobama white, Wari white, Zaria E,yar gangara yellow,El yellow local and zaria D with respective germination percentages 96.7%,90%,83.3%,76.3%,75%, and 73.3% in 5% sucrose solution are therefore recommended to breeders for the development of drought tolerant sweetcorn Varieties.

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Table 1: Source of Germplasm and Percentage Germination in Water, 5 and 10 % Sucrose Concentration.

Germplasm	Source	Country	Water	Sucrose 5 %	Sucrose 10%
Wari white	Ougodugu	Burkina faso	100	90	70
M1307-8	IITA	Nigeria	0	0	0
Zaria E	Saminaka/ Lere	Nigeria	90	83.3	63.33
Yar Gangara Yellow	Mirya Agric. D.	Niger	90	76.66	56.67
Zaria D	Saminaka/ Lere	Nigera	93.3	73.3	0
El yellow local	Wrandi Maradi	Niger Rep.	91.6	75	33.33
Jarobama white	Dogon dutse	Mali	100	96.7	60
Mailalle yellow	Mirya Agric D.	Niger Rep.	46.6	26.67	0
Yar Ghana white	Kasuwar Dabo	Niger Rep.	46.7	33.33	13.33
Yar Tasau Yellow	Tasau Village	Niger Rep.	43.3	40	0

Table 2: Mean Radicle Length (cm) in Water and Sucrose Concentration at 5 and 10 %

Germplasm	Mean Radicle Length in Water	Mean Radicle Length in Sucrose at 5 %	Mean Radicle Length in Sucrose at 10%
Wari white	5.21	3.74	0.98
M1307-8	0	0	0
Zaria E	4.57	1.46	1.29
Yar GangaraYellow	5.28	1.35	1.06
Zaria D	4.41	2.51	0
El yellow local	1.92	2.33	0.45
Jarobama white	4.70	1.55	0
Mailalle yellow	0.67	0.63	0
Yar Ghana white	2.06	5.55	0.86
Yar Tasau Yellow	5.19	0.40	0

Table 3: Mean Plumule Length (cm) in Water and Sucrose Concentration at 5 and 10 %

Germplasm	Mean Plumule Length in Water	Mean Plumule Length in Sucrose at 5 %	Mean Plumule Length in Sucrose at 10%
Wari white	2.61	1.88	0.58
M1307-8	0	0	0
Zaria E	1.61	1.11	0.58
Yar GangaraYellow	2.11	0.94	0.39
Zaria D	1.26	0.64	0
El yellow local	1.08	1.51	0.33
Jarobama white	2.36	1.43	0.75
Mailalle yellow	0.67	0.63	0
Yar Ghana white	0.42	0.71	0.38
Yar Tasau Yellow	2.18	1.04	0

EVALUATION OF ACUTE/ SUB CHRONIC TOXICITY OF MARIGOLD ESSENTIAL OIL ON BLOOD OF WISTAR RATS

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ABSTRACT

There had been recent increase in the demand and use of marigold and its essential oil as there are claims of its many potential medicinal benefits. The experiment was to evaluate the acute and sub-chronic effect of the essential oil and its toxic effect on the blood of wistar animals which will stand as a standard for its recommendation. The essential oil was applied at 0.1ml on the cleared surface of the skin as the test was a dermal test and the period of exposure was varied between 2 weeks to 6 weeks. At the end of the experiment, it was observed that the treatment had no significant effect on the blood parameters of the treated animals and the animals likewise did not show any sign of toxicity. This study shows that at the applied quantity, the essential oil does not have a toxic effect on the test animals.

Keywords: *Dermal, Essential oil, Marigold, Toxic, Wistar rat.*

INTRODUCTION

Many essential oils or their constituents are known to be potent antibacterial as well as anti-fungal and insecticidal agents. The genus *Tagetes* belongs to the Asteraceae family and comprises 56 species, 27 of them annuals and 29 perennials. It is a plant which is native to America, but it is naturalized in other countries in Africa, Asia, and Europe (Babu, 2007; Politi, et al., 2017). *Tagetes* sp. are grown all over the world as multi-purpose plants of which these species, *T. minuta, T. erecta, T. patula* and *T. tenuifolia,* are the most common (Vasudevan et al., 1997) that are studied because of their application in the field of agriculture, where they exhibit fungicidal, bactericidal, and insecticidal activities, as well as anticancer properties (Kashif, et al., 2015; Padalia, 2015; Politi, et al., 2017), resulting in their exploitation as beverages and condiments in folk medicine (Girón et al., 1991; Laferriere et al., 1991), to treat intestinal and stomach diseases and some of them have been found to possess biological activity (Tereschuk et al., 1997; Broussalis et al., 1999). This genus is recognized as a source of very interesting biologically active products, that is, carotenoids used as food colorants and feed additives (Timberlake and Henry, 1986) and possessing anticancer and anti-ageing effects (Block et al., 1992), essential oils known for their antibacterial and insecticidal properties (Piccaglia et al., 1996) and flavonoids having pharmacological properties (Tereschuk et al., 1997).

Volatile oils of *T. minuta* L. are used as antibacterial (Senatore et al., 2004), flavour components in food products and perfumes (Chamorro et al., 2008). They also have a suppressive biological activity against some insects and pathogens (Vasudevan et al., 1997). *T. minuta*, which also presented cytotoxic (Shirazi, et al., 2014) and anti-inflammatory activities.

Objective:

To evaluate the toxic effect of marigold essential oil on the blood of experimental animal through dermal application.

MATERIALS AND METHODS:

The experiment was carried out at the National Horticultural Research Institute Ibadan as well as Veterinary and Physiology Department, University of Ibadan, Nigeria. Twenty wistar rats were used for the experiment containing both males and females with average weight of 100g, animals were grouped and placed in a plastic cage. Acclimatization was done for 10 days after which treatment commenced. The animals were grouped into four (4) containing five (5) rats each of both sex and treatments were based on the period/time of exposure to the essential oil which was 2, 4 and 6 weeks. About 0.1ml of ketamine was injected to the animal inter-peritoneal (IP) and after 10 mins the animal fore/hair were scrapped off on the right side with soap and water using blade and exposing the skin in preparation for treatment application.

Data collected include weight gain or loss, change in appetite, physical changes, behavioral changes, hair growth, skin and blood. After hair removal, the animal skin was observed for possible surface damage and after 48 h treatment commenced. Two drops (0.1ml) of marigold essential oil was applied and evenly spread on the exposed skin every other day, it was allowed to dry so as to prevent oral contamination, then animals were returned to its cage. Food and water were given to the animals ad-libitum. At the end of the experiment, the bloods of animal were collected through ocular veins, animals were sacrificed through cervical dislocation and organs of interest was carefully harvested.

RESULT AND DISCUSSION

Plate 1: wistar rats in cages

At the third day of application, a set of the test animal showed slight discolorations on the sight of application of treatments but by the fifth day it cleared off, and on the termination of experiment there was no damage done to both skin and blood. This agrees with the findings of Devika *et al* who said *T. erecta* showed that its compounds have anti-inflammatory potential with no sign of toxicity.

Table1: Blood parameters

Parameters	Control	2 wk	4 wk	6 wk
PVC	39.42a	41.25a	39.00a	40.50a
HB	13.00a	13.125a	12.100a	12.800a
RBC	7.1231a	6.8150a	7.4175a	7.1800a
WBC	4986.83a	5073.00a	3183.13a	5435.50a
PLT	120006.00a	118000.00a	105750.00a	122000.00a
LYM	68.12a	70.25a	62.00a	67.50a
NEUT	25.40a	26.00a	24.50a	27.25a
MON	1.35a	1.75a	1.25a	1.75a
EOS	2.43a	2.50a	2.75a	2.25a

PCV; pack cell volume, HB; hemoglobin, RBC, red blood cell, WBC, white blood cell, PLT; Platelet, LYM; Lymphocytes, NEUT; Neutrophil, MON; Monocytes, EOS; Eosinophil a =means on the same row with same letter are not significantly different ($p>0.05$).

From the table above, it was observed that there were no significant differences among the blood parameters across the weeks for both control and treatments. PCV shows no significant differences among the weeks although; 2 weeks had the highest value (41.25) while 4 weeks had lowest (39.0). Same trend was observed for HB, PLT and LYM respectively. But for RBC, WBC, NEUT, MON and EOS there were variation in the trend where highest value in WBC and NEUT wasobserved at 6 weeks and lowest at 4week respectively. While RBC was highest at 4 weeks and lowest at 2 weeks, EOS had the highest value at 4 weeks and lowest at 6 week and MON was highest at both 2 and 6 weeks and lowest at 4 weeks. This agrees with the findings of Shetty (2008); Shetty et al. (2009) and Manisha et al. (2013) who reported that both aqueous and ethanolic fractions *T. erecta* flowers were found to be safe during acute toxicity study. The study was in accordance to OECD Guidelines 425 procedure using albino Wistar rats.

CONCLUSION

From the result, it is confirmed that marigold essential oil at the evaluated dosage does not have damaging effect on the wistar blood. It is therefore recommended that a step should be taken further to investigate its oral toxicity as marigold is suggestive to be used as food preservative.

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EFFECT OF FERTILIZER TYPES ON CUMULATIVE YIELD AND NUTRIENT UPTAKE OF SESAME (*Sesamum indicum Linn.)* IN OGBOMOSO

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ABSTRACT

Sesame (Sesamum indicum L.) is one of the oldest domesticated oilseed crops. Due to the presence of high oil, protein and other nutritional elements, its seed has become an important ingredient of food and feed. Poor soil fertility is among the major production problems responsible for poor growth and low yield of sesame in Nigeria. A pot experiment was carried out at the experimental plot at Ladoke Akintola University of Technology, Ogbomoso, Nigeria to evaluate the effects of fertilizer types on cumulative yield and nutrient uptake of sesame (Sesamum indicum L.) plants. Six treatments were used: T_0 (control), T_1 (2g of NPK/pot), T_2 (30g of organic neem /pot), T_3 (30g of organomineral/pot), T_4 (20g of poultry manure/pot), T_5 (30g of cow dung/pot). Data were collected on growth and yield parameters and were analyzed using ANOVA. Sesamum indicum responded best to the application of NPK but not significantly different (p = <0.5) from other treatments applied; Application of T_1 (NPK) produced the best of the yield parameters measured and therefore recommended for improving nutrients availability and sesame performance in the study area.

Keywords: *Cow dung, NPK, organ mineral, organic neem, poultry manure, sesame.*

INTRODUCTION

Sesame (*Sesamum indicum*) belongs to the family Pedaliaceae. The genus consists of about thirty-six species of which the most commonly recognized is *Sesamum indicum L.,* popularly known as beniseed in Nigeria (Alegbejo, *et al*., 2003). It is an erect, flowering annual plant which grows up to 50 to 250 cm tall or more, as determined by the soil or environmental conditions and varieties (Sharma, 2005). Sesame is usually propagated by seeds and matures within 70-150 days after sowing, depending on the varieties (Indu and Savithri, 2003). Flowering commences at 38-45 days after sowing and stops at 70-120 days after sowing (Langham and Wiermeers, 2006). Although sesame is relatively ranked amongst the drought-tolerant crops, but can dies in stagnant water (Weiss, 2000; Ray *et al.,* 2004). The precise natural origin of the species is unknown but numerous wild relatives are occurring mostly in Africa and a smaller number found in India (Ashri, 1998). However, it is believed to have originated from the tropical Africa where the greatest genetic diversity exists but was believed to have been introduced to India at a very early date, where a secondary center of diversity is well developed (Alegbejo *et al.,* 2003; Olaoye, 2007).

Sesame is primarily grown for its edible seeds and oil, with 65% of the seeds being used for oil extraction and 35% for food. Sesame seeds have outstanding amounts of oil and a desirable nutty flavour after cooking. For these reasons, they are much appreciated in bakery, the candy industry and for other food specialties (Hansen, 2011).

Research on the nutrition of sesame in the tropics shows significant yield increase due to application of N P K fertilizers in India, Pakistan, and Tanzania. In Ethiopia, N P fertilizers are commonly applied. Nitrogen is the most dynamic nutrient element and the most important nutrient that is required for the survival of all living things. Increases in N supply within limits are associated with increase in leaf area, carboxylases, and chlorophyll content, all of which determine the photosynthetic activities of leaf and ultimately dry matter production and allocation to the various organs of a plant. Similarly, good supply of P is usually associated with increased root density and proliferation, which aid in extensive exploration and supply of nutrients and water to the growing plant. N contributes up to 50% of all the nutrient inputs, and therefore, nitrogen is the determinant of farmers' crop yield. A general rule of thumb is that N is for leafy top growth, phosphorus is for root and fruit production, and potassium is for cold hardiness, disease resistance, drought tolerance, and general durability. Since N is the most dynamic nutrient and building block of all plant structures, its inclusion in the sesame production is critically important. Seed quality in sesame is determined by seed color, seed size, aroma, oil, and protein contents. (Shehu *et al.,* 2009).

MATERIALS AND METHODS

This research was conducted between March and August, 2021 at the Teaching and Research Farm, Ladoke Akintola University of Technology (LAUTECH), Ogbomoso, Oyo state, Nigeria, to assess the effects of fertilizer types on the cumulative yield and nutrient uptake of sesame in Ogbomoso, southern guinea savanna eco-region of Nigeria. The materials used were seeds of Sesame indicum (ncriben 05E), NPK. 1515-15 fertilizer, organic neem, organomineral, poultry manure, PH meter and cow dung caper-cropping soil samples were collected randomly using soil auger at 0-15 cm and samples collected were bulked into a composite sample, air dried and sieved through 2 mm and 0.5 MM meshes for the determination of particle size, pH (H20), total nitrogen (N), organic carbon, available Phosphorus (P), Iron (Fe), Copper (Cu), Znic (Zn), exchangeable captions (Ca, Na, Mg and K) and exchangeable acidity (H^+ and Al^{+3}). The experiment was carried out using completely randomize design (CRD). A total of 36 pots were each filled with 10kg soils and used for the experiment. The six fertilizer treatments used at recommended rate and the control as T_0 (no treatment), T_1 (NPK, 2 g/pot), T_2 (organic neem, 30 g/pot), T_3 (organomineral, 30 g/pot), T_4 (poultry manure, 20 g/pot), T_5 (Cow dung, 30 g/pot). Two pots per treatment were used, replicated three times. Soil available P was determined by extraction with Sodium bicarbonate (Olsen *et al.,* 1954). Organic carbon was determined by chromic acid digestion.

Dry weight and the total biomass production of the harvested Sesame plants shoot and root were determined by oven drying at 80°C to a constant weight for three days (72 hours). The plant samples were then milled in Wiley mill to pass through 1mm sieve and subjected to kjeldah digestion at 360°C for 4 hours with concentrated sulphuric acid, using selenium and sodium sulphate as catalyst. plant content of P, K, Ca, Mg, Mn, Zn, and Cu were determined by ash plant samples in muffle furnace at 600°C for 2hours, the ash was cooled and dissolved in 1N hydrochloric acid and the solution pass through filter paper into Smi volumetric flask and made up to the mark with distilled water. Total N was determined from the digest steam distillation with excess NaOH. From the digest P concentration was determined by the Vanadomolybdate yellow colorimetric method using spectrophotometer (spectromic 20). The K and Ca were determined by using flame photometer (comin model 400) while Mg, Fe, Zn and Ca were determined with atomic absorption spectrophotometer (AAS) of the Bulk Scientific Model (Akanbi *et al*., 2005). The nutrients accumulated in plants were calculated as; Nutrient uptake=% Nutrient content X sample dry with according to (Ombo, 1994) and (Gungunila, 1999). Yield parameters measured were dry shoot weight per plant, number of capsules, capsules fresh weight, root fresh weight, root dry weight.

RESULTS AND DISCUSSION

The pre-cropping soil chemical and physical analysis shows that the soil is slightly acidic with pH 6.20 (Table 1). The soil was grossly low in essential nutrients particularly total N (0.16%), and exchangeable bases (cmol kg–1); K, 0.30 and Fe. 10.20. The results were in line with findings of Olabode, *et al., (*2007) and Babajide, *et al*., (2008) which indicated that the soils at the study area was slightly acidic and that they were grossly low in essential nutrients.

Table 1: Physico- chemical analysis of the soil sample used

Soil properties	Values
pH (H_2O)	6.20
Organic Carbon (g kg^{-1})	3.16
Total N (g kg^{-1})	0.16
Available P (mg kg^{-1})	5.14
Fe (mg kg^{-1})	10.20
Cu (mg kg^{-1})	2.60
Zn (mg kg^{-1})	2.19
Exchangeable K (cmol k^{1})	0.30
Exchangeable Na (cmolkg^{1})	0.22
Exchangeable Ca (cmol kg^{-1})	0.11
Exchangeable Mg (cmol kg^{-1})	3.22
Sand (g kg^{-1})	779.00
Silt (g kg^{-1})	91.00
Clay (g kg^{-1})	130.00
Textural class	Sandy loam

Fertilizer application significantly improved the number of capsules produced, T_1 produced the highest number of capsules (102.83) but not significantly different from other treatments except over the control with the least value (42.6cm). For capsules fresh weight, T_1 had the highest value (67.62g) but was not significantly different from other treatments applied except over the control with least value (29.29g). For root fresh weight, T_1 had the highest value (87.36g) but not significantly different from other treatments applied except for the control which has the least value (36.22g). For root dry weight, T_1 has the highest value (19.45g) but not significantly different from other treatments applied except over the control which has the least value (4.03g). For shoot dry weight, T_5 has the highest value (24.80g) but not significantly different from other treatments applied except over the control which has the least value (12.42g).

Table 2: Effect of different fertilizer types on yield parameters of sesame

Treatments	Number of capsules	Capsules fresh weight	Root fresh weight	Root dry weight	Shoot dry weight
T0	42.6b	29.29b	36.22b	4.03b	12.42b
T1	102.83a	67.62a	87.36a	19.45a	19.55ab
T2	57.0b	46.05ab	49.36ab	8.89b	15.18ab
T3	69.5ab	48.71ab	82.47a	10.55a	22.63ab
T4	81.5a	65.42a	79.25ab	9.37a	22.39ab
T5	80.3ab	52.23ab	78.16ab	8.43b	24.80a

Means followed by same letters are not significant different at P=0.05 using least significant different (LSD), T0 = Control, T1=NPK, T2= neem, T3= organomineral, T4= poultry manure, T5= cow dung.

Uptake of nitrogen (N) was more with the application of T_1 but the value obtained (37.66g Kg) had no significant mean difference from other treatments except for the control it the least value (7.8kg). The uptake of phosphorus (p) was enhanced by the application of T_1 with the value (3.66g kg) but not significantly different from T_4 but significant different over other treatments least for the control (1.13kg). Similarly, the uptake of potassium (k) was enhanced by the application of T_1 (24.86kg) and not significantly different from T_5 but over other treatments and the control that had the least value (2.8kg). Calcium (Ca) uptake was more enhanced by the application of T_5 but not significantly different from other treatments except the control with the least value (0.83kg). Magnesium (Mg) uptake was enhanced by the application of T_4 and the value obtained (3.8Mg/kg) had no significant difference from T_5 but significantly over other treatments except the control with the least value (1.7kg). Sodium (Na) uptake was enhanced by all the treatment applied. Iron (Fe) uptake was enhanced by the application of T_2 with the value obtained (86.46Kg) but had no significant difference from other treatments but significant over T_5 while the control has the least value (35.3kg). The uptake of copper (Cu), was enhanced by the application of T_1 which had the highest value (10.4kg) but not significantly different from other treatments but significant over other treatments except for the control (7.42kg). The uptake of manganese (Mn), was enhanced by the application of T_1 which has the highest value (85.9kg) but not significantly different from other treatments except the control (31.5kg). The uptake of Zinc (Zn), was enhanced by the application of T_1 which has the highest value (85.9kg) but not significantly different from other treatments except over the control (24.4kg)

Table 3: Effects of Nutrients uptake of sesame under different fertilizer types applied

Treatments	N	P	K	Ca	Mg	Na	Fe	Cu	Mn	Zn
T0	7.8f	1.13d	2.8c	0.83c	1.7c	0.9a	35.3c	7.42b	31.5b	24.4b
T1	37.66a	3.66a	24.86a	2.8ab	2.16c	0.86a	77.6ab	10.4a	85.9a	53.4a
T2	23.4d	2.6bc	18.2b	2.96ab	2.73b	0.8a	85.46a	8.93a	40.9a	26.9ab
T3	30.2b	2.86b	19.06b	2.8ab	2.73b	0.76a	79.4ab	8.8a	43.63ab	28.6a
T4	1.91e	3.46a	19.06b	3.33a	3.8a	0.8a	78.76ab	10.2a	39.8ab	26.4ab
T5	27.4e	2.46c	24.26a	2.53b	3.53a	0.8a	74.53b	7.5a	33.13a	22.73a

Means followed by same letters are not significant different at P=0.05 using least significant different (LSD), T0 = Control, T1=NPK, T2= neem, T3= organomineral, T4= poultry manure, T5= cow dung

CONCLUSION

All the fertilizers applied significantly improved the yield parameters of *Sesamum indicum* measured. Application of NPK significantly improved the performance of *Sesamum indicum* and the value obtained when compared to the other fertilizer materials used. Nutrient uptake particularly N, P and K were also significantly enhanced through application of NPK fertilizer. Application of NPK is therefore recommended in the study area to improve the production of *Sesamum indicum in the locality*.

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FARMERS' PARTICIPATORY SELECTION FOR RELEASE OF HIGH YIELDING *FUSARIUM* WILT TOLERANT TOMATO VARIETIES IN NIGERIA

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ABSTRACT

Low yield in tomato production has been partly traced to attack by Fusarium wilt. The most sustainable control option remains the use of resistant varieties. Participatory development and selection of resistant or tolerant varieties during breeding process is germane to adoption and expected impact. The National Horticultural Research Institute (NIHORT) developed three high yielding Fusarium wilt tolerant varieties (HORTITOM1, HORTITOM2 and HORTITOM3) in line with appropriate breeding guidelines. On-farm evaluation trial was conducted on farmers' field to evaluate the three improved varieties and two local checks. Farmers' field day was organized by NIHORT for field evaluation of the tomato varieties by selected farmers in the locality. Thirty farmers were selected from different communities from Agricultural Development Programme, Iwo zone, Osun State for participation. Interview schedule and Focus Group Discussion were used to collect data. Data were analyzed using ranking, assignment of positions and frequency distribution. HORTITOM1, HORTITOM3 and HORTITOM2 ranked first, second and third respectively. Most (75%) respondents selected HORTITOM1 as the most preferred variety. Top priority outstanding traits of HORTITOM1 are high yielding, fruit colour, growth pattern with a score of 105, 95 and 95 respectively. Participating farmers are expecting release of the improved varieties for adoption due to their involvement in the selection process. Participatory selection of resistant or tolerant crop varieties is germane to adoption of improved crop varieties for optimum yield and income.

Keywords: *Fusarium wilt, HORTITOM1, HORTITOM2 and HORTITOM3, Participatory selection*

INTRODUCTION

Globally, tomato (*Lycopersicon lycopersicum*) is one of the priority fruit vegetable crops consumed among the populace (FAO, 2010). It has all-year round demand due to its usefulness in both fresh and processed form (Alwis *et al*., 2008). In Nigeria, it is the most cultivated fruit vegetable (Borisade *et al*., 2017) and one of the priority agricultural commodities in horticulture under the agricultural transformation agenda of the Federal government of Nigeria (Akinwumi, 2013). Red coloured tomatoes contains high lycopene and beta-carotene which are very important anti-oxidants that fight against cancerous cell formation by neutralizing free radicals that can damage body cells (Bhowmik *et al*., 2012). It is rich in Chromium which helps in regulating blood sugar in diabetic patients and a very good source of minerals and vitamins (Bhowmik *et al*., 2012). Low production of tomato (3-10t/ha) has been reported in African countries compared to European countries with over 400t/ha (FAO, 2016). The low production of tomato in Africa has been attributed to the problem of pests and diseases leading to loss of large quantity of the produce (Cladius *et al*., 2015). In Nigeria, tomato plant is subject to attack by insect pests and diseases from nursery until harvest. Pests such as green peach aphids *Myzus persicae*, whitefly *Bemisia tabaci,* cutworm *Agrotis ipsilon*, and fruitworm *Helicoverpa zea* were the major pests causing damage to tomato until 2015 devastating invasion of *Tuta absoluta* (Oke *et al.*, 2017b). Plant-parasitic nematodes also pose a major threat to tomato production with the estimated loss of USD 80 billion per year (Nicol *et al* 2011). Low yield in tomato has also been traced to the attack of *Fusarium* wilt which occurs at any growth stage of the plant causing great loss both on the field and in the screen houses (McGovern, 2015).

Fusarium wilt of tomato, caused by *Fusarium oxysporum* f.sp. *lycopersici* is a devastating disease in major tomato-growing regions worldwide and has been reported in at least 32 countries and particularly severe in countries with warm climate (Mui-Yun, 2003). The pathogen is soil borne and can persist for many years in the soil in the absence of a host. *Fusarium* wilt is known for causing serious damage during production which could lead to 30-40% damage and the losses could go up to 80%. Agro chemicals are commonly used for pests and diseases management. However, they are costly, with adverse effect like mammalian toxicity due to chemical residue, environmental pollution, with limitations such as unavailability of the chemical and lack of technical know-how. The current trend on “near to zero tolerance” to pesticide residue in fresh fruit and leafy vegetables, development of resistant to chemicals by the pathogens, damaging effects of chemicals on the environment and human necessitate the search for non-chemical means of controlling pests and diseases (Reuveni *et al*., 2002). The most viable, cost effective and environmentally safe control option remains use of resistant varieties.

Participatory selection is an inclusive approach to plant breeding that actively involves farmers, researchers, and other stakeholders in the process of varietal development, selection and release. Participatory breeding initiatives encourage farmers to participate in the selection process in order to create crop varieties that are more suitable for the region's agro-ecological conditions, satisfy farmers' preferences, and increased agricultural productivity. Cases of non-adoption of developed technologies have been reported due to non-involvement of relevant end-users in development process. Therefore, technology rejection is not just a mere negation of its acceptance, it needs to be discerned (Murty and Wani, 2013) and prevented accordingly to enhance adoption.

In a bid to solve the problem of *Fusarium* wilt and low yield in tomato production, a multidisciplinary team of Scientists from NIHORT developed 3 candidate tomato varieties (HORTITOM1, HORTITOM2 and HORTITOM3). In accordance with National Centre for Genetic Resources and Biotechnology (NACGRAB) guidelines, on-farm trials were conducted following appropriate protocols to ensure farmers participation in production, selection and release of the new varieties. On-farm is to test new technology on farmer’s field, validate farmers’ perception about the candidate varieties whether it will be accepted or not, whether it is better than what they have or not and whether it can be adaptable or not and for comparison of farmer’s varieties and the candidate varieties (NACGRAB, 2016). The major objective of the study was to assess farmers’ participatory selection in the release of high yielding *Fusarium* wilt tolerant tomato varieties in Nigeria. The specific objectives were to:

1. Conduct ranking of evaluated varieties by participating farmers at the on-farm trial field
2. Identify most preferred tomato varieties among farmers
3. Ascertain priority traits preference in the most preferred variety by farmers

METHODOLOGY

Five tomato varieties comprising three best candidate varieties from NIHORT with two local checks (existing variety and farmer’s variety) were taken to farmers’ fields for on-farm trial. Appropriate agronomic practices were done both at on station and on-farm using standard procedures. In order to gain farmers participation in the evaluation and selection process, farmers’ field day was organized by NIHORT on 15th November, 2022 at Iwo, Osun State. Thirty farmers were selected to participate at the farmers’ field day by the collaborating Agricultural Development Programme (ADP), Osun State, however, twenty six and 28 farmers participated at the on-farm ranking and varietal selection respectively. Selection cuts across both direct and indirect beneficiaries from Idi Araba, Oke Oba, Iwo, Eleko, Ejigbo, Molefon, Kara, Akindi, Olukotun, Patara, Olodo, Ajenisiwa, Gidigbo, Bode Osi Ola Oluwa in Osun State. Questionnaire and Focus Group Discussion (FGD) were used to collect information from farmers. Farmers were asked to assign positions 1-5 to the evaluated varieties at the on-farm trial field with the best variety taking the first and the least taking the fifth position. Visual assessment was done by each farmer on the field to select the most preferred variety among the five evaluated varieties. In addition, each farmer was asked to assign a score from 1-5 to desirable traits in the most preferred varieties, this was to identify the most desirable traits in the preferred variety. Data were analyzed using ranking, assignment of positions and frequency distribution.

RESULTS AND DISCUSSION

Ranking of the three evaluated varieties at the on-farm trial field by participating farmers

The different positions (1-5) assigned by farmers were added together and the variety with the least total score ranked first as the best variety and vice versa. In terms of performance on the field, HORTITOM 1 had a total score of 30, HORTITOM 3 had a total score of 63 and HORTITOM 2) had a total score of 75 while Ibadan local and kerewa had a total score of 94 and 130 respectively. HORTITOM 1, HORTITOM 3 and HORTITOM 2 ranked first, second and third respectively while Iwo local and kerewa varieties came fourth and fifth respectively (Table 1). Results of the FGD confirmed that farmers did not observe any challenge on the field during the evaluation period thus farmers are willing to grow and adopt the new varieties and also ready to pay for seeds depending on the prevailing market price. Farmers are of the opinion that the new varieties are highly marketable. As far as the participants are concerned, no threat is envisaged from adopting the new varieties. Farmers requested for capacity building in value addition to tomatoes especially at the period of glut when many farmers harvest for sale at the same period. This is to promote storability of produce. Request was made for irrigation facilities by farmers to promote dry season tomato production. The three new tomato varieties were selected by majority of the end users and were subsequently released by NIHORT during Varietal Release Committee Meeting at NACGRAB in January, 2023.

Table 1: Assignment of positions to evaluated varieties on the field

Participants	HORTITOM 1	HORTITOM 2	HORTITOM 3	Ibadan local	Farmers' varieties (local check)
1	1	2	3	4	5
2	1	2	3	4	5
3	3	4	1	2	5
4	1	4	2	3	5
5	1	2	3	4	5
6	1	2	3	4	5
7	1	2	3	4	5
8	1	2	3	4	5
9	1	2	3	4	5
10	2	3	1	4	5
11	1	3	4	2	5
12	1	3	2	4	5
13	1	4	2	3	5
14	1	4	2	3	5
15	1	3	2	4	5
16	1	3	2	4	5
17	1	3	2	4	5
18	1	3	2	4	5
19	1	3	4	2	5
20	1	2	3	4	5
21	1	3	2	4	5
22	1	4	3	4	5
23	1	3	2	4	5
24	1	3	2	4	5
25	1	2	3	4	5
26	2	4	1	3	5
Total score	30	75	63	94	130
Position	1st	3rd	2nd	4th	5th

Selection of the most preferred varieties by farmers

Table 2 reveals that most respondents (75%) selected HORTITOM 1 as the most preferred variety, 17.9% and 7.1% preferred HORTITOM 3 and Ibadan local respectively while none chose HORTITOM2 and Iwo local as the most preferred based on field performance of the different varieties at the time of evaluation. Few (7.1%) respondents still preferred the local varieties because it has been with them, however scoring appearance on the field, the local variety still ranked last confirming the uniqueness of the HORTITOM series. With reference to the observation and judgment of the farmers, HORTITOM1 was the most preferred variety followed by HORTITOM3. Despite the outstanding performance of the new tomato varieties on the field, few farmers still preferred the old varieties, this could be due to the fact that the old varieties has been with them for quite a number of years and they could actually predict its behaviour on the field rather than voting for a completely new variety. During FGD, all farmers agreed that the improved varieties are better and different from varieties grown by them in the locality, HORTITOM3 was singled out in terms of firmness and big fruit size while HORTITOM1 was observed to be high yielding and early maturing. Most farmers preferred HORTITOM1 and confirmed uniformity in growth, flowering and fruiting pattern on the field.

Table 2: Frequency distribution of farmers based on selection of the most preferred among the evaluated tomato varieties

S/N	Evaluated varieties	Farmers preference Frequency	Percentage	Ranking
1.	HORTITOM1	21	75%	1st
2.	HORTITOM3	5	17.90	3rd
3.	Ibadan local	2	7.1%	2nd
4.	HORTITOM2	Nil	-	-
5.	Iwo local	Nil	-	-
	Total	28	100	

Characteristics traits in most preferred variety by farmers

From Table 2, among the 28 farmers that participated in the scoring exercise, 21 farmers selected HORTITOM 1. Highest score that each trait can attract is 5 and the highest score for 21 respondents will be 21x5=105. Top priority outstanding traits of T4 among majority of the respondents are high yielding, fruit colour, growth pattern with a score of 105, 95 and 95 respectively. This is an indication that all the 21 respondents assigned a score of 5 to high yield. Adaptability to environment, fruit shape and firmness attracted a score of 94, 90 and 90 respectively. During FGD, most of the respondents preferred HORTITOM1 and confirmed uniformity in growth, flowering and fruiting pattern on the field. Value for money was not among the top priority traits because the participatory farmers were selected from both beneficiaries and non-beneficiaries farmers during the farmers field day. Value for money can only be determined when farmers are fully involved in production and marketing of the produce.

Farmers revealed during FGD that no challenge was observed on the field during the evaluation period, meaning that no threat is envisaged from adopting the new variety. Farmers expressed willingness to buy at the prevailing market price, grow and adopt the new variety whenever seeds are made available. Farmers requested for capacity building in value addition to tomatoes especially at the period of glut when many farmers harvest for sale at the same period. Irrigation facilities were also requested for to promote dry season tomato production.

Table 3: Assignment of scores to characteristics traits in most preferred variety

Variety	HY	TOL	FC	FSize	FSH	FRM	ST	ERL	APP	VFM	GRP	ADE	Total score
HORTITOM1	105	87	95	87	90	90	81	86	93	90	95	94	1,093
HORTITOM3	25	19	22	21	22	23	21	21	19	21	23	23	260
Ibadan Local	10	5	8	8	9	8	9	4	9	9	10	10	99

Key: HY=High Yielding; TOL=Tolerance; FC=Fruit Colour; FSize=Fruit size, FSH.=Fruit Shape; FRM=Firmness; ST.=Storability; ERL+ Earliness; APP=Appearance; VFM=Value for Money, GRP=Growth Pattern; ADE=Adaptability to Environment.

CONCLUSION AND RECOMMENDATION

The three HORTITOM series are highly acceptable to farmers, however, HORTITOM1 ranked first and most preferred by 75% respondents. Unique traits identified include high yield, fruit colour and growth pattern. Participatory varietal selection is germane to acceptability of improved technologies among farmers. To make our research more inclusive and acceptable, there is the need to always involve end-users in development and selection process.

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RESEARCH SCIENTISTS' PERCEPTION OF THE ENVIRONMENT FOR HORTICULTURAL TECHNOLOGY GENERATION AND DISSEMINATION IN NIGERIA

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ABSTRACT
This study was conducted to assess the perception of research scientists about the environment for horticultural technology generation and dissemination in Nigeria. National Horticultural Research Institute (NIHORT) with mandate for horticultural crops development in the country was purposively selected. The 137 research scientists in the institute in 2022 was the study population. Fifty percent of the population was sampled using stratified random sampling based on cadre, place of assignment, and sex. This resulted in 70 respondents comprising 41 males and 29 females. Data was collected with the aid of pretested structured questionnaire, and were analyzed using descriptive (frequency counts, percentages, and ranking) statistics based on completed and returned questionnaires (87.1%). Most (59.0%) of the respondents were male with a mean age of 45.2 ± 7.4 years, mainly less than 50 years old (70.5%). They have worked in the institute for an average of 12.0 ± 5.7 years. A sizable proportion (47.5%) had PhD, and they are mostly (80.3%) biological scientists. Majority (52.5%) of them perceived that the environment was conducive for horticultural technology generation and dissemination. Those with favourable perception towards the environment are slightly above half of the respondents. Concerted efforts should be instituted by the government to further improve research institutions' environment for horticultural technology generation and dissemination in the country.
Key words*: Horticulture, validity ranking, environment, structure, integrity*

INTRODUCTION

Technology generation and dissemination is the primary responsibility of any research organization (Ogungbaigbe, 2004). This is because appreciable development could only be guaranteed through innovation emanating from technology generation and dissemination. The Agricultural Research Council of Nigeria (ARCN) as entrenched in its mission posits that generating appropriate technologies is germane to achieve significant improvement in agricultural productivity, marketing and competitiveness (ARCN, 2021). Generation and dissemination of horticultural technologies is very vital to ensuring nutrition and food security, wealth creation, reduction of hidden hunger and generating employment among other myriads of advantages. Horticultural crops have great economic, health, social, cultural and environmental benefits that could only be accessed through innovation creation along the value chain. This is bordering on new and creative activities in the pre-production, production and post-production areas of the value chain. The National Horticultural Research Institute (NIHORT) is the organization saddled with national mandate for generating horticultural technologies in Nigeria. The Institute also disseminates these technologies via different fora in collaboration with partners.

Environment plays a key role in technology generation and dissemination. Olajide-Taiwo (2022) documented that right or conducive environment is needed to ensure the integrity of any system on any issue. If the research organizations' environment is conducive, generating and disseminating problem-solving technologies would be facilitated more effectively and efficiently with associated level of integrity. Research scientists are key staff in the research organizations who provides leadership in the conception, design, execution, documentation, and dissemination of research activities leading to output, outcome and impact in form of technologies to address problems for horticultural development. Their perception of the environment under which technology generation and dissemination are carried out is germane to determining the adequacy and relevance of the generated and disseminated technologies for national development.

Over the years, it has been presumed that research for development in agriculture generally, and horticulture in particular have been hampered as a result of environment-related challenges. Reported challenges include insufficient funding, dilapidated and inadequate infrastructures, substandard laboratory, inadequate transportation facilities, and personnel with insufficient capabilities among other problems (Wopreis, 2018; Akinyemi, Adejoro, Layade and Adegbite, 2018; Akinpelu, Adebayo, Farike and Adewale, 2013). Studies focusing on the perception of research scientists about the environment for horticultural technology generation and dissemination are very scarce. Therefore, the general objective of this study is to assess the perception of research scientists about the environment for horticultural technology generation and dissemination in Nigeria. Specifically, the objective is to:

i. Analyze the personal characteristics of the research scientists involved in horticultural technology generation and dissemination.
ii. Assess the respondents' perception about the environment for horticultural technology generation and dissemination

METHODOLOGY

Study population, sampling procedure and sample size

Study was purposively conducted in NIHORT being the research only institute with national mandate for horticultural technology generation and dissemination in Nigeria. The population of the study comprise all Research Scientists who have been in the Institute before 2022. A total population of 137 Research Scientists were obtained through the nominal roll, and information supplied by the Planning, Monitoring and Evaluation Department (PMED).

Respondents were selected using stratified random sampling technique. The population were stratified into different cadre and sex across the eight Research Programmes, three Research Units, Planning Monitoring and Evaluation (PME) Department, Information and Documentation (ID) Department in Ibadan headquarter (Oyo State) and Outstations (Bagauda - Kano State, Mbato - Imo State, Dadinkowa - Gombe State, Otukpa - Benue State, and Riyom - Pleteau State). Thereafter, 50% of samples totaling 70 made up of 41 males and 29 females were randomly obtained from each stratum (Table 1).

Table 1: Sampling population and sample size

Population	AD – Director		PRO – CRO		RO1 – SRO		Total		Sample (60%)	
	Male	Fem.	Male	Fem.	Male	Fem.	Male	Fem.	Male	Fem.
Programmes	11	13	30	24	11	15	52	42	26	21
Units	0	3	7	2	1	4	8	9	4	5
PM&ED	0	0	1	1	0	1	1	2	1	1
Info &Doc D	0	1	0	1	0	1	0	3	0	2
Outstations	1	0	10	0	9	0	20	0	10	0
Total	12	17	48	28	21	21	81	56	41	29

Data collection and analysis

Data were collected using pretested structured questionnaire. The 61 (87.1%) returned questionnaire was used for data analysis using descriptive (frequency counts, percentages and ranks) statistics.

RESULTS AND DISCUSSION

Most (59.0%) of the respondents were male, less than 50 years old (70.5%) with a mean age of 45.2 ± 7.4 years. They have worked in the institute for an average of 12.0 ± 5.7 years. A sizable proportion (47.5%) had PhD, and they are mostly (80.3%) biological scientists. Majority (63.9%) have worked somewhere before their present organization, predominantly (52.5%) in non-research organization (Table 2). This indicates that the respondents are highly resourceful with sufficient experience to hear their views about their perception of the environment, and existing structure on horticultural technology generation and dissemination. Going by their background, they could make valid and valuable contribution to horticultural research for development through their perception.

Table 2: Personal characteristics of respondents (n = 61)

Personal Characteristics	Frequency	Percentage	Mean	SD
Sex				
• Male	36	59		
• Female	25	41		
Age			45.2	7.4
• < 50	43	70.5		
• 50 – 59	17	27.9		
• ≥ 60	1	1.6		
Highest Educational Qualification				
• PhD	29	47.5		
• MSc	25	41.0		
• BSc	7	11.5		
Designation				
• AD – Director	10	16.4		
• PRO – CRO	32	52.5		
• RO1 – SRO	19	31.1		
Specialization				
• Biological	49	80.3		
• Social	12	19.7		
Work in Institute (Years)			12.0	5.7
• < 10	23	37.7		
• 10 – 19	36	59.0		
• ≥ 20	2	3.3		
Worked somewhere before				
• No	22	36.1		
• Yes	39	63.9		
Where worked before				
• None	22	36.1		
• Research/Academic	7	11.5		
• Others	32	52.5		
Headship of Department/ Programme/Unit/Station				
• No	32	52.5		
• Yes	29	47.5		
Headship experience (Years)			2.1	3.5
• None	32	52.5		
• 1 – 4	21	34.4		
• ≥ 5	8	13.1		

Perception of respondents about the environment for horticultural technology generation and dissemination

Few (3.3%) of the respondents perceived as "Not true" that "both relevant laws and principle are applied", and "appropriate and relevant personnel are involved" in the process of horticultural technology generation and dissemination. For every statement, the extent to which they were perceived to be true vary in proportion ranging from "True to a very small extent" to "True to a very large extent." A sizable percentage (44.3%) perceived that the statement that "there is no freedom from crisis and unrest" was not true (Table 3). The most valid statement perceived by the respondents in relation to the environment for horticultural technology generation and dissemination was, "Relevant laws and principles are applied" while the least valid was, "There is no freedom from crisis" (Table 4). This is an indication that the environment is perceived to be conducive for technology generation and dissemination by majority (52.5%) of the respondents as depicted in Figure 1

Table 3: Percentage distribution of respondents according to their perception of the environment for horticultural technology generation and dissemination (n = 61)

SN	Statements on perception of the environment for horticultural technology generation and dissemination	Not True	True to a very small extent	True to a small extent	True to an average extent	True to a large extent	True to a very large extent
1	Physical environment are not conducive	41.0	6.6	8.2	16.4	21.3	6.6
2	Relevant laws and principles are applied	3.3	8.2	18.0	14.8	32.8	23.0
3	Appropriate and relevant personnel are involved	3.3	8.2	3.3	18.0	32.8	34.4
4	There is no freedom from crisis and unrest	44.3	4.9	8.2	4.9	21.3	16.4
5	Equal opportunities are given to all actors	16.4	3.3	19.7	21.3	19.7	19.7

Table 4: Percentage distribution of respondents according to validity and ranking of perception statements about the environment for horticultural technology generation and dissemination (n = 61)

SN	Statements on perception of the environment for horticultural technology generation and dissemination	Mean	SD	Not valid	Valid	Validity Rank
1	Physical environment is not conducive	1.90	1.8	47.5	52.5	4
2	Relevant laws and principles are applied	3.34	1.40	29.5	70.5	1
3	Appropriate and relevant personnel are involved	3.72	1.36	32.8	67.2	2
4	There is no freedom from crisis and unrest	2.03	2.06	49.2	50.8	5
5	Equal opportunities are given to all actors	2.83	1.67	39.3	60.7	3

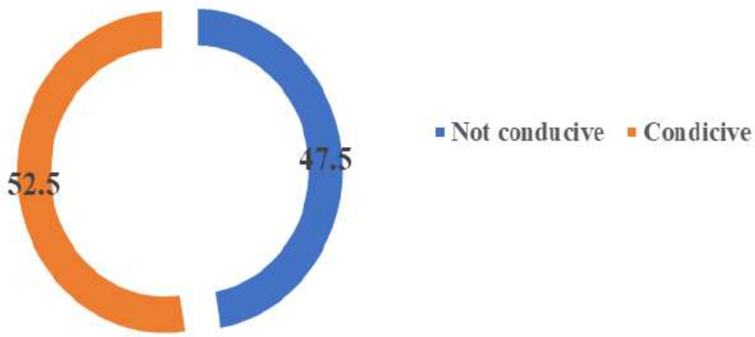

Figure 1: Percentage distribution of respondents according to their perception about conduciveness of environment (n = 61)

CONCLUSION AND RECOMMENDATION

A conducive environment is very vital for horticultural technology generation and dissemination. Majority of the respondents perceived that NIHORT's environment is conducive for horticultural technology generation and dissemination. However, those who sees environment in good light are slightly above half of the respondents. Concerted efforts should be put in place by the government to further improve research institutions' environment to enhance the quality and impact of research in the country.

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EFFECT OF DIFFERENT RATES OF INORGANIC AND ORGANIC FERTILIZER ON GROWTH AND YIELD OF ONION (*Allium cepa* L.) IN GOMBE, NIGERIA

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ABSTRACT
Inappropriate fertilizer application and poor soil fertility management practices are among the factors constraining onion production in Gombe state. Field experiment was conducted at students' demonstration farm, Department of Agricultural Education, Federal College of Education (Technical) Gombe, from June to October, 2022 to assess the effect of different rates of organic and inorganic fertilizer on growth and yield of onion. Treatments included To (0 t/ha PM + O kg NPK), T_1 (20 t/ha PM), T_2 (15 t/ha PM + 50 kg NPK), T_3 (10 t/ha PM + 100 kg NPK), T_4 (5 t/ha PM +150 kg NPK) and T_5 (200 kg NPK/ha). The experiment was laid out in a randomized complete block design (RCBD) with three replications. Plant treated with 20 t PM/ha recorded the tallest plants (45.17 cm), produced more leaves per plant (12.67), average thin bulb neck (4.80 cm) and average big bulb neck (12.77 cm) while the least values were obtained from the control. Longest leaf (17.37 cm) was recorded from plants treated 10 t/ha poultry manure + 100 kg/ha NPK and longest days to maturity was obtained from plants treated with 200 kg/ha NPK while least values of 11.10 cm and 76 days respectively. In conclusion, Plant treated with 20 t/ha PM performed relatively better than other treatments in most of the parameters measured but not significantly different from those applied 10 t/ha + 100 kg/ha NPK, thus, either of the treatments is recommended for the farmers in the study area for optimum production of onion.
Keywords: *organic manure, NPK, onion, gombe, growth, yield*

INTRODUCTION

Onion (*Allium cepa* L.) is one of the most vital vegetables in the world (Shigyo and Kik 2008). It is commonly used as flavorings or as vegetables in stews and salads. It is one of the richest sources of flavonoids in the human diet which has been associated with a reduced risk of cancer, heart disease and diabetes. Globally, the area under onion production is increasing due to its high profitability per unit area and ease of production (FAO, 2011). Onions is used in the preparation of most of the popular Nigerian delicacies. Some of its numerous health benefits include lowering of cholesterol, blood sugar and blood pressure levels. There are different varieties of onions. These include the red, white and yellow onions. The red is the popular one in the country and it is of great commercial value for farmers that cultivate it. Although many farmers are involved in the cultivation of red onions there is still a shortfall in meeting the demand of the Nigerian market especially during the rainy season. Onion is important in the daily Nigerian diet and all the plant parts are edible, although the bulbs are widely used as a seasoning or a vegetable in various dishes. Onion is valued for its distinct pungency and form essential ingredients for flavoring varieties of dishes, sauces, soup, sandwiches, snacks as onion rings *etc*. It is popular over the local shallots because of its high yield potential per unit area, availability of desirable cultivars for various uses and ease of propagation by seed (Lemma & Shimelis, 2021).

Organic fertilizers has positive effect on root growth by improving the root rhizosphere conditions (structure, humidity, etc) and also plant growth is encouraged by increasing the population of microorganisms (Shaheen *et al*., 2017). It is obvious that continuous use of inorganic fertilizers and inappropriate soil fertility management practices are among the major factors limiting productivity of onion. Continuous use of inorganic fertilizers without supplementation with organic manure has often resulted in micronutrient deficiencies imbalance and unsustainable crop production (Yohannes *et al*., 2017). Decomposition of organic materials would provide additional nutrients to the growing medium, which may lead to higher uptake of nutrients by the crop and subsequently high yield (Gererufael *et al*., 2020). There is increased interest in utilization of organic manure because of increased demand of onion and other vegetables as they grow faster and give considerable amount of yield (Boyhan and Torrance., 2020). Onion growth, number of leaves and bulb size were increased with the use of organic fertilizer (Lee, 2018). There is also limited information about application rate of organic manure to onion in the study area. Thus, the main objective of this study was to determine the effects of different rate of organic and inorganic fertilizer application on growth and yield of onion.

MATERIALS AND METHODS

The experiment was conducted at the Demonstration farm, School of Secondary Education (Vocational), Federal College of Education (Technical), Gombe, which is located between latitude 9° - 30° and 12° – 30° North, longitude 8° - 45° and 11° – 45° east in the Sudan Savannah zone Nigeria. The wet season starts from April/May to October with an annual rainfall of about 650-900 millimeters. The dry season begins from November to March, temperature varies from *18⁰C* – 41°C. The treatments consisted of six levels of combination of NPK and poultry manure (PM) (T_{0} = control; T_{1} = 20 t/ha PM; T_2 =15 t/ha PM+50kg/ha NPK; T_3 = 10 t/ha PM + 100kg/ha NPK; T_4 = 5t/ha PM + 150kg/ha NPK and; T_5 = 200kg/ha NPK). The organic fertilizer was applied two weeks before transplanting. The seedlings were transplanted when they have reached 3 to 4 leaves stage or attain the height of 12 to 15 cm. NPK was applied two weeks after transplanting. The experiment was laid out in a randomized complete block design (RCBD) with three replications.

A nursery bed of 5 m long and 1 m wide was marked out and cleared. The land was ploughed thoroughly and made into a fine tilth. Onion seed variety Red Wing was sown at 10 cm distance between rows lightly covered with soil and mulched with grass until seedlings emerge. All proper agronomic practices were carried out until seedlings were transplanted to the main field. Data on plant height, number of leaves per plant, leaf length, days to maturity, bulb diameter, neck diameter, average fresh bulb weight and total bulb weight were collected from five randomly selected plants, and total bulb yields were recorded per plot. Plants in the central rows were used for data collection, leaving aside plants in the border rows and those at the end of each row. Data collected were subjected to analysis of variance (ANOVA) using Star software version 2.0.1. Treatment means were separated using Fisher's Least Significant Difference (LSD) test at 5% probability level.

RESULTS AND DISCUSSIONS

The soil of the experimental site is sandy loam, slightly acidic, low in organic carbon, nitrogen and phosphorus (Table 1). Exchangeable bases are moderate for soil (Esu, 1991). The composition of the poultry manure showed that the pH value is slightly alkaline (7.22) high in organic carbon (28.87 g/kg), total nitrogen (3.62 g/kg), available phosphorus (1.22 mg/kg) and moderate exchangeable bases. Results of the effects of organic and inorganic fertilizer on plant height, number of leaves per plant, leaf length and days to maturity are shown on table 2. Results showed highly significant ($p<0.01$) on days to maturity and significant ($p<0.05$) on plant height and leaf length but showed no significant on number of leaves per plant. Plants applied 20 t/ha poultry manure recorded the tallest onion plant (45.17 cm) but not significantly different from other treatment combinations except the control with shortest plants (17.07 cm). The result is in agreement with the findings of Kokobe *et al*. (2013), Negasi *et al.* (2017) and Yohannes *et al*. (2017). The increment in plant height in response to increased application of the fertilizers is attributable to the role the different nutrients play in the plant in terms of enhancing photosynthetic rate and cell division, elongation and vegetative growth.

Plants treated with 10 t/ha PM and 100 kg/ha NPK produced longest leaf (17.37 cm) followed by those treated with 20 t/ha poultry manure (16.60 cm) while the control had the least (11.01 cm). Messele (2016) reported similar findings where significant increase in vegetative growth parameters of onion with increasing N supply from zero to 50 kg N ha−1. Maximum rate of N showed the highest increment in mean leaf length and number of leaves (Kokobe *et al*. 2013). This might be attributed to the simulative effect of N on vegetative growth, as it is involved in production and use of carbohydrate through photosynthesis and metabolism (Jeyakumar *et al.,* 2007 cited in Gererufael *et al.* 2020). Plants treated with 200 kg/ha NPK reached maturity late in 89.67 days followed by those treated with 5 t/ha poultry manure and 150 kg/ha NPK (87 days), while the control matured earlier in 76.33 days (Table 2). The findings of the present study is in line with the reports of (Girma 2011; Negasi *et al.,* 2017). Delayed maturity with increasing dose of fertilizer application might be attributed to the role that NPK plays in promoting vegetative growth before start of bulb development. Though the effect organic and inorganic fertilizer on number of leaves per plant of onion indicated no significant effect, nevertheless, plants treated with 20 t/ha poultry appeared to produce more leaves (12.67) than other treatment combinations, while the control produced the least number of leaves (9.67). Jeyakumar *et al.* (2007) also reported similar findings. The increase in number of leaves in response to increased application of fertilizers might be due to the role of the different nutrient elements such as N and phosphorus plays in root and shoot growth and development and formation of phosphoproteins and phospho-lipids that encourage meristematic activity of plants, resulting in increased number of leaves per plant (Bagali *et al.*, 2012).

Results of organic and inorganic fertilizer on the number of bulbs per plant, total bulbs weight, average bulb weight, average bulb thin neck and average bulb big neck are shown on table 3. The results indicated no significant effect ($p>0.05$) effect on the number of bulbs per plant, total bulbs weight and average bulb weight but showed significant ($p<0.05$) effect on the average bulb thin neck and average big neck. Plants treated with 5 t/ha PM + 150 kg/ha NPK appeared to produced more number of bulbs per plant (14.33) while control had the least (12.00). In the same vein plants treated with 20 t/ha poultry manure appeared to produce highest total bulb weight (179.60) while the control had the least (6.03). Also, plants treated with 20 t/ha poultry manure had the highest average bulb weight of 23.34 g, while control had the least with 0.99 g. Plants treated with 20 t/ha poultry manure recorded the thinnest and biggest bulb neck with values 4.80 cm and 12.77 cm respectively, while the control having the least (1.56 cm and 2.98 cm for average thin and big neck respectively). Corroborating result was reported by Kokobe *et al.* (2013) who indicated a highest (36.85 t ha−1) bulb yield of onion was obtained at combined application of 100 kg N ha−1 and 45 t FYM ha−1. Similarly, Bashir and Qureshi (2014) reported higher bulb yield of onion at application of 180 kg N ha−1 and 24 t FYM ha−1.

The lowest total bulb yield in the control or zero application of both fertilizers might be due to the fact that plots were deficient of the essential plant nutrients of N and organic manure. The findings in the present study could be due to the activities of NPK and poultry manure in promoting physiological and metabolic processes in plant which improved dry matter production and accumulation. Moreover, the beneficial effect of organic manures on yield might be due to additional supply of plant nutrients and improved physical and biological properties of soil (Datt *et al.*, 2003). The result is in agreement with the findings of Kokobe *et al.* (2013) who reported that interaction effects of N and FYM significantly affected bulb weight of onion. Moreover, integrated use of organic and chemical fertilizers increased bulb weight by about 8.1–12.2% over control (Jayathilake *et al.* 2002). The increase in bulb weight could be attributed to the increase in plant height, number of leaves produced and leaf length in response to the highest rate of N (Shedeed *et al*. 2014).

CONCLUSION AND RECOMMENDATIONS

The findings of this study indicated that organic and inorganic fertilizer significantly influence the growth and yield of onion. Application of 20 tons of poultry manure per hectare improved most of the growth and yield parameters of onion assessed. Thus application of 20 t/ha PM is hereby recommended for optimum production of onion in the study area.

Table 1: Physico-Chemical properties of the soil and Poultry Manure Used in the experimental site

Parameters	SOIL	Poultry Manure
pH water	5.18	7.22
Organic Carbon (g/kg)	0.21	28.87
Total Nitrogen (g/kg)	0.013	3.62
Available P. (mg/kg)	3.45	1.22
Exchangeable bases (cmol/kg)		
Calcium	1.28	2.86
Magnesium (Mg)	0.47	0.09
Potassium (K)	0.12	2.71
Sodium (Na)	0.12	0.48
Soil Texture (%)		
Sand	90.24	
Silt	5.28	
Clay	4.48	
Textural Class	SL	

Table 2: Effect of Organic and Inorganic Manures on the Plant Height, Number of Leaves per plant, leaf Length and Days to Maturity of Onion

Treatment	PLH	NLF	LLT	DTM
To (Control)	17.07b	9.67	11.10b	76.33e
T1 (20tPM/ha)	45.17a	12.67	16.60a	79.67de
T2 (15tPM/ha+50kg/ha NPK)	35.47ab	12.00	16.37ab	82.33cd
T3 (10tPM/ha+100kg/ha NPK)	37.20ab	12.00	17.37a	84.67bc
T4 (5tPM/ha+150kg/ha NPK)	25.50ab	12.00	14.37ab	87.00ab
T5 (200kg/ha NPK)	35.53ab	11.60	14.97ab	89.67a
LS	*	NS	*	**
SE	6.97	1.16	1.56	1.28
CV (%)	26.14	12.13	12.65	1.88

* and ** mean significant at 5% and 1% Probability level. NS indicates not significant. Means with similar letters in the same column are not significantly different.

Table 3: Effect of Organic and Inorganic Manures on the Number of Bulbs per Plant, Total Bulb Weight, Average Bulb Weight, Average Thin Neck and Average Big Neck

Treatment	NBP	TBW	ABW	ATN	ABN
To (Control)	12.00	6.03	0.99	1.56c	2.98c
T1 (20tPM/ha)	13.33	179.60	23.34	4.80a	12.77a
T2 (15tPM/ha+50kg/ha NPK)	13.33	101.31	12.44	3.68ab	9.91ab
T3 (10tPM/ha+100kg/ha NPK)	13.00	116.73	15.28	3.65ab	9.77ab
T4 (5tPM/ha+150kg/ha NPK)	14.33	44.33	6.78	3.51b	6.64abc
T5 (200kg/ha NPK)	13.33	72.73	4.76	3.59b	5.67bc
LS	NS	NS	NS	**	**
SE	1.380	52.570	6.340	0.336	1.790
CV (%)	12.17	74.19	73.30	11.86	27.48

* and ** mean significant at 5% and 1% Probability level. NS indicates not significant. Means with similar letters in the same column are not significantly different.

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EFFECTS OF PROPORTIONATE APPLICATION OF NPK FERTILIZER AND NEEM COMPOST ON THE PERFORMANCE OF SESAME (*Sesamum indicum Linn*.) IN OGBOMOSO

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ABSTRACT

A pot experiment was carried out at the Teaching and Research Farms, Ladoke Akintola University of Technology (LAUTECH) Ogbomoso, Nigeria around March-April 2021 to determine the effects of proportionate application of NPK fertilizer and neem compost on performance of sesame (Sesamum indicum) plants. Six treatments were introduced which are: T0 (no fertilizer application); T1(100% NPK fertilizer application) ; T2(75%NPK +25% neem compost); T3(50% NPK + 50% neem compost) ; T4(25%NPK + 75% neem compost): T5(100% neem compost). The experiment was arranged in a completely randomized design (CRD) with each treatment replicated three times. Data were collected on growth and yield parameters and were analysed using ANOVA. The significant means were compared using Duncan's Multiple Range Test (DMRT). Soil sample used was relatively low in major N, P, and K. Application of 100% NPK(T1) significantly improved the performance of sesame. The value obtained from T1 was not significantly different from T2, T3, T4 and T5 while the control (T0) had the least performance. Nutrient uptake particularly N, P and K were also significantly enhanced through application of T1(100% NPK). T2(75%NPK +25% neem compost) is however recommended for improved performance of sesame in the study area.

Keywords: Fertilizer, Neem compost, NPK, Sesame, Performance, treatments.

INTRODUCTION

Sesame (*Sesamum indicum L.*) is one of the most ancient crops and oilseeds known and used by mankind mainly due to its ease of extraction, great stability, and resistance to drought. It is known by many names such as beniseed, gingelly, sinsin, sesame, and till. Sesame crop is cultivated in almost all tropical and subtropical Asian and African countries for its highly nutritious and edible seeds (Iwo *et al.*, 2002). Sesame is grown mainly for its seeds that contain approximately 50% oil and 25% protein (Burden, 2005). The seeds serves as ingredients in soup and a source of oil (Biswas *et al.*, 2001) and the cake after oil extraction is used in livestock feed. It is also used in local preparation of weaning food (Lalude and Fashakin, 2006). Seeds are used as raw food as well as in confectioneries, sweets, bakery products and also the oil is used in industries in preparation of soap, perfume, and carbon papers as well as in vegetable oil (Khan *et al.*, 2001). The sesame plant measures 60 to 120 cm tall, it is whitish to brown or black seeds depending on the variety with a high oil content of 44-60%, deep rooting. In Nigeria, the crop has remained a popular cash crop among farmers due to its good local and international markets potentials even though its production volume is fluctuating in recent years. For optimum development and yield, sesame requires 25°C to 37°C temperature throughout its growth period. A temperature of 25°C to 27°C encourages rapid germination, initial growth, and flower formation. Temperature below 20°C for any length of time inhibits germination or delay, and a temperature of less than 18°C after emergence will severely retard growth of seedlings. The seeds will not germinate at all at temperature below 11°C (Bennet, 2011). In Nigeria, sesame is cultivated on over 80,000 ha across most of the Northern States. Benue and Nasarawa States are the highest sesame producer in Nigeria with an annual output of not less than an average of 40,000MT each per annum (Raw Materials Research and Development Council, 2004). It will grow on relatively poor soils in climates generally unsuitable for other crops, and so it is widely valued for its nutritional and financial yield from otherwise inclement areas. It is well suited to smallholder farming with a relatively short harvest cycle of 90 – 140 days allowing other crops to be grown in the field (USDA, 2005).

Sesame seed oil is being investigated as a cell growth regulator that slows down cell growth and replication partly through its antioxidant properties. Research shows that the oil can neutralize free oxygen radicals within the skin and surrounding tissues. other experiments have demonstrated positive effects for helping clear blocked arteries. The oil quickly permeates and penetrates the skin, entering the blood stream through capillaries. While in the blood stream, molecules of sesame seed oil maintain good cholesterol and assist the body in removing bad cholesterol (Bergougnoux, 2004). The above benefits and more is the reason for the research carried out on sesame with an objective to evaluate the effect of proportional application of NPK fertilizer and neem compost on the performance of sesame.

MATERIALS AND METHODS

The experiment was conducted at the experimental plot of Agronomy Department, Ladoke Akintola University of Technology, Ogbomoso. Materials used were NPK fertilizer, sesame seed, mesh wire, iron pole, hoe, measuring tape, cutlass, vernier caliper, watering can, shovel, soil sample, rake, wheelbarrow, plastics pots and sensitive scale. Pre-planting collection of the soil sample was carried out using soil auger at depth of 0-15 cm. Samples were collected randomly from the arable experimental plot located behind Bee-Hall, Faculty of Agricultural Sciences, LAUTECH and were bulked into a composite sample. The samples were air dried, crushed and sieved through 2 mm and 0.5 mm meshes for the determination of particle size for physical and chemical analysis of the soil pH, organic C, total N, P and K%, and also the exchangeable cations Ca, Mg, Na and k. Pots used for the experiment were perforated at the bottom with 8 kg soil. Sowing was done 12^{th} April, 2021. Shallow holes(1cm) were made in the pots and few seeds were sown in each hole and lightly covered with soil. Regular watering was done throughout the experiment with the use of watering can. Tinning was carried out two weeks after sowing and the plants were reduced to two plants per pot. NPK fertilizer and neem compost was integrated four weeks after sowing.

Weeding of pots was done by uprooting with hands. Hoe weeding was done around the surrounding at weekly intervals. Cypermethrin was used for the control of insects by spraying with a knapsack sprayer at two weeks interval. The treatments introduced were NPK and neem compost; T0= control (no fertilizer applied), T1= 100% NPK at recommended rate (2.7g\pot), T2= 75%NPK (2.1g\pot) + 25% Neem (2.8g\pot), T3=50% NPK (1.35g\pot) + 50% Neem (5.6g\pot), T4=25%NPK (0.7g\pot) + 75% Neem (8.4g\pot), T5=100% Neem (11.1g\pot). The experiment was arranged in a Completely Randomized Design (CRD) with each treatment replicated three times. The fertilizer treatments were applied at two weeks after sowing (2 WAS). Data collection commenced at 5 weeks after sowing, (5WAS). The growth parameters observed were number of leaves, number of branches, plant height and stem girth. Yield parameters obtained were shoot fresh weight, shoot dry weight, root fresh weight, root dry weight, seed wet weight, seed dry weight, number of capsule and extracted seed weight.

Number of leaves was determined by visual observation and direct counting of fully opened leaves per plant. Number of branches was also determined by visual observation and direct counting of branches away from the stem. Plant height was determined using tape rule at the stem base and run to the tip of the plant. Stem girth was determined by using vernier caliper to give the actual stem girth. The weight of the yield parameters was measured with the use of sensitive electronic weighing balance citizen model. All data collected were subjected to Analysis of variance (ANOVA) and significant means were compared by Duncan Multiple Range Test (DMRT) at 5% probability.

RESULTS AND DISCUSSION

The pre-cropping chemical and physical analyses of the soil sample used showed that the soil is slightly acidic with a pH of 6.10 (Table 1). The soil sample was low in essential nutrients particularly N (0.18 g kg^{-1}) P (3.72g kg^{-1}) and Na (0.24 cmol kg^{-1}). Also, the soil was texturally sandy loam. The results correspond with the earlier researcher finding of (Babajide *et al*., 2008) which stated that the soil in the study area are grossly low in essential nutrients**.**

Table 1: Physical and chemical Analysis of the soil used

Soil characteristics	**Values**
pH (H_2O)	6.10
Organic Carbon (g kg^{-1})	2.42
Total N (g kg^{-1})	0.18
Available P (mg kg^{-1})	3.72
Fe (mg kg^{-1})	12.52
Cu (mg kg^{-1})	2.84
Zn (mg kg^{-1})	3.14
Exchangeable K (cmol kg^{-1})	0.19
Exchangeable Na (cmol kg^{-1})	0.24
Exchangeable Ca (cmol kg^{-1})	1.96
Exchangeable Mg (cmol kg^{-1})	2.60
Sand (g kg-1)	780.04
Silt (g kg-1)	120.03
Clay (g kg-1)	99.93
Textural class	Sandy loam

Table 2: Effect of NPK fertilizer and Neem compost application on the yield parameters of *sesamum indicum*

Treatment	**FSW (g)**	**DSA(g)**	**FRW(g)**	**DRW(g)**	**WSW(g)**	**DSW(g)**	**NC**	**ESW(g)**
T0	168.4a	41.6a	45.6b	13.3b	50.9ab	21.3a	54.7a	12.4ab
T1	394.4a	86.9a	134.5a	47.2a	96.1a	34.9a	90.7a	23.9a
T2	216.9a	44a	79.2ab	22.4b	68.1ab	30.5a	78.4a	20.6ab
T3	201.6a	45.3a	47.3b	10.2b	73.3ab	30.2a	75.6a	18.2ab
T4	169.1a	37.9a	29.5b	10.5b	31.3b	18.1a	35.8a	9.6b
T5	202.1a	34.1a	34.1b	9.5b	36.9ab	19.0a	37.5a	11.7ab

Means followed by the same letters within the same column are not significantly different at $p<0.05$, using DMRT. T0= No application, T1=100%NPK fertilizer application, T2=75% NPK + 25% neem compost, T3= 50% NPK + 50% neem compost, T4= 25% NPK + 75% neem compost, T5= 100% neem compost. FSW= Fresh shoot weight, DSA= Dry shoot weight, FRW= Fresh root weight, DRW= Dry root weight, WSW= Wet seed weight, DSW= Dry seed weight, NC= Number of capsule, ESW= Extracted seed weight.

Table 2 shows the effect of NPK fertilizer and Neem compost application on yield parameters of sesame. At fresh shoot weight (FSW), T1 had the highest mean value of (394.4g) which is not significantly different from the mean of other treatment tested and the control had the least mean value (168.4g). At dry shoot weight (DSW), T1 had the highest mean value (89.9g) but not significantly different from the mean of other treatment tested. T5 had the least mean value (34.1g). At fresh root weight (FRW), T1 had the highest mean value (134.5g) but not significantly different from T2, but significantly different from other treatment tested. T4 had the least mean value (29.5g). At dry root weight (DRW), T1 had the highest mean value of (47.2g) which is significantly different from the mean of other treatment tested. T5 had the least mean value (9.5g). At wet seed weight (WSW), T1 had the highest mean value (96.1g) but not significantly different from other treatment tested but significantly different from T4 which also had the least mean value (31.3g). At dry seed weight (DSW), T1 had the highest mean value (34.9g) but not significantly different from the mean of other treatment tested, T4 had the least mean value (18.1g). At number of capsule (NC), T1 had the highest mean value (90.7g) but not significantly different from the mean of other treatment tested, T4 had the least mean value (35.8g). At extracted seed weight (ESW), T1 had the highest mean value (23.9g) but not significantly different from the mean of other treatment tested but significantly different from the mean value of T4(9.6g) which had the least mean value.

CONCLUSION

The control which is the zero application of fertilizer had the least value of all the parameters measured. It can therefore be deduced from this research that application of NPK and Neem compost could be appropriate to supply adequate nutrient required for optimum growth of *sesamum indicum* in the study area. In conclusion, varying application of NPK and Neem compost improve the growth and fruit yield of *sesamum indicum.* Therefore, I would recommend the use of Neem compost and NPK fertilizer integrations to local farmers for good yield of sesame and also to increase the economic supply of sesame to the society.

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GROWTH AND FRUIT YIELD OF OKRA *(Abelmoschus esculentus)* AS INFLUENCED BY SOLE AND COMBINED APPLICATION OF NPK FERTILIZER AND POULTRY MANURE IN OGBOMOSO

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ABSTRACT
A pot experiment was carried out at the teaching and research farm, Ladoke Akintola University of Technology (LAUTECH), Ogbomoso, Nigeria to evaluate the growth and fruit yield of okra (Abelmoschus esculentus) under sole and combined application of NPK fertilizer and poultry manure in Ogbomoso. Six treatments introduced were: T0 (Zero fertilizer application), T1(100% NPK), T2(75% NPK and 25% poultry manure), T3(50% NPK and 50% poultry manure), T4(25% NPK and 75% poultry manure), T5(100% poultry manure). The trial was arranged in Completely Randomized Design and replicated three times. Data were collected on growth and yield parameters and were analyzed using ANOVA. Significant means were separated using Duncan's Multiple Range test (DMRT). Application of 25% NPK and 75% poultry manure (T4) produced significantly higher number of branches, shoot fresh and dry weight, root fresh and dry weight, and fruit weight, while 100% poultry manure (T5) significantly enhanced plant height, number of leaves, although the values obtained were not significantly different from T4 (25% NPK and 75% poultry manure).
***Keywords**: Abelmoschus esculentus, NPK, and Poultry manure*

INTRODUCTION

Okra (*Abelmoschus esculentus* (L.) Moench) belongs to the genus *Abelmoschus* of the family *Malvaceae*. Okra also known as lady's finger or gumbo is believed to have originated from East Africa and is an important vegetable crop consumed worldwide. It is ranked third to tomato and pepper (Ibeawuchi, 2007). It is widely cultivated in the tropics and subtropics for its immature edible green fruits which are consumed as a vegetable (Iyagba *et al*., 2013). In Nigeria, it is produced mainly for its young leaves and green pods by peasant farmers, in-home gardens or in mix-cropping with cereal. Okra pods contain a mucilaginous substance used to thicken soups and stews, and as plasma replacement or blood volume expander (Onunkun, 2012). The young leaves and fruits are boiled or fried and eaten as a vegetable or in a soup. The crop plays an important role in human diet due to the supply of carbohydrates, proteins, fats, minerals and vitamins (Abd El-Kader *et al.,* 2010). Okra is a good source of vitamin A, B and C including minerals especially iodine and amino acids found in the seeds; which competes favorable with those in poultry, eggs and soybean (Senjobi *et al*., 2000). The stem is useful as fiber, while the leaves are considered good cattle feed and are sometimes consumed by man.

According to Adekiya *et al*., the yield of okra in Nigeria is currently very low about 2.7 t ha−1 owing to low native soil fertility status among other factors. Lack of sufficient amounts of nutrients result in poor performance of the crop with growth been affected resulting to low yield. It has been reported that the maintenance of soil organic matter (OM) is the basis of sustainable crop production in Nigeria and other tropical countries (Oladipo *et al*., 2005). Hence, there is need to improve the fertility of the soil for continuous and increased crop production. Okra cultivation requires nutrients such as nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), sodium (Na) and Sulphur (S) for fertility maintenance and crop production. These nutrients are specific in function and must be supplied to plants at the right time and at the right quantity. The improvement of soil fertility through the application of fertilizers has become an essential factor that enables the world to feed billions of people (Abdul-Elkader *et al*., 2010). (Majanbu *et al.,* 2016) reported that NPK are the most important macro-nutrients that okra required for proper growth and yield. NPK fertilization among the various agronomic practices also influenced the growth and yield of okra. Mixing organic and inorganic fertilizers may be a sound soil fertility management strategy in many countries. Apart from enhancing crop yields, the practice has a greater beneficial residual effect that can be derived from use of either organic or inorganic fertilizers applied alone. Okra responds well to the application of poultry manure and NPK fertilizer.

MATERIALS AND METHODS

This experiment was carried out at the experimental plot, Ladoke Akintola University of Technology, Ogbomoso in the guinea Savannah zone of Nigeria, between March and July, 2021. The materials used were: seeds of *Abelmoschus esculentus* (Clemson spineless variety), planting pots, NPK 15-15-15 fertilizer, poultry manure, insecticide, hoe, cutlass, watering can, rake, knapsack sprayer and water etc. Land clearing and preparation were carried out manually, using hoe, cutlass, rake etc. and the area was fenced with wire mesh to protect the crops and materials from predators (animals, thieves, etc.). The top soil was then collected at the depth of 0-15cm and sieved with a 2mm sieve to remove the stone and some large particles for physical and chemical analysis. The pots were then filled up with 10kg soil and the number of pots was thirty-six (36). The six treatments used were: T0 = control (zero fertilizer application), T1 = (100% NPK fertilizer application), T2 = (75% NPK + 25% Poultry manure fertilizer application), T3 = (50% NPK + 50% Poultry manure fertilizer application), T4 = (25% NPK + 75% Poultry manure fertilizer application), T5 = (100% Poultry manure fertilizer application). The trial was arranged in completely randomized design (CRD), with three replications. Okra seeds were sown directly into the pot at 2 seeds per pot, and the seeds germinated 5days after. The first fertilizer application was 3weeks after sowing, and watering continued throughout the experimental period and it was harvested after maturity. Pots were manually weeded with hands. Data collection commenced at fourth week after sowing (4WAS). The growth parameters observed were Plant height, number of leaves, number of branches and stem girth. All the data collected were analyzed using the following procedures of analysis of variance (ANOVA). Duncan Multiple Range Test (DMRT) was used to compare differences in means (SAS, 2009).

RESULTS AND DISCUSSION

Effect of fertilizer application on yield parameters and nutrient uptake of *Abelmochus esculentus* as affected by different fertilizer types.

T4 (25% NPK + 75% poultry manure fertilizer application) had a highly significant effect on the shoot fresh weight (SFW) and root fresh weight (RFW) and the values obtained (65.1 and 26.8) had no significant difference from other treatments tested except the T0 (no fertilizer application) which had the least values. (Table 4.6). T3 50% NPK + 50% poultry manure fertilizer application had a highly significant effect on the shoot dry weight (SDW) and the value obtained (26.3) had no significant difference from other treatments tested except the T0 no fertilizer application which had the least values, while T4 (25% NPK + 75% poultry manure fertilizer application) had a highly significant effect on the root dry weight (RDW) and the value obtained (7.6) had no significant difference from other treatments tested except the T0 no fertilizer application which had the least values (Table 4.6). T4 in the first harvest (HAR1) had the highest mean fruit weight of 18.2g which is significantly different from other treatments tested, while T0 had the least value of 2.9. At second harvest (HAR2), T3 had the highest mean fruit weight of 25.4g which was not significantly different from other treatments tested except T0, T1 and T2 which had the least value of 4.9. T1 in the third harvest (HAR3) had the highest mean fruit weight of 3.6g which was not significantly different from other treatments tested except T3, T0 and T2. While T4 in the fourth harvest (HAR4) had the highest mean fruit weight of 11.5g which was not significantly different from other treatments tested except T3 (Table 4.7).

Table 1: Effect of fertilizer application on yield parameters of *Abelmochus esculentus* as affected by different fertilizer types.

Treatments	SFW(g)	RFW(g)	SDW(g)	RDW(g)
T0	38.7b	14.5b	13.4b	4.0b
T1	61.3a	24.2a	21.4ab	4.8ab
T2	53.8ab	22.0ab	23.9ab	5.5ab
T3	59.6ab	23.1ab	26.3a	6.3a
T4	65.1a	26.8a	25.7a	7.6a
T5	48.0ab	17.1ab	25.7a	6.7a

Mean followed by the same letters within the same column are not significantly different at p≤0.05, using DMRT. T0= No application, T1= 100% NPK fertilizer application, T2= 75% NPK + 25% poultry manure, T3= 50% NPK + 50% poultry manure, T4= 25% NPK + 75% poultry manure, T5= 100% Poultry manure. RFW= Root fresh weight, SFW= Shoot fresh weight, RDW= Root dry weight, SDW= Shoot dry weight..

Table 2: Effect of fertilizer application on yield parameters (fruit weight) of *Abelmochus esculentus* as affected by different fertilizer types.

Treatments	HAR1	HAR2	HAR3	HAR4
T0	2.9c	6.3c	0b	3.7ab
T1	5.9bc	12.2b	3.6a	5.5ab
T2	4bc	4.9c	0b	8.4a
T3	3.3bc	25.4a	0.9b	1.1b
T4	18.2a	16.5ab	2.3a	11.5a
T5	7.7b	19.5a	2.8a	3.5ab

Mean followed by the same letters within the same column are not significantly different at p≤0.05, using DMRT. T0= No application, T1= 100% NPK fertilizer application, T2= 75% NPK + 25% poultry manure, T3= 50% NPK + 50% poultry manure, T4= 25% NPK + 75% poultry manure, T5= 100% Poultry manure. HAR1=First Harvest, HAR2 = Second Harvest, HAR3 = Third Harvest, HAR4 = Fourth Harvest.

CONCLUSION AND RECOMMENDATION

All fertilizers that were applied significantly enhanced plant growth of okra, the control which is the zero application of fertilizer has the least values of all the parameters measured except in the 8, 9, and 10WAS when the T1 got infected with okra leaf curl virus, it can be therefore deduced from this research that application of NPK and poultry manure could be appropriate to supply adequate nutrients required for optimum growth of okra in the study area. Soil sample used was very low in major soil nutrients which include; Nitrogen (N), Phosphorus (P), Application of NPK fertilizer and poultry manure produced the best growth parameters measured, with this research I thereby concluded that varying application of poultry manure and NPK fertilizer improve the growth and fruit yield of okra.

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EFFECT OF DIFFERENT APPLICATION FREQUENCIES OF *TEPHROSIA VOGELII* AQUEOUS AD ETHANOLIC LEAF EXTRACTS ON EGGPLANT, *SOLANUM GILO* AGAINST EGGPLANT SHOOT AND FRUIT BORER (EFSB), *LEUCINODES ORBONALIS* GUEN. (Lepidoptera: Pyralidae) INFESTATION IN OKIGWE, IMO STATE

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ABSTRACT
The study aimed to assess the effect of Tephrosia vogelii and application frequencies on various parameters related to larval population and infestation in eggplants by L. orbonalis. The results showed that T27 x 1W treatment had the most significant effect on reducing the larval population, with only 0.46 larvae observed. Furthermore, this treatment also resulted in the lowest number of adult moths, with an average of 1.44. Additionally, the application of treatments resulted in a significant reduction in percentage fruit infestation and fruit damage. Overall, these findings highlight the potential of T. vogelii and application frequencies in controlling adult moth and larval populations, and minimizing fruit damage in eggplants.

INTRODUCTION

This trial explores the effects of different levels of *Tephrosia vogelii* leaf extracts and their application frequencies on the control of eggplant fruit and shoot borer, *Leucinodes orbonalis*. The study holds great significance as *L. orbonalis* is known to cause significant damage to eggplants, leading to substantial economic losses for farmers. This experiment aims to investigate the potentials of ethanolic and aqueous extracts of *T. vogelii* as natural control method, and to develop a sustainable and environmentally friendly solution to mitigate the impact of this insect pest on eggplant.

MATERIALS AND METHODS

The experiment was carried out at the Vegetable Research Farm, National Horticultural Research Institute (NIHORT) Mbato Outstation, Okigwe, Imo State during 2019/2020 cropping season. Eggplant, *Solanum gilo,* locally known as Ngwa large was used for the experiment.

Botanical/ Preparation and Application of Plant Extract

Fresh leaves of *Tephrosia vogelii* were collected and dried at room temperature for 14 days. Aqueous extract of the plant material was formulated by mixing the powdered plant material with distilled water (Inades, 1996; Sihwinarni, 1999). The mixture was soaked overnight. Before spraying, soap was added at 1 tablespoon per litre (Fohring, 1998; Adams, 1998) as sticker to increase the effectiveness. Thereafter, the mixture was stirred vigorously for 3 minutes and filtered through muslin cloth (Stoll, 1998). Three aqueous rates were of *T. vogelii* extracts were made:

1. 10 %w/v (T10), 10 g of *T. vogelii* aqueous extract per 100 ml (10 g/ml or 1.6 kg/16 L)
2. 15 %w/v (T15), 15 g of *T. vogelii* aqueous extract per 100 ml (15 g/ml or 2.4 kg/ 16 L)
3. 20 % w/v (T20), 20 g of *T. vogelii* aqueous extract per 100 ml (20 g/ml or 3.2 kg/16 L)

Ethanolic extract of *T. vogelii* leaf extract was formulated by mixing grounded 25 kg of freshly collected leaves with 20 L of ethanol and 1 cup of detergent (Karlsson, 1995). The mixture was allowed to stand for 24 hours and thereafter, it was filtered through muslin cloth. From the stock solution formulated, serial dilution was made by adding adequate proportion of water to obtain:

4. 9 %v/v (T9) of *T. vogelii* ethanolic extract
5. 18 %v/v (T18) of *T. vogelii* ethanolic extract
6. 27 %v/v (T27) of *T. vogelii* ethanolic extract
7. Cypermethrin (CYP) was applied at the rate of 5 ml of the product per 3 L (i.e., recommended rate of 800 ml/ha (Hamman *et al.,* 2012),
8. Control (C)

Application Frequencies:

The application frequency consisted of three (3) spraying regimes as shown below:

1. Spraying once a week (1W)
2. Spraying once in two weeks (2W)
3. Spraying once in three weeks (3W)

Experimental Design and Layout

The experiment was 8 x 3 factorial experiments consisting of the eight levels of *T. vogelii* leaf extracts and three levels of application frequencies laid out in Randomized Complete Block Design (RCBD) with three replications.

Data collection:

Data were collected on populations of *L. orbonalis* moth and larvae, percentage fruit damage and percentage reduction in fruit damage

Data analysis:

Data collected were subjected to Analysis of Variance (ANOVA) using GenStat Software Programme (2010). The significant means were compared with Least Significant Difference (LSD) at $P \leq 0.05$.

RESULTS AND DISCUSSION

Treatment combination of *T. vogelii* extracts and frequency of application had significant effect ($P \leq 0.05$) on the number of larvae and adult moth of *L. orbonalis* (Tables 1 and 2). Their application reduced the population of this insect pest on eggplants in the field compared to the untreated plots (Tables 1 and 2). This is consistent with the long-established use of plants and their extracts against insect pests (Isman, 2000). *T. vogelii* is a source of rotenone, which is an important non-residual insecticide (Adebayo, 2003). The plant contains high amounts of insecticidal phytochemicals, including flavonoids, tannins, alkaloids, steroids, cardiac glycosides, and saponins (Dafam *et al*., 2014). These phytochemicals possess toxic, growth regulating, and anti-feedant effects against various insect pests (Sunita and Lalijee, 2008). The lowest number of larvae (0.18) was counted at CYP × 1W and this result varied significantly from the other combinations except CYP × 2W (0.44), CYP × 3W (0.76), T27 × 1W (0.46), and T27 × 2W (0.92) (Table 1). The active components in *T. vogelii* leaves have been reported to have anti-feedant, insecticidal, acaricidal, ovicidal, and ichthyotoxic properties, responsible for stomach poisoning in insects (Gaskins *et al.,* 1972).

The number of adult moths per plant per plot were significantly reduced with the application of treatments (Table 2). Results showed that, T27 × 1W resulted to significant reduction in the number of adult moths (1.44) (Table 2). Treatments had significant effect ($P \leq 0.05$) on percentage fruit infestation by *L. orbornalis* larva (Table 3). Treatment combination of T27 × 1W had the least percentage fruit infestation of 2.28 % compared to other *T. vogelii* extracts, it also exhibited high efficacy against the activities of *L. orbonalis* by recording 4.51 % fruit infestation (Table 3). This result may be attributed to the fact that higher concentrations of insecticidal phytochemicals produce greater effects in controlling insect pests as earlier reported by Matovu and Olila (2007).

Results presented in Table 4 revealed that treatment application caused significant reduction in percentage fruit damage. Treatment combination of T27 × 1W (91.14 %), T27 × 2W (87.64 %), T27 × 3W (87.90 %), T18 × 1W (86.08 %), and T18 × 2W (83.29 %) were effective in reducing fruit damage compared to other treatments evaluated (Table 4). These results are in line with previous studies that have shown that increased concentration and application frequency of insecticides greatly decrease the biological activities of insect pests (Prabhat and Johnsen, 2000; Solange *et al.,* 2017).

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Table 1: Treatment effect on number of larvae

	T. vogelii **leaf extracts**								
Application frequency	C	CYP	T10	T15	T20	T9	T18	T27	Mean
1W	6.80	0.18	3.98	3.47	2.47	2.06	1.45	0.46	2.61
2W	7.76	0.44	4.10	3.67	2.85	2.22	1.70	0.92	2.02
3W	7.01	0.76	4.75	3.82	3.15	2.36	1.91	1.09	3.11
Mean	7.19	0.46	4.28	3.65	2.82	2.21	1.69	0.82	

$LSD_{0.05}$ (Treatment × Application Frequency) = 1.05

1W - Weekly application, 2W - Applying once in two weeks, 3W - Applying once in three weeks, T10 - *Tephrosia vogelii* aqueous extract (10 % w/v), T15 - *Tephrosia vogelii* aqueous extract (15 % w/v), T20 - *Tephrosia vogelii* aqueous extract (20 % w/v), T9 - *Tephrosia vogelii* ethanol extract (9 % v/v), T18 - *Tephrosia vogelii* ethanol extract (18 % v/v), T27 - *Tephrosia vogelii* ethanol extract (27 % v/v), CYP - Cypermethrin, C - Control

Table 2: Treatment effect on number of adult moths

	T. vogelii **leaf extracts**								
Application frequency	C	CYP	T10	T15	T20	T9	T18	T27	Mean
1W	10.42	1.13	7.28	6.00	4.74	3.66	2.48	1.44	4.64
2W	12.33	1.33	7.82	6.62	5.13	3.85	2.74	1.87	5.21
3W	12.54	1.66	8.26	6.58	5.63	4.20	3.04	2.25	5.52
Mean	11.76	1.37	7.79	6.4	5.17	3.90	2.75	1.85	

$LSD_{0.05}$ (Treatment × Application Frequency) = 1.03

1W - Weekly application, 2W - Applying once in two weeks, 3W - Applying once in three weeks, T10 - *Tephrosia vogelii* aqueous extract (10 % w/v), T15 - *Tephrosia vogelii* aqueous extract (15 % w/v), T20 - *Tephrosia vogelii* aqueous extract (20 % w/v), T9 - *Tephrosia vogelii* ethanol extract (9 % v/v), T18 - *Tephrosia vogelii* ethanol extract (18 % v/v), T27 - *Tephrosia vogelii* ethanol extract (27 % v/v), CYP - Cypermethrin, C - Control

Table 3: Percentage fruit infestation

Application Frequency	*T. vogelii* leaf extracts (%)								
	C	CYP	T10	T15	T20	T9	T18	T27	Mean
1W	73.53	1.68	36.36	29.28	19.14	11.90	6.31	2.28	22.56
2W	76.71	2.37	42.73	34.15	24.93	16.05	9.21	3.94	26.26
3W	80.88	2.08	49.53	37.14	30.96	17.46	11.49	6.29	29.48
Mean	77.04	2.04	42.87	33.52	25.01	15.14	9.00	4.17	

$LSD_{0.05}$ (Treatment × Application frequency) = 6.38

1W - Weekly application, 2W - Applying once in two weeks, 3W - Applying once in three weeks, T10 - *Tephrosia vogelii* aqueous extract (10 % w/v), T15 - *Tephrosia vogelii* aqueous extract (15 % w/v), T20 - *Tephrosia vogelii* aqueous extract (20 % w/v), T9 - *Tephrosia vogelii* ethanol extract (9 % v/v), T18 - *Tephrosia vogelii* ethanol extract (18 % v/v), T27 - *Tephrosia vogelii* ethanol extract (27 % v/v), CYP - Cypermethrin, C - Control

Table 4: Percentage reduction in fruit damage

Application frequency	*T. vogelii* leaf extracts (%)								
	C	CYP	T10	T15	T20	T9	T18	T27	Mean
1W	0.00	94.41	51.07	57.10	74.01	74.46	86.08	91.14	66.03
2W	0.00	93.58	55.54	56.70	66.76	75.17	83.29	87.64	64.84
3W	0.00	93.80	52.59	55.21	55.87	71.42	80.31	87.90	62.14
Mean	0.00	93.93	53.07	56.34	65.55	73.68	83.23	88.89	

$LSD_{0.05}$ (Treatment x Application Frequency) = 12.00

1W - Weekly application, 2W - Applying once in two weeks, 3W - Applying once in three weeks, T10 - *Tephrosia vogelii* aqueous extract (10 % w/v), T15 - *Tephrosia vogelii* aqueous extract (15 % w/v), T20 - *Tephrosia vogelii* aqueous extract (20 % w/v), T9 - *Tephrosia vogelii* ethanol extract (9 % v/v), T18 - *Tephrosia vogelii* ethanol extract (18 % v/v), T27 - *Tephrosia vogelii* ethanol extract (27 % v/v), CYP - Cypermethrin, C - Control

Efficacy of *Azadirachta indica* A. Juss and *Moringa oleifera* Lam Seed Essential Oil Spray in the Management of Fruit Fly, *Bactrocera dorsalis* Hendel (Diptera: Tephritidae)

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ABSTRACT

Fruit flies attack can severely damage important fruit crops worldwide. Bactrocera dorsalis (BD) an invasive fruit fly, is a destructive pest causing high yield loss. Synthetic insecticides have been widely used to control BD but they pose serious environmental problems. The use of biopesticides, such as Azadirachta indica (AI) and Moringa oleifera (MO) have proven effective in managing some field pests, therefore, the biological activity of MO and AI seed oil extracts against BD was investigated. Adult fruit flies were sprayed with MO and AI seed oil extract (SOE) at different concentrations to assess their potency. Percentage adult mortality was assessed at 24, 48 and 72 hours. Mated females were introduced into a cages and allowed to lay eggs on the treated fruits. Fruits sprayed with AI extract recorded highest percentage mortality (HPM) of (65.0±4.7) at 72 hours and lowest percentage mortality (LPM) of (17.5±5.4) at 24 hours. While, HPM of (60.0±3.5) was observed at 72 hours and LPM of (8.8±2.7) was observed at 24 hours from fruits treated with moringa SOE. Adult emergence was higher in moringa treated fruits when compared to AI extract. Azadirachta indica SOE of 8.0% concentration caused higher mortality and suppressed adult emergence of fruit fly. This study suggests that A. indica seed oil extract can be used in fruit fly management strategies.

Keywords: *Bactrocera, Essential oil, Moringa, Neem, Seed oil extract,*

INTRODUCTION

Fruits play a significant role in human nutrition, as sources of vitamins, minerals, and dietary fiber (Wargovich, 2000), these include mango, citrus, cherries, cashew, grapes etc. Fruit production provides raw material for various agro-based industries. Major production constraints include pests, diseases, drought, shortage of fertilizer, and the price of fuel for pumping irrigation water. They are attacked by wide varieties of pests and diseases which include fruit flies, codling moth, stem borers, brown rot fungus, fire blight, scab, bacterial canker, leave rollers (Yoder *et al*., 2017). Fruit flies attack and severely damage important fruit crops. Fruit flies can be a problem year round; as they are mostly attracted to ripened fruits and vegetables.

Bactrocera dorsalis (Diptera: Tephritidae) is an invasive species commonly known as the oriental fruit fly, it is a very destructive pest of fruit in areas where it occurs (Umeh and Onukwu, 2016). Invasive *B. dorsalis* has proved to be highly competitive with native fruit flies where it has established, quickly becoming the dominant fruit fly pest (Duyck *et al*., 2004; Vargas *et al*., 2007; Vayssières *et al*., 2015). At present, the main aspect of the fruit fly control programme is based on the use of chemical insecticides. Traditional control measures using chemical insecticides experience disadvantages such as pest resistance, residues in food, environmental contamination, outbreaks of secondary pests, reductions in populations of beneficial insects and inability of insecticides to penetrate infested fruits to kill larvae (Sultana *et al*., 2013). The use of botanical alternatives to synthetic pesticides has become popular for their environmentally safe activity (Ivbijaro and Agbaje 1986). Thus, the objectives of the study is to determine the efficacy of different concentrations of moringa (*Moringa oleifera)* and neem (*Azadirachta indica)* seed oil extracts on *Bactrocera dorsalis* adult mortality in the laboratory and adult emergence on treated fruits.

MATERIALS AND METHODS

Ripe Ogbomosho mangoes were purchased and sorted to remove damaged ones. Punctures were made on the surface of the mangoes with a needle to allow easy penetration of the female ovipositor to lay eggs. *Bactrocera dorsalis* of both sexes were gotten from an already existing fruit fly culture in an Insectary at the National Horticultural Research Institute, Ibadan. The experiment was carried out in the laboratory with a room temperature of 25±5ºC and relative humidity of 72±6%.

Moringa and Neem seed oil extraction

Moringa and neem seeds were shelled, ground and sent to the National Institute of Science and Laboratory Technology (NISLT), Ibadan for essential oil extraction using soxhlet extractor and n-hexane as a solvent following the method of Tesfaye and Tefera, (2017).

Neem and moringa seed oil extract sprayed on adult fruit flies

A total of 20 adults fruit fly made of 10 males and 10 females were introduced into each cage. Each cage was covered at the side by fine wire mesh and at the top by a Perspex glass while the bottom was made of wood. Using 2 L hand spray, fruit flies were separately sprayed with neem and moringa seed extract at 2.0, 4.0, 6.0 and 8.0%. Thirty jets of sprays were applied in each cage. Artificial feed and water was placed in each cage to serve as food for the adults. A control was set up whereby the fruit flies were sprayed with distilled water. Each treatment was replicated four times and arranged in a Completely Randomized Design (CRD). Observations for mortality were made at 24, 48, and 72 hours.

Mango treatments with neem and moringa seed oil extract.

Mango fruits were weighed and separately sprayed with moringa and neem seed extracts using a 2 L hand spray. Twenty (20) mated female fruit flies were introduced into a cages with two (2) treated fruits each. Treatment concentrations were 2.0, 4.0, 6.0, and 8.0% each of moringa and neem seed oil extracts. Artificial diet and water were also put in each cage. Control experiment was set up with mango fruits sprayed with distilled water with the same number of mated fruit fly.

The experiment was arranged in a completely randomized design (CRD) with four replicates. After 72 hours, the fruits were collected and incubated and 10 days after, emerged adults were counted from each fruit.

Statistical analysis

Mortality were calculated and expressed as percentage mortality. Data were analysed using Analysis of Variance (ANOVA) to establish significant differences between treatments. Significantly different means were separated using Student Newman-Keuls (SNK) Test. All statistical analyses were judged significant at 5% probability level (P=0.05).

RESULTS

Neem and moringa seed oil extracts sprayed on adult fruit flies

There were no significant differences ($p>0.05$) in the percentage mortality of adult fruit flies sprayed with neem seed oil at 24 and 48 hours after spraying (Table1). At 72 hours, significant differences ($p<0.05$) were observed among the treatments applied with percentage mortality increased with increase in time and concentration after spray. However, no significant difference was observed between 6 and 8% treatment concentrations. There was no mortality recorded in the control experiment. (Table1).

Moringa seed oil spray showed significant differences ($p<0.05$) at 24, 48, and 72 hours (Table 2) with exception of 6 and 8% concentration at 24 and 48 hours. Highest mortality (60.0%) was recorded at 72 hours for 8.0% concentration. There was no mortality recorded in the control experiment.

Table 1: Effects of neem seed essential oil (NSEO) sprayed on adult fruit flies in a laboratory bioassay

Treatments	Percentage mortality		
	24 hours	48 hours	72 hours
2% NSEO	$17.5±5.4^a$	$27.5±1.3^a$	$28.8±2.1^c$
4% NSEO	$35.0±5.6^a$	$36.3±3.7^a$	$41.3±3.7^b$
6% NSEO	$35.0±8.3^a$	$43.8±4.0^a$	$55.0±4.0^a$
8% NSEO	$35.0±11.4^a$	$50.0±6.9^a$	$65.0±4.7^a$
Control	$0.0±0.0^a$	$0.0±0.0^b$	$0.0±0.0^d$

Means with the same letters down the column are not significantly different ($p>0.05$) using Student Newman-Keuls (SNK) Test.

Table 2: Effects of moringa seed essential oil (MSEO) sprayed on adult fruit flies in a laboratory bioassay

Treatments	Percentage mortality		
	24 hours	**48 hours**	**72 hours**
2% MSEO	8.8±2.7^{b}	12.5±2.2^{bc}	16.3±2.1^{cd}
4% MSEO	10.0±3.5^{b}	17.5±4.2^{b}	23.8±2.1^{c}
6% MSEO	23.8±3.3^{a}	37.5±2.2^{a}	45.0±5.6^{b}
8% MSEO	22.5±5.1^{a}	43.8±4.8^{a}	60.0±3.5^{a}
Control	0.0±0.0^{b}	0.0±0.0^{c}	0.0±0.0^{d}

Means with the same letters down the column are not significantly different (P>0.05) using Student Newman-Keuls (SNK) Test.

Number of adult emergent from mango treated with neem and moringa seed oil extracts.

Figure 1 shows the number of adult emerging from mangoes treated with neem and moringa seed oil extracts. The result shows that higher number of adult emergence was recorded in moringa seed oil extract treated fruits compared to neem extract that recorded fewer number of adult emergence. There was no significant difference (p>0.05) in adult emergence between the neem experiment and moringa seed oil treatment concentrations except at 2.0% concentration. Increase in concentration of the seed oil extracts of both neem and moringa reduced the number of adults emerged.

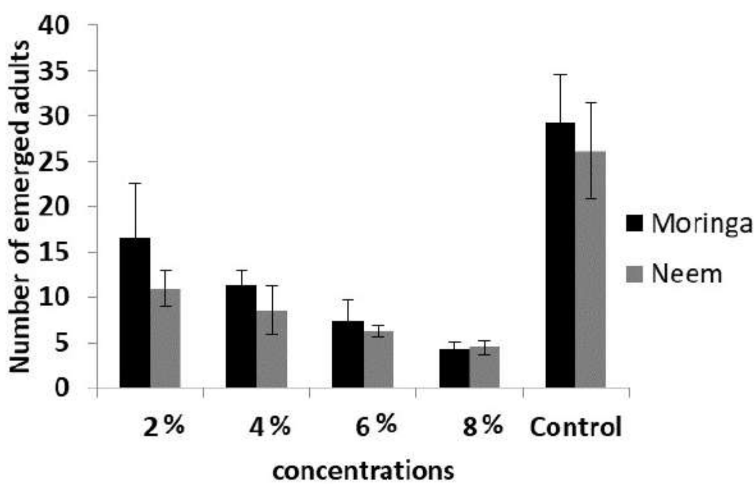

Figure 1: Number of emerged adults from mango treated with neem and moringa seed oil extracts in the laboratory.

DISCUSSION

When fruit flies in cages were sprayed with neem and moringa seed essential oil, mortality recorded was lower in moringa-sprayed fruit flies compared to neem extract with higher mortality. There were significant differences between the mortality rate of moringa and neem. This is in agreement with the findings of Irikannu *et al*., (2015) who reported the pesticidal effect of *Moringa oleifera* seed oil extract against *Tribolium castaneum* and *Tribolium confusum* on milled maize. The mortalities observed in this study increased with time and concentrations. Sharma *et al.* (2016) observed in a similar study that neem spray formulations can be effectively used to manage fruit fly due to its lethal effects.

Experiment carried out on adult emergence on treated mangoes showed that there were fewer number of adult emerged when neem was applied compared to moringa. This is due to the repellent properties of neem, which repelled most of the females and prevented them from perching and laying eggs on the treated mangoes. Hence the reduced number of adult emergence. Singh and Singh (1998) had reported deterrent effects of neem seed kernel extracts and Azadirachtin against *B. cucurbitae* and Oriental fruit fly, *B. dorsalis*. Similar findings have been reported for *B. dorsalis* after the insect was treated with neem extracts (Chen *et al*., 1996). Mahmood and Shoeib (2008) observed a high effect of neem formulation in repelling oviposition in *B. zonata*. Since the treatments were applied on the fruits, they had no effects on the development of the fruit flies that escaped the repelling effect and were able to lay eggs inside the fruits probably because the treatments were not ingested. In the control experiment there were higher numbers of adult emergence because no treatment was applied.

CONCLUSION

Biopesticides have proved to be a better option for the control of pests due to its eco-friendly nature, low pollution level, affects only target species, they are cheap due to the fact that they occur naturally and reduce cost of production making it beneficial to local farmers.

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MAXIMISING BANANA PRODUCTION FOR FOOD SECURITY AND ECONOMIC EMPOWERMENT IN NIGERIA- A BRIEF REVIEW

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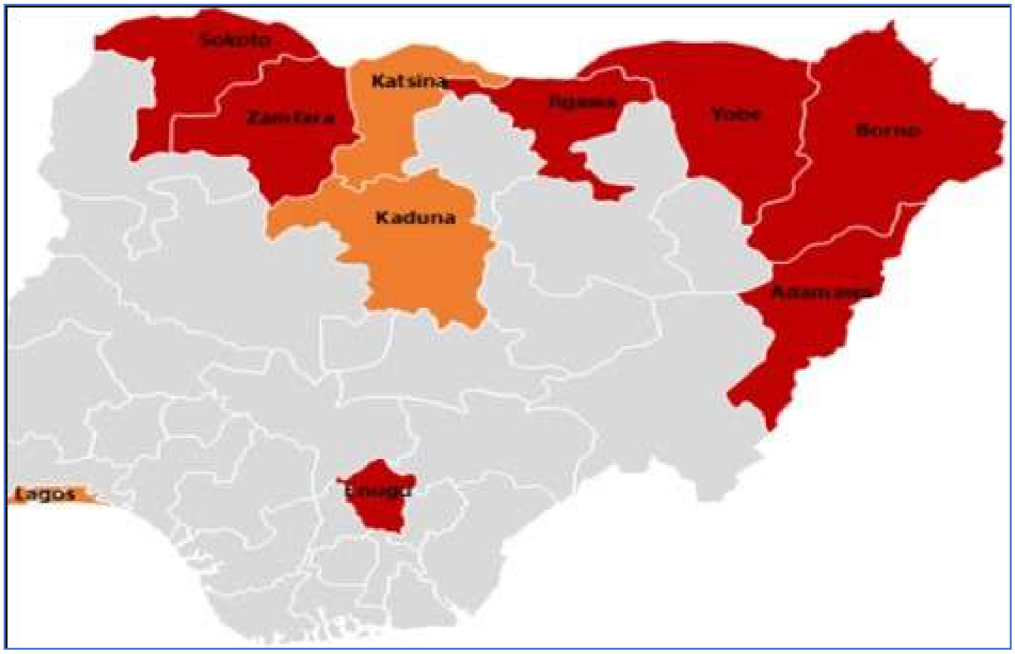
ABSTRACT
The growth in the population of Nigeria with its attendant increase in food demand calls for an urgent strategy and policy framework for rapid transformation in our agricultural production system. There is a need to continue strengthening our focus on farm produce which has huge prospects for food security and economic empowerment. Bananas as one possess the capacity to provide food and nutrition security among millions of people in Nigeria and largely other developing countries in the African region who are at risk with the problem of food insecurity. Bananas have gone beyond the enclave of backyard cultivated fruit to the most consumed and exported fruit in the world; occupying a leading position for economic prosperity and nutritional security. They are rich sources of potassium, calcium, magnesium, sodium, and zinc as well as vitamins A and C. It is free from fat and cholesterol. Nigeria can scale up banana production to have more market share in the global banana trade. In the Local market; a bunch of bananas could go as much as four thousand naira (#4000) or more depending on the period of harvest and variety. Thus, Banana can strengthen food security and reduce poverty levels in Nigeria.
Keywords: *Nigeria, Food security, Banana production, Economic prosperity*

INTRODUCTION

Food and nutrition security is an indispensable prerequisite for the survival of mankind, it is essentially needed to guarantee and support the good quality of his existence. Thus; food must be sufficiently and appropriately provided for; to achieve this goal, a very strong framework as well as institutional reforms that will support production and make agriculture attractive particularly to the youth, to raise productivity must be a priority. Nigeria has a large expanse of fertile land that can be productively engaged to boost supply and insulate the populace from the unpleasant effect of food insecurity. Food security is a situation that exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs for an active and healthy life and the opposite of this scenario is referred to as food insecurity (Otaha, 2013). The problem of food insecurity in many developing countries has become a serious challenge and burden where many merely rely on what is available to fill stomach and not necessarily to meet dietary needs and requirements. The problem of food insecurity; because of the dire consequences it portends for our collective socioeconomic stability remains a strong subject of discussion in many forums among International Development institutions.
There are about 17 million people currently at the risk of food insecurity and this figure may further rise to 25 million or more if the situation is not urgently addressed. (WFP,2023). Factors such as continued conflict, changes in climate, and an increase in inflation are factors that have been implicated to likely trigger the increase in the number of people that will be at risk of food insecurity and its attendant consequences in the near future. However, we can do something urgent and radical as necessary intervention by encouraging production. In the Northern part of Nigeria; North East in particular; access to food has been affected by persistent violence, armed banditry, and kidnapping in the states like Katsina, Kaduna, Benue, and Niger as shown in (Figure 1) with states highlighted in color as the worst hit.



Banana (*Musa Paradaisica*) is a tropical plant cultivated in more than 130 countries. India ranks first in the total world's production of bananas (Alemu, 2017). In 2018, around 155 million metric tons of bananas were produced around the world, of which 27% came from sub-Saharan Africa (SSA) (FAOSTAT, 2020). Banana is a valuable fruit crop globally whose production could advance economic growth and reduce the problem of food insecurity in any country where its production is well harnessed. Improving banana production to meet demand beyond local consumption through massive production would not only benefit the rural poor, but it will also create jobs and improve the outlook of the national economy for competitiveness among her peers. According to the FAO, banana is consumed across major countries and region globally: - Japan, India, China, Russia, the USA, and Europe (FAO, 2021). The increase in consumption will continue to rise as long as the world population grows; thus opportunity in banana production will continue as the leading fruit crop in terms of volume and value in the world market (Woldu *et al*., 2015). The top 10 producing countries in the world are represented in Figure 2.

Banana production comparatively is still underdeveloped in Nigeria considering the volume of trades globally (Shahbandeh, 2O23); probably due to a lack of incentives from the government and constraints in marketing. In smallholder farming, the absence of modern technology and harvesting practices, fruits are always susceptible to physiological and physical damage (Akinyemi *et al*., 2017). The farmers need to develop themselves into cooperative clusters for effective banana production and marketing management. The banana export market in Nigeria is largely unnoticeable in world ranking despite being one of the top producers in Africa. The farmers ought to be engaged and informed about modern farming operations, varieties, and qualities that will meet export requirements and specifications. Bananas are largely imported to Europe because they depend on external supply and it very popular among consumers due to its health benefits. They are important source of potassium, calcium, magnesium, sodium, iron, copper, zinc as well as vitamins A and C. It is easy to digest, and free from fat and cholesterol.

An estimated 1,000 varieties of bananas are grown in several countries. However, the Cavendish has become the most consumed and exported variety, now accounting for almost half of all varieties grown worldwide and nearly 100% of internationally traded fresh bananas (FAO,2020).

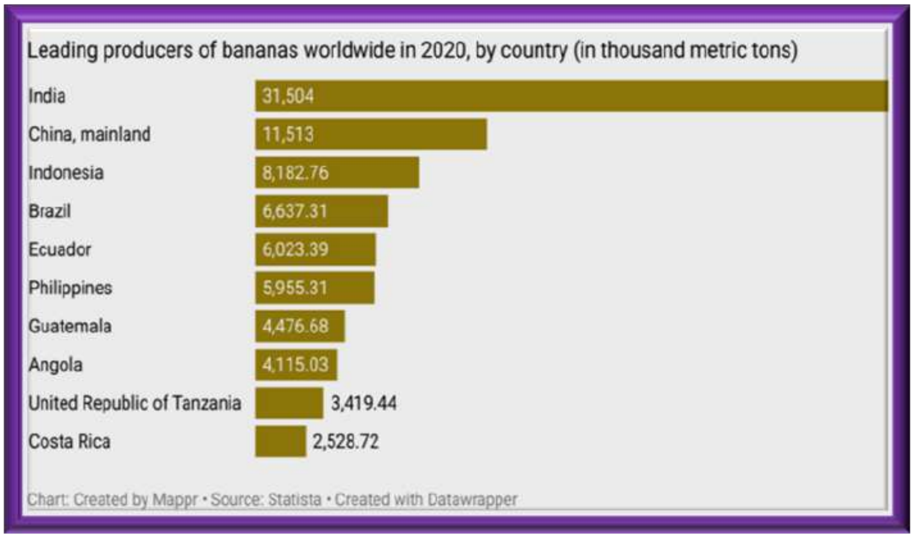


Fig 2: The 10 largest producers of bananas in the world (FAO 2021)

Bananas are exported mostly by sea freight between the production zones and destination markets, in ships in refrigerated containers. Bananas destined for export are washed, cut into bunches of four to eight bananas, labelled, and packed into boxes for shipping (Dole, 2013). On arrival at the destination ports, the boxes of bananas are still green, stored in ripening centers under a regulated temperature of between 16 and 18°C, and a gaseous mixture of ethylene and nitrogen is injected into its atmosphere to trigger maturation. After a few days (4 to 6 days, depending on the market requirements), yellow bananas will be available for the market as in Figures 3a and 3b. The hands are graded based on the number and size of fingers in each hand. Overripe and injured fruits are discarded at this stage. However, Bananas are usually sent to the local market as bunches.

Fig 3a: Banana package for export

Fig 3b. Ripen banana at the storage center

Overview of African banana trade between 2021-2022

Table 1: Banana export in Africa between 2021 and 2022(FAO,2022)

Countries	2021 Total Export in thousand	2022 Total Export in thousand
Cameroon	188	216
Cote d'Ivoire	339	322
Ghana	63	51

Table 2: Banana import in Africa between 2021 and 2022 (FAO,2022)

countries	2021 Total import in thousand	2022 Total import in thousand
Algeria	159	60
South Africa	162	203
Tunisia	66	35

Overview of global banana trade between 2018-2022

Table 3: Global banana export in millions between 2018 - 2022

Regions	2018	2019	2020	2021	2022
Latin America &Caribbean	15.5	15.9	16.4	15.9	15.1
Asian	3.5	5.9	5.2	3.9	3.9
Africa	0.7	0.7	0.6	0.6	0.7

Table 4: Global banana net import in million in 2022 (FAO, 2022)

Region/Country	Percentage import
European Union	26.3%
USA	21.3%
China	10.6%
Russian Federation	7.4%
Japan	5.7%
Latin America & Caribbean	4.6%

Although, Nigeria is one of the leading producer of bananas in Africa with an estimated annual production of 2.73 million metric tons, her market share in the global banana trade still largely remain unnoticed as shown in (Table1). The government and other stakeholders can develop strategies that will boost the production of more bananas, especially for export. This will shift Nigeria from a crude oil mono-economy that is susceptible to external shock to a more resilient economy built around promising agricultural produce like bananas. Other countries such as Cameroon, Coted'lvore, and Ghana in Africa are already making their footprint known in the global banana market and Nigeria too can make an impact if the government can look into the direction of maximizing bananas production potentials to reduce food insecurity, create more jobs, boost foreign earning and improve overall economic growth.

CONCLUSION

The interest of Nigeria in maximizing the potential of banana production for food security and export market demands could be a viable option for the solution against the emerging threat of food insecurity and poor economic outlook. To achieve this, however, building a sustainable banana production system cannot be in the back seat. Farmers must be supported and effective market structures that will take up farmers produce should be developed to ensure fair reward of effort. These along with other measures will strengthen our food security and promote economic prosperity.

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YIELD RESPONSE OF CUCUMBER (*Cucumis Sativus l.*) TO POULTRY MANURE AND INTRA-ROW SPACING IN NOTHERN GUINEA SAVANNA OF NIGERIA

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ABSTRACT
Field trials were conducted during the 2019 wet season at research farms in the Institute for Agricultural Research, Samaru, in the Northern Guinea savanna, and the National Horticultural Research Institute, Bagauda sub-station, in the Sudan savanna agro-ecological zone of Nigeria to study the effects of poultry manure rates and intra-row spacing on cucumber growth (Cucumis sativus L.). Four poultry manure rates (0, 2, 4, and 6 t/ha) along with NPK fertilizer were tested, combined with three intra-row spacings (100 cm, 75 cm, 50 cm). Results showed that applying 6 t/ha poultry manure led to broader, heavier, and longer fruits with higher total yields similar to the NPK application. Intra-row spacing of 100 cm resulted in size improvement in one location, while 75 cm spacing gave higher total yields in both locations. In conclusion, using 6 t/ha poultry manure and adopting 75 cm intra-row spacing improved cucumber growth and yield.
***Keywords**: Fruit yield, Intra-row spacing, Poultry manure, Northern Guinea Savanna*

INTRODUCTION
Cucumber (*Cucumis sativus* L.) belongs to the family Cucurbitaceae. It is an annual creeping vine that grows up trellises, wrapping around them with thin, spiral tendrils. It has a soft succulent watery green fruit. It ranks fourth in importance in Asia after tomato, cabbage and onion and is second after tomato in Europe (Eifediyi and Remison, 2010). Cucumber originated in India and has grown widely traded in the global market. It has been cultivated for 3,000 years. FAO (2020) reported that China produced 60% of the global output of cucumber in 2005, followed by Turkey, Russia, Iran and the United States. The top ten cucumber producers in 2010 were China, Iran, Turkey, Russia, USA, Ukraine, Spain, Egypt, Japan and Indonesia.
It is adapted to warm climates. The plant trails or climbs to heights ranging from 1.5- 4.5 meters using tendrils. It is a creeping vine that roots in the ground and grows up trellises or other supporting frames, wrapping around supports with thin, spiralling tendrils. Leaves are large and form a canopy over the fruit (Pandey and Kujur, 2022). Fruits are cylindrical when ripe and produced between 5-8 weeks after planting. The cucumber is a short-maturing crop. It is harvested 7-9 weeks from planting. Cucumber requires warm temperatures for growth. Optimum temperatures for germination and growth ranged from 11 - 18ºc (Bharathi and John, 2013) and 18.3 - 23.9ºc respectively. Long days also favour cucumber growth and development. High winds and high relative humidity are detrimental to its growth and development as they cause flower loss and foliar diseases. Moisture deficit leads to flower drying and abortion (Rout *et al*., 2021). Cucumber grows well in almost any fertile, well-drained soil. However, lighter soils like sandy loam or silt loam, which warm up rapidly during the wet season are preferred for early maturity. For higher yields, loamy or clay loam is better, mainly when the moisture supply depends on rainfall. Heavy soils promote larger fruits and extend harvesting periods. Well-drained soils with good moisture retention and an abundance of humus or organic matter are considered most desirable for the growth of cucumbers (Bharathi and John, 2013).
Cucumbers are sensitive to acid soils and grow better on near-neutral or slightly alkaline soils with acidity of 6.6- 7.2 (Šimek and Cooper, 2002). Cucumber is used for salad dishes or consumed fresh, as desserts after meals, as juice or in combination with other food materials. (Adeoye and Balogun 2016). As a vegetable, the fruit is low in nutrients but contains good levels of essential minerals and vitamins. The seed is a rich source of food protein, it contains 57% edible oil. The fruit and foliage are reported to have medicinal properties and used as pot herbs in East Africa and Asia (Aremu *et al*., 2021). Cucumber has 90% water and is used as a cooling agent. In many tropical and arid environments, it promotes hair growth due to its high silicon and sulphur content; it cures constipation as a good diuretic and relieves a burning sensation in the stomach from hyperacidity and ulcers. Cucumber production is constrained by many factors which include fertilization and plant spacing.

Studies revealed that cucumber responded to poultry manure application up to 20 t ha^{-1} (Mangila *et al.* (2008), Agbede *et al.* (2008)). Adekiya and Ojeniyi (2002) and Ewulo *et al.* (2008) attributed the improved yield performance of cucumber to the release of more nutrient elements and moisture available in the manure. John *et al.* (2004) observed that poultry manure released essential elements which promote high photosynthetic activities that enhanced the growth and yield of crop plants. They attributed vigorous growth and increased fruit yield to a high supply of nutrient elements from applied manure. Intra-row spacing is an index of plant population and plant density which directly influences competition for growth resources needed among individual plants. Spacing is one factor that affects the productivity of cucumbers. However, the effect depends on the soil regime, varietal vigour and cultural management being used.

Ningaraju and Joseph (2014) reported that plants grown at low densities had longer vines, higher growth rates and number of flowers with higher fruit yield than those at higher densities. Likewise, Sanni and Adenubi (2020) evaluated different spacing (density) and irrigation intervals and observed that plants spaced at 40cm and planted in 2 plants per hill recorded the highest yields. Geboluglu and Saglam (1999) in Tokat, Turkey found that 20cm inter-row spacing resulted in the highest yield/ha. However, Jaffar and Wahid (2014) observed no significant effect of the interaction of cucumber varieties and different intra-row spacing on cucumbers' growth and yield parameters. This study therefore, was conducted to determine the effects of poultry manure rates and intra-row spacing on the yield of cucumber (*Cucumis sativus* L.) in the Sudan savanna agro-ecological zone of Nigeria.

MATERIALS AND METHODS

Two field trials were conducted during 2019 wet season at Research farm of the Institute for Agricultural Research, Samaru, in the Northern Guinea Savanna (Latitude 11°11′ N and Longitude 07°38′ E 686 metres above sea level) and its Irrigation Research Station of farm ~~at~~ Kadawa (Latitude 11°39′ N and Longitude 8°03′ E 500m above sea level) in the Sudan savanna ecological zone of Nigeria. Treatments consisted of four poultry manure rates (0, 2, 4, and 6 t/ha) in addition to recommended NPK (15:15:15) fertilizer (10:50:50 kg ha^{-1}) and three intra-row spacings (100cm, 75cm and 50cm) replicated three times and laid out in a Randomized Complete Block Design. The gross plot size was 4.5m x 3m (13.5m^2) while the net plot size was 3m x 3m (9m^2). Cucumber salad variety *Mona lisa* with uniform cylindrical dark green fruit was used. It has distinct fruit quality, earliness to maturity, higher yields and disease resistance. Meteorological data, (daily temperature, sunshine hours and relative humidity during the experiment were obtained from the meteorological station of the Institute for Agricultural Research Samaru and Kadawa.

Soil samples were randomly collected from the experimental site using an auger from the two locations at a depth of 0-15 cm. Soil samples were taken after ploughing before poultry manure application. The sample in each location was bulked, dried, ground, sieved and subjected to physical and chemical analysis using standard procedures (Hazelton and Murphy, 2016). Using the standard procedure, a representative sample of poultry manure was analysed for organic carbon, organic matter, total nitrogen, available phosphorus and exchangeable bases such as potassium, magnesium, calcium and sodium. The experimental sites were harrowed twice at the onset of the rainy season. Ridges were made 75 cm apart, and the area was marked out into plots of 13.5m^2 and 9m^2 gross and net plots, respectively. Four levels of poultry manure rate (0, 2, 4, 6 tonnes/ha) were applied. NPK fertilizer was applied in two doses. The first dose of 100:50:50 kg/ha using NPK (15:15:15) as basal fertilizer was applied at 2 WAS, and a further 50kg N/ha was applied at 6 WAS as top-dressing using urea (46% N) as the nitrogen source Planting was done two weeks after poultry manure application at the intra-row spacing of 50cm, 75cm and 100cm. Planting was done on 14th August 2019 at Samaru and 15th August 2019 at Bagauda. Weeds were controlled manually by hoeing. This continued based on the weed infestation until foliage covered the crop and was dense enough to smother competing weeds. Fruits were harvested by hand picking 45 to 50 days after sowing when the fruit's skin changed from dull green to glossy green. Data were collected at harvest on number of fruits, diameter of fruits, weight of fruits per plant and total fruit yield per hectare. Data collected were statistically analyzed using an analysis of variance (ANOVA~~,~~ Duncan's Multiple Range Test was used to evaluate differences among treatment means (Murphy *et al*., 2014).

RESULTS AND DISCUSSIONS

Table 1 shows the physical and chemical properties of soils at experimental sites during the 2019 wet season. The textural class was sandy loam in both locations. At Samaru, it is moderately acidic (5.51) with low organic carbon (1.02 g kg^{-1}) and total nitrogen (0.95 g kg^{-1}). Available phosphorus (10.54 mg kg^{-1}), calcium (2.61 cmol kg^{-1}), magnesium (0.36 cmol kg^{-1}), potassium (0.18 cmol kg^{-1}) and sodium (0.21 cmol kg^{-1}) contents were medium, cation exchange capacity was low (3.65). At Bagauda, the soil pH was moderately acidic (5.84). Organic carbon (1.22 g kg^{-1}), total nitrogen (1.18 g kg^{-1}) and available phosphorus (6.26 mg kg^{-1}) contents were low. In contrast, calcium (3.15 cmol kg^{-1}), magnesium (0.56 cmol kg^{-1}), potassium (0.18 cmol kg^{-1}), and sodium (1.18 cmol kg^{-1}) contents were all medium, cation exchange capacity of the soil was low (4.32). this implies that the soils at each location are ideal and suitable for cucumber production. Its structure, composition, aeration and nutritive composition are within the recommended for cucumber production. Table 2 shows the chemical composition of poultry manure used in the experiment. Available nitrogen content was 20.15 g kg^{-1} while available phosphorus and potassium contents were 15.60 g kg^{-1} and 13.16 g kg^{-1} respectively. The calcium was 5.61 g kg^{-1}. These indicate that poultry manure is rich in essential nutrients that are readily available for crop growth and development.

Table 3 presents cucumber fruit yield and its contributing characteristics as influenced by poultry manure application and intra-row spacing at Samaru and Bagauda during the 2019 wet season. Application of 2 and 4 t ha^{-1} poultry manure recorded numerous and longer fruits with wider diameters at par with 100:50:50:kg ha PK (15:15:15) in Samaru and Bagauda respectively. Likewise, higher fruit weight per plant and total fruit yield was recorded by 2 and 4 t ha^{-1} in Samaru and Bagauda respectively. Enujeke (2013) reported that cucumber responded up to 20 t ha^{-1} poultry manure. Beyond these rates, there was no significant increase in values of all parameters assessed in each location. This could be attributed to the beneficial effects of poultry manure through the provision of readily available nutrients especially N, P K as well as calcium and magnesium. This further enhanced soil porosity and water-holding capacity for proper crop growth and development. Similar results were reported by several workers who attributed the nutrient and soil-enhancing properties of the poultry manure (Oke *et. al*., 2020 Tahir *et. al.,* 2019).

The effect of intra-row spacing on number of fruit per plant, fruit length and weight per plant was not significant at Samaru. However, 50 cm intra-row spacing recorded a higher number of fruits that were longer at Bagauda though comparable to 75 cm spacing. The fruit diameter and weight per plant were not significant at Bagauda. In contrast, total fruit yield recorded linear response up to 100cm spacing although it was not significant at Bagauda. This could be attributed to few plants and less competition for light, space and nutrients at wider spacing. The contrasting results obtained in this study are similar to the findings of Ansa and Garjila (2019) and Jaffar and Wahid (2014). Izaj *et al.* (2017) reported higher fruit weight per plant while Sanni and Adenubi (2020) observed higher fruit numbers at wider spacing respectively. No poultry manure and intra-row spacing significant interaction was observed on any of the parameters assessed in both locations.

CONCLUSION

Based on the results of this study, application of 2 and 4 t ha^{-1} poultry manure at Samaru and Bagauda respectively and adoption of 75 cm intra-row spacing in both locations were optimum for cucumber production in the areas.

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Table 1: Physical and chemical properties of soil of the experimental sites during the 2019 wet season

Physical composition	**Samaru**	**Bagauda**
	0-30 cm	0-30 cm
Sand	600	610
Silt	240	210
Clay	160	180
Textual class	Sandy Loam	Sandy Loam
Chemical composition		
pH in H_2O (1:2.5)	6.01	6.58
pH in 0.01M $CaCl_2$ (1:2.5)	5.09	5.25
Organic carbon (g/kg)	14.15	16.78
Available phosphorus (mg/kg)	10.65	12.10
Total nitrogen (g/kg)	1.61	1.86
Exchangeable bases (cmol/kg)		
Ca	3.15	3.56
Mg	0.68	0.72
K	0.15	0.21
Na	0.23	0.29
Al + H	0.20	0.18
CEC	4.41	4.96

CEC = Cation Exchange Capacity

Source: As analyzed Department of Agronomy, Ahmadu Bello University Zaria

Table 2: Chemical composition of the poultry manure used in the experiment during the 2019 wet season

Chemical composition	Value
Total nitrogen (gkg^{-1})	20.15
Available phosphorus (gkg^{-1})	15.60
Available Potassium (gkg^{-1})	13.16
Calcium (gkg^{-1})	5.61

Source: As analyzed Department of Agronomy, Ahmadu Bello University Zaria

Table 3: Fruit yield and some of yield components of cucumber as influenced by poultry manure and intra-row spacing at Kadawa and Bagauda during the 2019 wet season

Treatment	Fruit number		Fruit length (m)		Fruit diameter (cm)		Fruit weight plant-1 (g)		Total fruit yield (kg ha-1)	
	Samaru	Bagauda	Samaru	Bagauda	Samaru	Bagauda	Samaru	Bagauda	Samaru	Bagauda
Poultry manure P, (tha-1)										
0	9.8b	16.2c	15.0b	13.1c	4.1b	4.2c	47.2b	47.9b	5.2b	10.6c
2	23.9a	23.2bc	17.5a	15.5b	4.4ab	4.3bc	101.1a	68.4b	19.9a	15.8bc
4	27.4a	40.2ab	18.9a	16.4b	4.6a	4.7abc	98.1a	117.1a	19.6a	26.5ab
6	29.0a	48.4a	17.7a	18.1a	4.8a	5.1a	99.0a	118.4a	24.3a	35.9a
NPK	24.3a	39.7ab	18.2a	17.9a	4.8a	4.8ab	111.3a	115.3a	20.9a	31.4a
SE±	2.165	5.774	0.611	0.502	0.164	0.197	5.784	10.870	3.028	4.912
Intra-row spacing S, (cm)										
50	21.4	41.5a	18.1	16.5a	4.8a	4.6	79.4b	97.5	12.4b	19.9
75	24.1	33.4ab	17.5	16.7a	4.6ab	4.6	101.0a	94.4	17.7ab	24.8
100	23.2	25.8b	16.8	15.4b	4.2b	4.6	93.6a	88.4	24.0a	27.3
SE±	1.677	4.473	0.473	0.389	0.127	0.152	4.480	8.420	2.345	3.805
Interaction										
P*S	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) in the same column are not different statistically at *P=0.05* using DMRT
NS = Not significant

Acalypha wilkesiana Muell. Arg.: A PLANT WIDELY APPRECIATED FOR ITS ORNAMENTAL USE BUT LARGELY UNDERUTILIZED FOR ITS MEDICINAL POTENTIALS - A REVIEW

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ABSTRACT
Acalypha wilkesiana Muell. Arg. widely known and accepted for its aesthetic value as ornamental plant has yet to be maximally exploited as herbal medicament for the wellness of man. There is a gradual growing consciousness on the traditional herbal remedy of the plant; this has been aided by its embrace for use in tackling some gastrointestinal and dermatological disorders especially relating to infants by the resource constraint rural settlers. Also, the antimicrobial potentials of this nature's endowed plant are attracting interest in the therapeutic prospect of Acalypha wilkesiana in the healthcare domain. This work seeks to collate information on the various ethnomedicinal uses for which Acalypha wilkesiana had shown great promise and to equally highlight its encouraging antimicrobial potency. With a background work as this, a baseline is established for the manufacture of drugs with proven efficacy.
***Keyword**: Acalypha wilkesiana, ornamental plant, traditional medicine, antimicrobial, cultivar*

INTRODUCTION

Plants are a valuable life support and sustaining resource to man. The usefulness of plants to man abound in many ways than can be imagined. Many plants are of multipurpose value ranging from their use as food, medicine, furniture, aesthetics (ornamental), clothing, fuel, and the likes. Quite a number of plants become known for one usefulness or the other due to their overriding acceptance in that particular area of utilization. Oftentimes, the wide usage of a plant for a specific purpose beclouds its other valuable impact and derivatives. Typical of such a plant is the Bush Mango (*Irvingia gabonensis*), targeted mainly for its kernel seed extracts as condiment for soup as opposed to the consumption of its edible fruit (Oben, 2011). Another notable example is the Eggplant (*Solanum melongena*) with its fruit as the primary focus of consumption by a vast majority undermining the usefulness of the leaf as a veritable vegetable resource in soup preparation (Ibe *et al.,* 2022). Many plants with multipurpose use abound that are underutilized and herein lies the onus on researchers to venture deep and wide in the continued quest to fully exploit the vast resources of nature's potentials at our disposal. In this vein, a plant like *Acalypha wilkesiana* commonly used as ornamental plant but underutilized for its medicinal value; is placed in the spotlight for its ethnomedicinal uses and therapeutic potentials.

Acalypha wilkesiana Muell. Arg. is a plant which by taxonomical alignment is placed in the family Euphorbiaceae. It is popularly known as copper leaf, Jacob's coat, fire dragon with other local names like "awor-oso" by the Yorubas and "Jiwene" or "Jinwinini" by the Hausas. *Acalypha wilkesiana* is an evergreen shrub that grows to between 2 – 4 metres and in some cases higher. It grows to maturity showcasing a blend of alluring colour variants ranging from bronze red to mild red, including either of pink, purple, white, orange, yellow or green depending on the cultivar. There are widespread cultivars the world over, with Nigeria having a rich reserve which include the godseffiana, hispida, macrophylla, macefeena, hoffmanni, racemose and marginata (Ikewuchi *et al.,* 2010; Awe *et al.*, 2013). A cultivar of the *Acalypha sp*. is shown in Fig. 1.

The flowers of *Acalypha wilkesiana* lack petals and nectar discs but possess distinct male (hang downwards in long spikes) and female (in short spikes) phenotype on the catkin-like racemes beneath the foliage on the same plant. February to December is usually its flowering season (Sagun *et al.,* 2010). The convenient and appropriate means of regeneration for the plant throughout the year is by air layering or stem cutting (Edward, 2011).

(i) Red Acalypha (ii) Java White

Fig. 1: *Acalypha wilkesiana var. macrophylla*

COMPILATION OF SOME OF THE ETHNOMEDICINAL USES INCLUDING ANTIMICROBIAL PROPERTIES OF *Acalypha wilkesiana*

The healing and health promotion attributes of many of the plants in our environment have attracted several individuals to engage their patronage as a cost-effective alternative to maintaining their wellness drive in the face of depleting financial power. One of such useful plants for ethnomedicinal application is *Acalypha wilkesiana*. This plant has become a valuable herbal remedy for several health challenges as are highlighted in Table 1 below. Many laboratory research expeditions have been undertaken to further give credence to the ethnomedicinal usefulness of *A. wilkesiana*.

Table 1: Some of the various medicinal uses of *Acalypha wilkesiana*

S/N	Traditional Medicine Uses	Plant parts used	Mode of preparation and application	Reference
1.	Management of hypertension	Leaves	Nutraceutical (leaves eaten as vegetable)	Iwu M. M., 1993; Ikewuchi *et al.,* 2008
2.	Treatment of dermatological challenges like fungal / bacterial skin infections	Leaves	The leaves are rubbed in between palms and the juice is smeared on the affected part of a patient	Neuwinger, 2000; Lim *et al.,* 2013
3.	Remedy for headache, swellings, cold and malaria	Leaves	leaf-poultice	Akinyemi *et al.,* 2005
4.	Treatment of diarrhoea and dysentery	Leaves	Leaves are squeezed into water and the resulting solution drunk	World Health Organization, 2009
5.	Treatment for pleurisy	Leaves and bark	Infusion of leaves and bark	Acalypha wilkesiana (PROSEA), 2022
6.	Treatment of babies with skin infection	Leaves	cold extract of the leaves is used to bath the subject	Adesina *et al.,* 2000
7.	Mitigation and handling of haemorrhoids.	Roots	Roots are boiled to wash haemorrhoids	Ong, 2006
8.	Treatment of gastritis and lymphoid swellings	Leaves	Decoction of the leaves	Acalypha wilkesiana (PROSEA), 2022
9.	First aid for ruptured appendicitis	Leaves	Leaves are chewed on	World Health Organization, 2009
10.	Treatment of gastrointestinal	Leaves	Strain out juice / boiled	Oliver, 1959;

	disorders		decoction	Ogundaini, 2005
11.	Treatment of neonatal jaundice	Leaves	Aqueous leaf extract administered orally	Alade and Irobi, 1993
12.	Treatment of malaria, breast tumors and inflammation	Seeds	The seeds are used in compounding a complex plant mixture	Bussing *et al.,* 1999; Taraphdar *et al.,* 2001; Oyelami *et al.,* 2003; Akinyemi *et al.,* 2005
13.	To regulate menstruation	Leaves	The leaves are squeezed and mixed with water, and drunk	Acalypha wilkesiana (PROSEA), 2022
14.	As abortifacient	Leaves	Fresh shoots are squeezed into water and solution drunk	World Health Organization, 2009
15.	Remedy for stomach ache and as worm expellant	Stems and roots	Chopped pieces of dried stem and root steeped in alcohol	Onocha and Olusanya, 2010

Some findings on the Potentials of the Leaf Extracts of *Acalypha wilkesiana*

The several test results on the leaf extracts of *Acalypha wilkesiana* revealed the presence of active constituents capable of inhibiting the growth of many of the common pathogenic microorganisms of bacterial (active against both gram positive and negative strains) and fungi origin including antioxidant properties (Alade and Irobi, 1993; Oladunmoye, 2006; Majekodunmi and Nubani, 2014; Anokwuru *et al.,* 2015).

CONCLUSION

Acalypha wilkesiana Muell. Arg. is a household ornamental plant accepted for its appealing allure and aesthetic impact. However, the plant is now exploited for its several medicinal potentials. It has become pertinent that the therapeutic values of this plant are given prominence in the pursuit of alternative medical approach to wellness. *Acalypha wilkesiana* gaining patronage as herbal medicament is therefore a good candidate plant for the pharmaceutical industry in search of pharmacological solution to a handful of the health challenges of man.

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EFFECTS OF FERTILIZER TYPES AND MODES OF PROPAGATION ON SESAME (*Sesamum indicum L.)* IN OGBOMOSO.

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ABSTRACT

Poor soil fertility is among the major production problems responsible for poor growth and low yield of sesame in Nigeria. A field experiment was conducted at the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso, Nigeria to determine the effects of application of fertilizers types on growth and yield of sesame variety E8. Five fertilizer types and two modes of propagation were assessed. The 5 by 2 factorial experiment was laid out in a Randomized Complete Block Design (RCBD), replicated three times. FO = zero application, Fl = NPK fertilizer, F2 = Organic Neem fertilizer, F3 = Organo-mineral, F4 = poultry manure, F5 = Cow Dung, M0 = Direct Seeding, M1 = Transplanting. All data collected on the growth and yield parameters were subjected to analysis of variance (ANOVA). Means were separated using Duncan Multiple Range Test at 5% probability level. The application of Zero fertilizer and Transplanting (M1F0) had the least values across all the parameters measured. Nutrient uptake particularly N, P and K were also significantly enhanced by the application of Organomineral and Transplanting (M1F3). Therefore, the application Organomineral and other organic fertilizers are recommended, so as to alleviate chemical loads on the soil.

Keywords: *Fertilizer, NPK, Propagation, Sesame*

INTRODUCTION

Sesame (*Sesamum indicum L)* is an annual flowering plant in the genus Sesamum and family Pedaliaceae. It is an erect plant which grows between 50 to 250 cm tall depending on the variety, soil and environmental conditions (Sharma, 2005). It is an important oil seed crop with great commercial attributes by virtue of its oil having an edible quality and medicinal value. It yields 50-60% oil and the oil is highly stable against rancidity due to the presence of the natural antioxidants sesamin and sesamolin (Weiss, 2000 and Sabah El-Khier *et al.,* 2008). Sesame seeds have been widely employed in culinary as well as in traditional medicines for their nutritive, preventive, and curative properties. It is potentially capable of producing large quantities of seeds per unit area but the yield is low ha-1 (Ahmad *et al.,* 2001) due to lack of improved varieties and improper fertilization (Rao *et al.,* 1994). Sesame (*Sesamum indicum* L.) is described as the "queen of oil seeds" because of its high oil, protein, calcium and phosphorus (Prasad, 2002; Misari and Iwo, 2000) Sesame is cultivated in tropical and sub-tropical Africa for its highly nutritious and edible seeds (Iwo *et al*., 2002).

The use of fertilizers is considered one of the most important factors to increase crop yields on per unit basis. The base element of all biological cells starts with nitrogen and its role cannot be substituted in crop production. Nitrogen is a component of protein and nucleic acids and an integral component of many other compounds essential for plant growth processes including chlorophyll and many enzymes. It also mediates the utilization of phosphorus, potassium and other elements in plants good seed and dry matter yield. Incorrect application of chemical fertilizers and lack of appropriate soil management /conservation strategies are the major causes of rapid depletion of soil nutrients and subsequently low crop productivity persisting in the tropics. Tropical farmers apply chemical fertilizers "anyhow" regardless of scientific recommendations for different crops as well as the importance of improving and maintaining organic matters in the soil system (Sobulo, 2000). Also, human activities (such as incessant yearly bush burning, continuous cropping, monocropping, overgrazing, mining, bulldozing, open-clean-clear cultivation, ridging-along-the-slope, excessive logging etc.) and other climatic attributes (such as torrential rainfall and high solar radiation) are equally aggravating nutrient balances and rapidity of nutrient depletion in the tropics (Babajide *et al*., 2008).

MATERIALS AND METHODS

The Experiments was carried out during the rainy seasons of 2021 at the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso, Nigeria. The seed of sesame (*Sesamum indicum* L.) was obtained from the National Cereals Research Institute Badeggi, Niger State. Sowing of the seeds was done at the rate of 10 seeds per hole. Seedlings were then thinned to one plant per stand and also transplanted at two weeks after sowing (WAS). Regular watering was maintained. Also, weeding was done manually using hoe and cutlass on regular basis. Application of NPK, Organic Neem fertilizer, Organomineral, poultry manure and Cow dung was done at four weeks after sowing and another was applied eight weeks after sowing. Six fertilizer types and two propagation methods were introduced, FO = zero application, Fl = NPK fertilizer, F2 = Organic Neem fertilizer, F3 = Organomineral, F4 = poultry manure, F5 = Cow Dung, M0 = Direct Seeding, M1 = Transplanting.

Data collection commenced at five weeks (5 WAS) after sowing. The growth parameters determined were plant height, numbers of leaves, numbers of tillers, and stem girth. Number of leaves was determined by the visual observation and direct counting of all the fully opened leaves per plant. Plant height was determined by using tape rule placed at the stem base and run into the tip of the longest leaf. Stem girth was determined by measuring the stem diameter using venier caliper (3cm above the soil). The value obtained was then converted to stem girth using a formula π D (where $\pi = 3.142$ and D = stem diameter). The yield parameters determined were fresh and dry weight after harvesting immediately (fresh weight) while after oven drying of plants samples at 80°C for 72 hours, the dry shoot weight was-determined using electronic weighing balance.

Dry weight and the total biomass production of the harvested sesame plants shoot and root were determined by oven drying at 80°C to a constant weight for three days (72 hours). The plant samples were then milled in Wiley mill to pass through 1mm sieve and subjected to kjeldah digestion at 360°C for 4 hours with concentrated sulphuric acid, using selenium and sodium sulphate as catalyst. plant content of P, K, Ca, Mg, Mn, Zn, and Cu were determined by ash plant samples in muffle furnace at 600°C for 2 hrs, the ash was cooled and dissolved in 1N hydrochloric acid and the solution pass through filter paper into Smi volumetric flask and made up to the mark with distilled water. Total N was determined from the digest steam distillation with excess NaOH. From the digest P concentration was determined by the Vanadomolybdate yellow colorimetric method using spectrophotometer (spectronic 20). The nutrients accumulated in plants were calculated as; Nutrient uptake=% Nutrient content x sample dry with according Gungunla, (1999).

RESULTS AND DISCUSSION

The application of M0F2 greatly enhanced the number of capsules at 9WAS, 10WAS and 11WAS which were observed to have the highest values (98.3g), (165.0g) and (210.0g) respectively which was not significantly different from the other treatments but significantly different from M1F0 which had the least values (13.3g), (41.7g) and (76.0g).

At 12WAS, it was obtained that M1F2 increased the number of capsules with the highest value (227.7g) observed, which was not significantly different from the other treatments but significantly different than the M1F0 which has the least value (88.7g) as shown in the Table 1

Table 1: Effects of Fertilizer Types and Mode of Propagation on the Yield Parameters of Sesame.

	WEEKS AFTER SOWING (WAS)			
TREATMENT	SFW	SDW	RFW	RDW
M0F0	221.8a	53.9a	96.9a	21.6a
M0F1	197.4a	44.9a	56.6a	3.5a
M0F2	171.9a	46.5a	53.1a	17.5a
M0F3	197.2a	48.3a	82.4a	18.2a
M0F4	214.8a	54.2a	80.6a	18.0a
M0F5	192.7a	52.1a	63.4a	20.4a
M1F0	145.2a	38.1a	41.7a	11.9a
M1F1	157.5a	44.4a	63.2a	17.6a
M1F2	223.4a	61.5a	86.7a	21.1a
M1F3	266.1a	61.7a	85.5a	22.4a
M1F4	189.5a	53.5a	59.9a	18.8a
M1F5	229.2a	53.7a	88.3a	19.8a

Means with the same letter are not significantly different from each other at P = 0.05 using DMRT. FO = zero application, Fl = NPK fertilizer, F2 = Organic Neem fertilizer, F3 = Organomineral, F4 = poultry manure, F5 = Cow Dung, M0 = Direct Seeding, M1 = Transplanting, SFW= Shoot Fresh Weight, SDE= Shoot Dry Weight, RFE= Root Fresh Weight, RDW= Root Dry Weight.

Effects of Fertilizer Types and Mode of Propagation on The Nutrients Uptake

Among all the treatments introduced, M1F3 significantly enhance Nitrogen uptake with a value of 45.8. The control M0F0 had the least value (5.6) of N-uptake. In terms of phosphorus (P) and Potassium (K) uptake, M1F3 was observed to have the highest values of 47.1 and 38.0 respectively, which is significantly different from the other applied treatments. But the control had the least values of 0.9 and 0.8 respectively.

The uptake of Ca was enhanced in M1F3 with value of 8.8, which is significantly not different from M0F3, M0F5 and M1F1 but significantly different from the other treatment, while the control M0F0 has the least value of 0.8. M1F3 enhances the uptake of Mg which is significantly different from the other applied treatments while the control M0F0 has the least value of 0.7. The uptake of Na was significantly enhanced in M0F1 which was significantly different from the other applied treatments. The uptake of Fe was enhanced in M0F2 with obtained value of 145.7 which is significantly different from the other applied treatments while the control M0F0 has the least value of 81.3.

Cu uptake was greatly enhanced in M1F4 which is not significantly different from M1F3 but significantly different from the other applied treatments with the control having the least value. The Mn uptake was influenced in M0F1 which is significantly not different from M0F0 but significantly different from the other treatments. While the M1F0 has the least obtained value of 44.0. Zn was influenced in M0F2 which was found not to be significantly different from M1F3, M1F4, M0F0 and M1F5 but significantly different than what other treatments, with the M0F4 having the least value of 16.5.

Table 3: Effects of Fertilizer Types and Mode of Propagation on The Nutrients Uptake of Sesame.

WEEKS AFTER SOWING (WAS)

TREAT	gkg^{-1}			$mgkg^{-1}$						
MENT	N	P	K	Ca	Mg	Na	Fe	Cu	Mn	Zn
M0F0	5.6g	0.9e	0.8f	0.8e	0.7g	0.6f	81.3f	1.8f	90.4a	30.9ab
M0F1	7.6g	16.3d	16.5de	2.9d	0.9g	2.2a	123.1b	6.5b	90.8a	36.6a
M0F2	8.7g	15.7d	18.2cde	5.8c	2.6ef	1.6bc	145.7a	5.9bc	44.9d	23.2cde
M0F3	22.7c	6.6d	19.3bcde	8.2a	5.2b	0.7ef	107.1cde	3.5de	40.7d	20.1def
M0F4	18.9cde	17.4d	7.9cde	5.8c	3.5d	0.7ef	108.0cde	4.6de	36.8e	16.5f
M0F5	18.4de	17.2d	21.4bc	8.3a	2.8e	0.7ef	113.9cd	4.5de	35.3e	18.0ef
M1F0	13.5f	15.6d	16.1e	6.1bc	2.2f	0.9def	114.4c	3.5de	44.0d	27.8bc
M1F1	15.9ef	17.9d	20.9bcd	8.0a	2.6ef	1.5bc	104.8de	4.9cd	59.6bc	24.3cd
M1F2	21.8cd	17.2d	18.5bcde	3.7d	0.7g	1.7b	105.0de	6.6b	63.7b	31.3ab
M1F3	45.8a	47.1a	38.0a	8.8a	6.7a	1.1cde	102.9e	7.9a	53.1c	34.8a
M1F4	34.1b	25.0b	22.9b	6.9b	4.3c	1.2bcd	104.5de	8.5a	53.3c	34.2a
M1F5	37.1b	20.3c	22.1bc	6.5b	2.6ef	1.4bc	107.6cde	6.5b	59.9bc	32.1ab

Means with the same letter are not significantly different from each other at P = 0.05 using DMRT. FO = zero application, Fl = NPK fertilizer, F2 = Organic Neem fertilizer, F3 = Organomineral, F4 = poultry manure, F5 = Cow Dung, M0 = Direct Seeding, M1 = Transplanting

CONCLUSION

All treatments applied significantly enhanced the growth and yield parameters of *Sesamum indicum L.* The application of Zero fertilizer and Transplanting (M1F0) had the least values across all the parameters measured. The growth, yield parameters and nutrient uptake particularly N, P and K were also significantly enhanced through the application of Organomineral and Transplanting (M1F3). Therefore, the application Organomineral and other organic fertilizers are recommended, so as to alleviate chemical loads on the soil.

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INFLUENCE OF BAP ON *IN-VITRO* PROPAGATION OF ROSE (*Rosa* Spp.)

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ABSTRACT

Micro propagation is the best method to rapidly propagate healthy and high uniformity rose cultivars. In this study the effect of some plant growth regulators on the in-vitro propagation of rose were investigated. Cultures of surface sterilized single bud nodal rose explants were initiated on MS media supplemented with 30 g/l sugar, 8g/l agar and different concentrations of BAP (0, 1, 2 and 3 mg/l) in combination with (NAA) along with other plant nutrients. The longest shoot was found to occur in treatment III with BAP at 2 mg/l. There was no significant difference as compared to treatment IV with BAP at 3 mg/l while the best shoot proliferation was found to occur with treatment IV. The least response in shoot length and proliferation was found with the control (treatment I) in which BAP and NAA were not present.

Keywords: *Biotechnology, Floriculture, Micro-propagation, Plant growth regulators, Tissue culture.*

INTRODUCTION

Rose, popularly known as the queen of flowers is one of the most important ornamental plants in the world and also the most widely cultivated cut flower with high demand. One of the primary problems with its cultivation aside their susceptibility to diseases like black spot, powdery mildew, bacterial blight, etc. is its difficulty in propagation. Rose is generally propagated by vegetative methods like cutting, layering, budding and grafting. Although propagation by vegetative means is a predominant technique in roses, it does not ensure disease-free plants. Moreover, dependence on season and slow multiplication rates are some of the other major limiting factors in conventional propagation (Aggarwal *et al*., 2020). Plant tissue culture refers to the micro propagation or *in vitro* culture of plants from plants parts such as tissues, organs, embryos, protoplasts, single cell on a suitable nutrient medium supplemented with the required amount of plant hormones which include auxins, cytokinin and growth regulators with similar metabolic effects under aseptic conditions (Kaya and Karakutuk, 2018, Kaya and Huyop 2020).

Statement of research problem

Roses can be propagated by seeds, cuttings, layering, and grafting. These vegetative methods of rose propagation are conventionally slow and sometimes produce unhealthy plants. Therefore, there is need to use an efficient method for improved propagation of roses and one of such method is by "Plant tissue culture". The aim of this research is to develop an effective protocol for the rapid production of healthy rose plants via *in vitro* propagation.

Objective

To ascertain the effect of BAP (6-Benzyl Amino Purine) on rose (Rosa *spp.*) via *in-vitro* propagation

MATERIALS AND METHODS

Preparation of explant: Rose explants used for the tissue culture were obtained from mature roses (Rosa *spp*.) from the Floriculture garden of the Institute, NIHORT. The explants were brought into the laboratory, cuttings of about 3 cm were obtained from it and surface sterilized starting by placing them under running tap for one hour to wash off surface dirt with the application of a few drops of tween-20. The clean cuttings were later immersed in 20% chlorox for 30 minutes and rinsed thrice with sterile distilled water. This was followed by immersing in 70% ethanol (under the laminar flow) for 10 minutes and then rinsed thrice with sterile distilled water.

Sterilization process: The forceps, scalpels, Petri-dishes, boiling tubes and cutting slab were wrapped in aluminum foil, sealed with tape and sterilized in an autoclave at 121ºC. The laminar hood was thoroughly cleansed with absolute ethanol, UV-light was also initiated to completely sterilize the chamber before commencing to work. All activities were carried out inside the laminar hood. Other sterile measures and procedures were strictly observed.

Media Preparation: Full strength MS medium (Murashige and Skoog, 1962) supplemented with 3% sucrose, 50 mg Adenine sulphate, 0.125g Myoinositol and 0.8% Agar and different concentrations and combination of BAP and NAA were used for shoot initiation. The pH was adjusted to 5.8 prior to melting the gel and autoclaving.

Experimental Design: Four treatments with varying concentrations and combination of BAP and NAA as shown in Table 1 were used in this experiment. Each treatment consists of 15 cuttings having at least one apical node. All experiments were carried out in two replicates. MS medium without growth hormones was used as control. All the in vitro cultures were incubated at 26 ± 2°C in a growth room on a 16/8 hour light/dark and 3,000 lux light intensity provided by cool-white fluorescent light. All data were subjected to analysis of variance and mean comparison were performed using the least significant difference (LSD) with a significance level of 5% according to (Gomez and Gomez, 1984).

RESULTS

The sterilization procedure showed significant difference with a contamination rate of 7% as compared to previous trials with a contamination rate of 90%. Increasing the sterilization time from 10 minutes to 30 minutes and using a higher concentration of sodium hypochlorite from 10% to 20% greatly impeded the growth and expression of microorganisms in the cultures. Treatments with BAP and NAA showed significant growth difference on the shoot initiation stage as compared with treatment having no growth hormones. The longest shoot length was observed in treatment III with 2 mg/l of BAP and 0.1 mg/ml of NAA while the lowest was observed with treatment I with no growth hormones which serve as control (Figure 1). There was no significant difference in the number of shoots between treatments III and IV at week 4 respectively however there were significant difference compared to treatment II with 1mg/l as well as treatment I (control). The highest proliferation rate was found in treatment IV with 3 mg/l as shown in figure I while the least response in proliferation rate was observed in treatment I as seen in plate II.

DISCUSSION

The *in-vitro* propagation of rose is for the rapid supply of healthy quality plants with desirable characteristics especially for commercial purposes. A major concern when it comes to the tissue culture of any plant is contamination. As a result of this, it is imperative that the surface sterilization step be taking handled meticulously (Tawfik *et al*., 2018). The use of 20% chlorox for a longer time range was observed to be effective as the sodium hypochlorite greatly impede the growth and expression of endogenous microbes. Studies have shown that the use of appropriate plant growth regulators (PGRs) is a major contributory factor to the successful initiation and multiplication of any plant under *in-vitro* conditions. Cytokinins are known to stimulate or initiate shoot induction and multiplication (Lella *et al*., 2021). The basal media was MS medium supplemented with necessary plant growth regulators. Butyl Amino Purine (BAP) was the cytokinin used in this investigation. Different concentrations of BAP were studied to investigate their effects on the shoot initiation and multiplication / proliferation rate *in-vitro* propagated roses. It was observed that treatments with 2 and 3mg/l BAP was significantly different in the rate of proliferation compared with treatments with 0 and 1 mg/l. The longest shoot (4.5 cm) was recorded with 2mg/l BAP while the least shoot length was recorded with the control (1cm). Ash *et* al., 2020, also state that 3.5mg/l BAP in combination with kinetin produced the maximum response of shoot regeneration of rose. Lower concentrations of BAP may be responsible for the slow growth response of the plant. This is similarly reported by (Thi *et al*., 2021), pointing that BAP 3mg/l was suitable for shoot initiation and multiplication of rose (Hybrid rose *spp*.)

CONCLUSION

The influence of BAP at 2mg/l and 3mg/l on the *in-vitro* propagation of rose is very significant and this can be utilized and optimized for the rapid mass propagation of roses for commercial scale.

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Table 1: Nutrient component and concentration used for *in-vitro* propagation of rose

Treatment / Reagent	T.I	T.1I	T.III	T.IV
MS Salt	4.43 g	4.43 g	4.43 g	4.43 g
Adenine Sulphate	50 mg	50 mg	50 mg	50 mg
Myoinisitol	125 mg	125 mg	125 mg	125 mg
Sucrose	30 g	30 g	30 g	30 g
BAP	-	1 mg	2 mg	2 mg
NAA	-	0.1 mg	0.1 mg	0.2 mg
pH	5.8	5.8	5.8	5.8
Agar	8.0 g	8.0 g	8.0 g	8.0 g

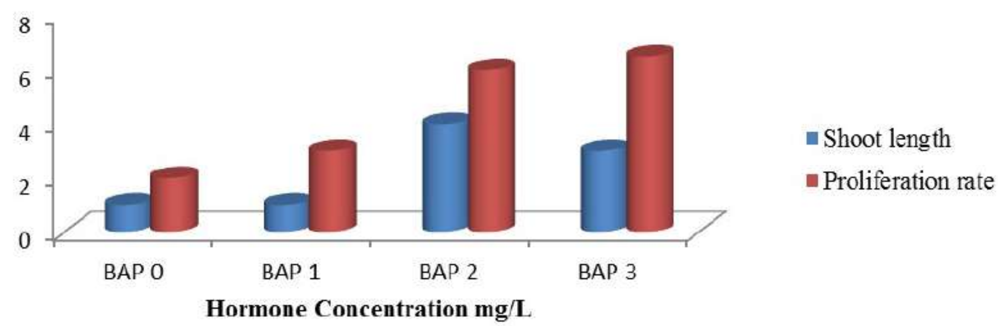

Figure 1: Effect of Different Concentration of BAP on Shoot length and Proliferation rate.

Plate 1: cross section of rose tissue culture at day 1 and day 33 respectively.

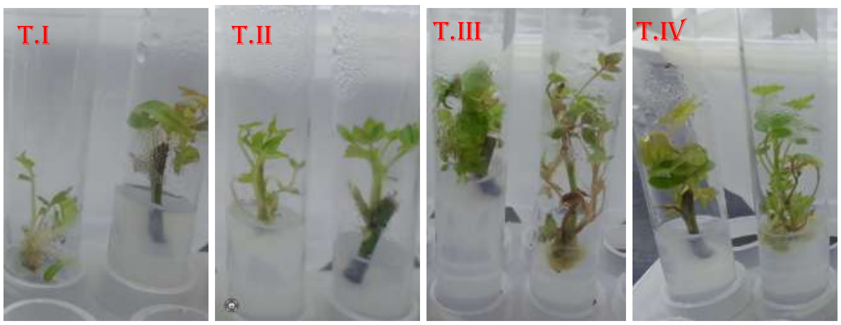

Plate 2: Shoot proliferation of Rosa *spp.* at week 4;
T.I = (treatment I with 0mg BAP), T.II = (treatment II with 1mg BAP), T.III = (treatment III with 2mg BAP), T.IV = (treatment IV with 3mg BAP).

EFFICACY OF GUM ARABIC FUNCTIONALIZED WITH CINNAMON OIL ON THE NUTRITIONAL AND PHYSICOCHEMICAL QUALITIES OF SCOTCH BONNET (*Capsicum chinense*)

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ABSTRACT
The postharvest losses of horticultural products are very high and the rate of losses significantly depends on the type of products and postharvest handling practices. Effect of gum Arabic coatings combined with cinnamon oil on freshly harvested mature scotch bonnet fruits during storage was studied. The scotch bonnet was grouped into 3; Group A was the control and it was dipped in distilled water, group B was dipped in 10% gum Arabic + 3 ml of cinnamon oil and group C was dipped in 10% gum Arabic. The coated fruits were stored for 16 days and observed every 4 days for nutritional and physicochemical changes using standard methods. It was observed that Group C had the least incidence of decay and moisture loss at 40.80 % and 49.91 % respectively. Significantly (p<0.05) lower pH (5.98) and 0.56 % Total Titratable Acidity (TTA) values recorded for Group B revealed that the coating caused a reduction in the ripening rate of the fruit compared with the control (Group A) and Group C. Group B was effective in preserving the carotenoid contents of the stored fruits as it recorded the significantly highest values at day 16 for both Lycopene and β-carotene. Results from this study has revealed that 10 % Gum Arabic coating is an effective storage medium for scotch bonnet fruits, while the presence of Cinnamon essential oil helps to maintain the nutritional contents and as well slow down the ripening rate.
Key Words: *Postharvest, essential oil, horticultural, coating*

INTRODUCTION
On a global scale, postharvest losses of fresh produce are estimated to range from 15% to 50%. The main causes of this loss are microbial deterioration, a rapid rise in respiration, and the generation of ethylene, which causes fruit to ripen quickly even after harvest (Borah *et al*., 2016; FAO, 2019; Bist and Bist, 2021). In developing nations, where appropriate methods for storing fruits and vegetables are unavailable, this percentage is far higher (FAO, 2019). The principal causes of losses across the supply chain are postharvest pathogens and disease incidence, which are favored by these changes. Due to the non-degradability of synthetic coating materials, awareness is being drawn to use of eco-friendly biodegradable and bio-polymeric materials in preservation, of which Gum Arabic and essential oils are part. Essential oil, which is a natural compound extracted from aromatic plants. Most of these oils are generally recognized as safe (GRAS) for the environment and human health, and there is growing interest in using these oils for sustainable agriculture. A lot of research has been done with records to backup this claim that plant essential oils and extracts can serve as pharmaceuticals and food preservatives (Miguel *et al*., 2006).
In order to decrease these post-harvest losses, decay-control measures must be developed to retain the quality of fruits and vegetables and offer protection against post-harvest diseases.Thus, this study aims at development of an edible coating from natural bio-materials (gum Arabic and cinnamon oil) for postharvest management of scotch bonnet.

MATERIALS AND METHODS
Collection of materials
Cinnamon bark was procured from mandate market, Ilorin, Kwara state, while fresh Scotch Bonnet was obtained from a farm in Ilorin, Kwara State and transported to Nigerian Stored Products Research Institute (NSPRI), Ilorin, Kwara State laboratory in reusable plastic crates in the early hours of the morning.
Extraction of cinnamon oil

Cinnamon oil was extracted as described by Abubakar *et al.* (2014)

Preparation and Application of coating medium

Gum Arabic coating was prepared according to the method of Utami *et al*., (2014) with modification. Ten gramme (10 g) Gum Arabic was dissolved in 100 mL distilled water at 50 °C on a hotplate and stirred for 60 minutes using a magnetic stirrer. The solution was filtered using a muslin cloth to eliminate impurities and 2 mL of glycerol was added to the solution mixture as plasticizer to enhance the potency and elasticity of the solution. This was followed by the addition of 3 mL cinnamon oil and tagged solution A. Solution B was prepared as solution A above but without the addition of cinnamon essential oil. The Scotch Bonnet fruits were sorted washed and surface sterilized by immersing in 0.01% hypochlorite solution for one minute and air-dried. The fruits were divided into three (3) lots; Group A (control) was dipped in distilled water for 1-2 minutes, group B was dipped in solution A, and group C was dipped in solution B and allowed to air dry. The treated and untreated fruits were subjected to the same storage conditions and closely monitored with a data logger and stored for 16 days with chemical analyses carried out at 4 days interval.

Estimation of Decay Incidence (%) and Weight Loss (%)

The decay incidence and weight loss was calculated according to the procedure outlined by Lawal *et al*. (2019) and Fashanu *et al.* (2019) respectively.

Determination of Moisture content, Total Soluble Solid (TSS), pH and Total Titratable Acidity (TTA) (%)

Moisture content, pH, TTA and TSS of the stored fruits were determined according to the methods of AOAC (2019).

Carotenoids determination

Lycopene and β-Carotene contents were determined and calculated using the spectrophotometric method reported by Fashanu *et al*. (2019)

Determination of vitamin C content

Vitamin C content was determined using the 2, 6-dichlorophenol indophenol titrimetric method described by Lawal *et al*. (2019).

Statistical analyses

Triplicate data was subjected to Analysis of Variance (ANOVA) and tested for significant difference among treatments by New Duncan's Multiple Range F-Test (DMRT) at ($p<0.05$) using SPSS software package version 20.0.0

RESULTS AND DISCUSSIONS

Decay incidence and weight loss

Figure 1 shows the decay incidence and weight loss of the tested and control groups. Group C had the lowest decay incidence and weight loss at 40.80 and 49.91 % respectively after the experimental period. This group showed more pronounced effects in reducing the decay incidence and weight loss as compared with Group B, (treated with gum Arabic + cinnamon essential oil) and Group A (control). However, the increased decay incidence recorded in group B could be as a result of reduced respiration rate caused by cinnamaldehyde; a major organic compound of cinnamon essential oil (Shen *et al*., 2021) thereby putting the fruits in a complete anaerobic state. This result is in agreement with the findings of Maqbool *et al*. (2011) where Gum Arabic and essential oil was used to prevent anthracnose in banana and papaya.

Total soluble solid (TSS)

The total soluble solids, ranged from 0.1 to 0.9 ºBrix (Fig. 2) with group A having significantly ($p<0.05$) higher value (0.9 ºBrix) compared to groups B (0.6 Brix°) and C (0.7 Brix°) respectively at the end of the experimental period (Day 16). Generally, there was an increase in TSS as the storage days progressed, however there was no significant ($p>0.05$) difference between groups B and C at day 16. The increase in TSS of both the treated and the control groups might be due to change in carbohydrate composition from starch to sugar as well as increased respiration rate which can be attributed to environmental conditions thus causing an acceleration to ripening of the fruits (Fashanu *et al.,* 2019).

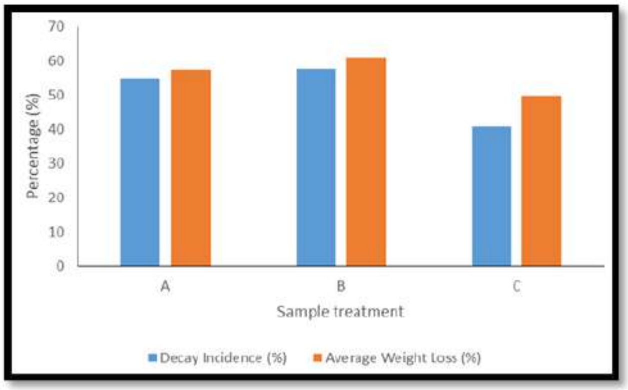

Figure 1: Effect of gum Arabic functionalized with cinnamon oil coating on Decay incidence and average weight loss of scotch bonnet. A=Control; B=10% Gum Arabic + 3mL cinnamon oil; C=10% Gum Arabic

pH and total titratable acidity (TTA)

The pH of both the control and tested groups ranged from 5.8 to 6.8 as shown in Figure 2. The control group had a significantly ($p<0.05$) higher value (6.8) at day 16 which was above the normal pH range of scotch bonnet (5.0 - 6.0) as reported by Bray, (2022). This result indicates that group B maintained the normal pH range of scotch bonnet and thus could be used in extending the shelf life of scotch bonnet. On the other hand, the TTA value recorded within the storage period ranged from 0.48 – 0.95% (Table 1). There was no significant ($p>0.05$) difference in the TTA of control and treated samples at day 0, this was expected because they were all from the same source. Conversely, a significant ($p<0.05$) decrease was recorded for all Groups at day 16,with Group A and C showing no significant ($p<0.05$) difference. This showed that the acidity of the scotch bonnet reduced over the storage period. The results of pH and acidity are in agreement because, increase in fruit acidity correspond to decrease in pH. This result shows similar trend with the findings of Maqbool *et al.* (2011) where Gum Arabic and essential oil was used to prevent anthracnose in banana and papaya.

Moisture Content (MC)

The moisture contents of the stored scotch bonnet fruits, as shown in Table 1, reduced as the storage days progressed and it ranged from 71.08 to 88.07%. Group C had a significantly higher MC (79.98%) at the end of the experimental period. This showed that Gum Arabic alone is capable of reducing water loss during the storage period, which is in agreement with Ogungbemi *et al.* (2020).

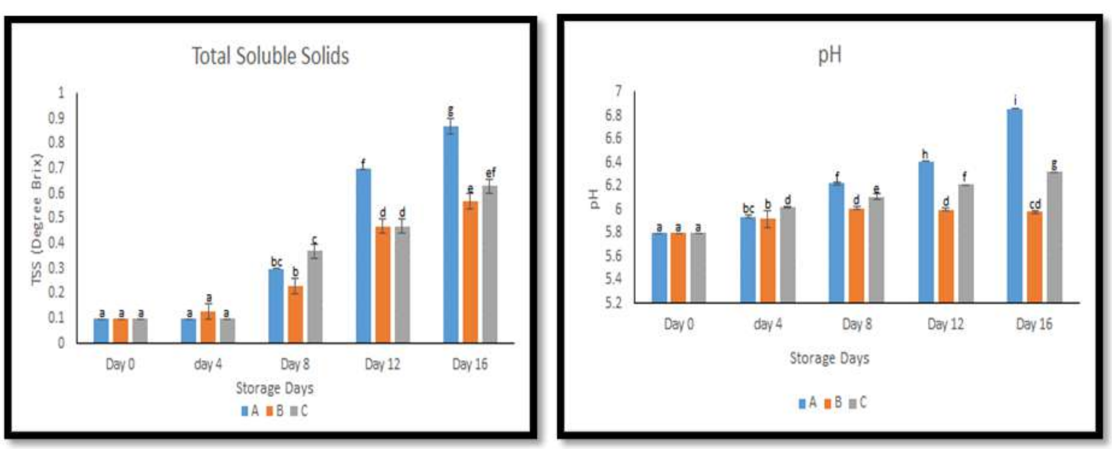

Figure 2: Effect of gum Arabic functionalized with cinnamon oil coating on total soluble solids and pH of scotch bonnet. Each bar represents mean of triplicate readings (n=3). A=Control; B=10% Gum Arabic + 3 mL cinnamon oil; C=10% Gum Arabic. Bars with unshared alphabet are significantly different ($p<0.05$). Error bars represent standard error (SE) of the mean

Table 1: Effect of gum Arabic functionalized with cinnamon oil coating on moisture content and total titratable acidity of scotch bonnet.

Sample	Days	Moisture (%)	TTA (%)
A		$88.07^{i}\pm0.06$	$0.95^{h}\pm0.02$
B	0	$88.07^{i}\pm0.03$	$0.95^{h}\pm0.03$
C		$88.07^{i}\pm0.02$	$0.95^{h}\pm0.03$
A		$85.41^{gh}\pm0.18$	$0.82^{fg}\pm0.01$
B	4	$85.15^{fgh}\pm0.32$	$0.84^{g}\pm0.01$
C		$86.17^{h}\pm0.69$	$0.84^{g}\pm0.02$
A		$83.82^{ef}\pm0.55$	$0.78^{ef}\pm0.01$
B	8	$83.78^{ef}\pm0.39$	$0.76^{e}\pm0.01$
C		$84.59^{fg}\pm0.19$	$0.69^{d}\pm0.00$
A		$80.76^{d}\pm0.34$	$0.62^{c}\pm0.02$
B	12	$75.10^{b}\pm0.66$	$0.69^{d}\pm0.00$
C		$82.97^{e}\pm0.42$	$0.67^{d}\pm0.00$
A		$78.58^{c}\pm0.80$	$0.48^{a}\pm0.01$
B	16	$71.08^{a}\pm0.88$	$0.56^{b}\pm0.01$
C		$79.98^{d}\pm0.29$	$0.49^{a}\pm0.00$

Result shows mean ± SE of triplicate readings (n=3). A=Control; B=10% Gum Arabic and 3ml cinnamon oil; C=10% Gum Arabic. Bars with unshared alphabet are significantly different (p<0.05)

Lycopene, β-carotene and Vitamin C content

The lycopene contents range from 14.91 to 64.21µg/100g (Table 2) with group B having a significantly (p<0.05) higher value (64.2 µg/100g) while group C was significantly lowest (33.53 µg/100g) after the experimental period which lasted for 16 days. β-carotene content ranged from 14.34 to 36.77 with group B having a significantly (p<0.05) higher value (36.77 µg/100g) and group C (15.30 µg/100g). The Ascorbic acid content observed in Group C was significantly higher (p<0.05) than the other groups (28.27mg/100g) at day 16. The result from this study correlated with the studies of Guo *et al*. (2020) who noted that the incorporation of cinnamaldehyde with the carboxymethylcellulose based film packaging helps to maintain the storage quality of cherry tomatoes by suppressing some metabolic activities including respiration.

Table 2: Effect of gum Arabic functionalized with cinnamon oil coating on lycopene, β-carotene and vitamin C content of scotch bonnet

Sample	Days	Lycopene (µg/100g)	β-Carotene (µg/100g)	Ascorbic Acid (mg/100g)
A		$14.91^{a}\pm0.15$	$14.34^{a}\pm0.61$	$10.42^{a}\pm0.17$
B	0	$14.91^{a}\pm0.15$	$14.34^{a}\pm0.61$	$10.35^{a}\pm0.11$
C		$14.91^{a}\pm0.15$	$14.34^{a}\pm0.61$	$10.35^{a}\pm0.08$
A		$26.73^{d}\pm0.04$	$22.68^{e}\pm0.23$	$24.00^{def}\pm2.04$
B	4	$21.64^{b}\pm0.06$	$15.85^{ab}\pm0.41$	$28.81^{g}\pm0.11$
C		$23.77^{c}\pm0.14$	$21.89^{e}\pm1.12$	$22.46^{d}\pm0.10$
A		$29.55^{e}\pm0.34$	$28.65^{f}\pm0.32$	$19.48^{c}\pm0.12$
B	8	$33.82^{f}\pm1.18$	$17.49^{bc}\pm0.31$	$25.17^{f}\pm0.17$
C		$36.23^{h}\pm0.12$	$21.45^{e}\pm0.04$	$18.75^{c}\pm0.07$
A		$49.30^{i}\pm0.10$	$32.28^{g}\pm0.18$	$24.55^{ef}\pm0.06$
B	12	58.52k±0.16	$18.73^{cd}\pm0.13$	$23.36^{de}\pm0.25$
C		$35.04^{g}\pm0.08$	$16.42^{ab}\pm1.92$	$24.50^{ef}\pm0.03$
A		51.09j±0.19	$20.73^{de}\pm0.49$	$14.39^{b}\pm0.54$
B	16	64.21i±0.07	$36.77^{h}\pm0.72$	$18.90^{c}\pm0.07$
C		$33.53^{f}\pm0.21$	$15.30^{a}\pm0.10$	$28.27^{g}\pm0.04$

Result shows mean±SE of triplicate readings (n=3). A=Control; B=10% Gum Arabic and 3 mL cinnamon oil; C=10% Gum Arabic. Bars with unshared alphabet are significantly different (p<0.05)

CONCLUSION

The study has revealed that 10 % Gum Arabic coating is an effective storage medium for scotch bonnet fruits, while the presence of Cinnamon essential oil helps to maintain the nutritional contents and as well slow down the ripening rate.

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MANAGEMENT OF BACTERIAL WILT OF TOMATO (*Solanum lycopersicum* L.) USING CALCIUM-RICH SOIL AMENDMENT

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ABSTRACT
The study focused on the management of bacterial wilt disease in tomato plants caused by Ralstonia solanacearum. Current control methods have limitations, such as environmental and human health risks associated with chemical control. The effect of soil amendment with calcium-rich chicken eggshell powder on disease management was investigated. Bacterial isolates were collected from wilting tomato plants and identified as R. solanacearum. Pathogenicity tests showed that two isolates, along with a reference isolate, caused severe wilting in tomato cultivars. Soil was amended with three levels of chicken eggshell powder at 5, 10 and 15% and two tomato varieties (Beske and Roma VF seedlings were inoculated with the virulent bacterial pathogen and transplanted into soils in 5 kg pots replicated four times. The study found that treating Roma VF tomato seedlings with 5% eggshell powder resulted in the highest seedling vigor, and lower disease incidence compared to other treatments. The findings suggest that chicken eggshell powder can be a cost-effective and environmentally friendly approach for managing bacterial wilt disease, but further research is needed to determine optimal application rates.
***Keywords**: Bacterial wilt, disease incidence, Ralstonia solanacearum, chicken eggshell powder.*

INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is a flowering plant in the nightshade family, known for its edible fruit (Petruzzello, 2018; Quinet *et al*., 2019). It originated in South America and was later introduced to Europe and other parts of the world (Petruzzello, 2018). Tomato fruits are rich in vitamins and phytochemicals, particularly lycopene, which gives them their characteristic red color (Dasgupta and Klein, 2016; Quinet *et al*., 2019; Story *et al*., 2010). They are the second most important fruit or vegetable globally, with a production of 182.3 million tonnes annually (FAOSTAT, 2019). Nigeria is the largest tomato producer in sub-Saharan Africa (Umar, 2019; Ibirogba, 2021). Vascular wilt disease is a significant threat to tomato production worldwide. It can be caused by bacteria and by fungi such as Fusarium and Verticillium species (Rhoades, 2021). These diseases affect the plant's vascular system, leading to wilting and plant death. Bacterial wilt, caused by *Ralstonia solanacearum*, affects various plant species and causes symptoms like droopy foliage, stem collapse, and bacterial ooze (Champoiseau and Momol, 2009). Several management strategies have been developed to control bacterial wilt, including grafting, the use of biocontrol agents, biofumigation, and resistant varieties (Le *et al*., 2020; Pradhanang *et al*., 2003; Rivard *et al*., 2012; Suchoff *et al*., 2019). Chemical pesticides have also been used but have negative side effects. However, due to the pathogen's wide host range and genetic diversity, bacterial wilt management remains challenging. Integrated management approaches are commonly employed (Rahman *et al*., 2021).

Nutrient management, including the provision of essential nutrients, can contribute to disease control. Calcium is crucial for plant growth and plays a role in plant defense against pathogens (Liu *et al*., 2015). External application of calcium has been shown to enhance plant resistance to *R. solanacearum* in tomato and reduce disease severity caused by other pathogens (Jiang *et al*., 2013; Yamazaki *et al*., 1997, 1999, 2000). Calcium can be supplied to plants through chemical fertilizers or organic sources like eggshells, animal bones, or oyster shells (Hassani and Leverette, 2021; Rhoades, 2021). This study used calcium-rich soil amendment derived from chicken eggshells for the management of bacterial wilt in tomato plant. Therefore, the objective of this study was to evaluate the effects of eggshell-amended soil on seed germination, seedling vigor, and survival, and assessing the impact on disease severity and tomato growth.

MATERIALS AND METHODS

Experimental site: The research was conducted at the Roof Top Garden and Pathology research laboratory, Department of Crop Protection and Environmental Biology, University of Ibadan, Oyo State, Nigeria.

Soil and eggshell preparation and analysis: Topsoil was obtained from the Teaching and Research Farm, University of Ibadan and sterilized at 190°C for six hours, using an electrical soil sterilizer. Chicken eggshells were obtained from students' hostels in the University of Ibadan and local markets in Ibadan. The eggshells were washed with warm water to remove oil and dirt and then air dried. The eggshells were ground into fine powder and stored in plastic bags. Soil and eggshell samples were taken to the laboratory for physical and chemical analyses following standard laboratory routine procedure.

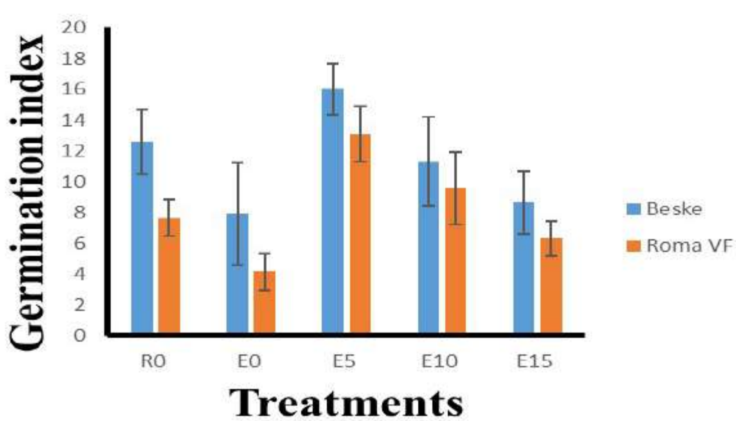
Isolation of *Ralstonia solanacearum* from infected plant samples: Wilting tomato plants were obtained from a tomato experimental field at the Federal College of Agriculture (Moor Plantation), Ibadan, Oyo State, the Crop garden in the Department of Crop Protection and Environmental Biology, University of Ibadan and a Tomato field at Ajibode, Ibadan, Oyo State. *Ralstonia solanacearum* was isolated from the infected tissues by suspending them in water and streaking on Triphenyl Tetrazolium Chloride (TTC) agar. Gram staining, Potassium hydroxide (KOH) solubility test, catalase test and tobacco hypersensitivity test were carried out on the isolates (Khasabulli *et al*. 2017; Pawaskar *et al*. 2014; Lozano and Sequeira, 1970).

Treatments and experimental design: The experiment was set up in a completely randomized design of four replicates consisting of two tomato varieties (Beske and RomaVF) sown in 2kg trays of eggshell treated (5, 10 and 15%) soil inoculated with *R. solanacearum*. The seeds were sown at fifteen seeds per tray. Two week old seedlings of the same varieties were also transplanted into 5kg of eggshell treated (5, 10 and 15%) soil in pots replicated four times.

Data collection and analysis: Germination data on the tray experiment was collected daily for three weeks and this was used to determine seedling vigour. The seedling vigour was determined by calculating the germination index using the following formula: $G.I = \frac{n}{d}$ where n represents the number of seedlings that emerge on day 'd' which represents the day after planting (Gupta, 1993). Data collection for the pot experiment was done weekly for eight weeks. Number of leaves and disease severity using a modified method of Ayana *et al*., (2011) were assessed. Data were analysed using Analysis of Variance (ANOVA) and means were separated using Fisher's LSD at 5% level of probability.

RESULTS

Identification of bacterial isolates from diseased tomato plants: Twelve bacterial isolates were obtained from the three sampling locations. Only five of the isolates (ART, ERT, JST, F4R and OST) were *R. solanacearum* exhibiting mucoid, fluidal and irregular colonies with pink centres surrounded by big white or cream-coloured margins. All isolates were pink coloured and rod-shaped indicating that they were gram negative. All isolates also formed a viscous elastic string when smeared in KOH and lifted with an inoculating loop. After 36 hours of tobacco leaf infiltration, the leaves presented with necrosis or browning in the middle surrounded by yellow halos, typical of Race 1 *R. solanacearum*.



R0 = Plants inoculated with *R. solanacearum* only
E0 = Eggshell powder at 0%
E5 = Eggshell powder at 5%
E10 = Eggshell powder at 10%
E15= Eggshell powder at 15%

Figure 1: Effect of chicken eggshell amendment on seedling vigour

Table 1: Effect of chicken eggshell amendment number of leaves of Beske and Roma VF at eight weeks after inoculation.

Treatments	Beske	Roma VF
R0	71.00a	74.00ab
E0	183.00b	79.33ab
E5	115.67ab	105.33ab
E10	73.67a	113.67b
E15	66a	53.33a
LSD	83.48	57.92

Means in the column with same letter are not significantly different (p>0.05)

Table 2: Effect of chicken eggshell amendment on disease severity in Beske plants weeks after inoculation

Variety	Treatments	Week 4	Week 5	Week 6	Week 7	Week 8
Beske	R0	2.25±1.44a	3.5±1.66b	3.5±1.66a	3.75±1.52ab	4.5 ± 1.00b
	E0	1±0.00a	1±0.00a	1±0.00a	1.25±0.29a	1.5 ± 0.58a
	E5	1±0.00a	1±0.00a	1±0.00a	1.25±0.29a	3 ± 0.94ab
	E10	1±0.00a	1±0.00a	2.25 ±1.09a	3±1.25ab	3.25± 1.19ab
	E15	1±0.00a	2±1.15ab	3.25±1.52a	4.5±1.37b	3.75± 0.82ab
	LSD	1.68	2.37	2.93	2.84	2.68
Roma	R0	1.5±0.58a	1.75±0.87a	1.75±0.87a	3.25±1.52a	5± 0.82b
	E0	1±0.00a	1±0.00a	1±0.00a	1±0.00a	1± 0.00a
	E5	1±0.00a	1±0.00a	1±0.00a	1±0.00a	1.5± 0.58a
	E10	1±0.00a	1±0.00a	1±0.00a	1±0.00a	2± 1.15a
	E15	1.75±0.87a	2±1.15a	2±1.15a	2.25±1.44a	2.2 ± 1.44a
	LSD	1.22	1.69	1.69	2.45	2.45

Means in the column with same letter are not significantly different (p>0.05)

DISCUSSION

Five isolates of *R. solanacearum* were obtained from infected plants exhibiting wilt symptoms. Two isolates showed virulent characteristics with mucoid pink-centred colonies and white edges, while the other three isolates had similar colonies but with thinner white edges. This correlates with the findings of Liu *et al* (2004) who described the colonies of virulent strains of *R. solanacearum* to be irregular, fluidal or highly mobile, humid with a pink spot in the middle surrounded by a large white edge while the avirulent strains possess more rounded colonies that are immobile, dry and grow on TTC as red-centred colonies with thinner or no white edge. Hypersensitivity tests revealed that all isolates belonged to race 1, characterized by brown necrotic regions with yellow halos and this is in agreement with the findings of Lozano and Sequiera, (1970), Lemessa and Zeller (2007) and Popoola *et al*. (2015) that symptoms of *R. solanacearum* belonging to Race 1 present as brown necrotic regions with yellow halos 36 hrs after inoculation. The tomato varieties used in the study exhibited wilting symptoms, indicating susceptibility to *R. solanacearum* as previously reported by Nwanguma *et al*. (2001), Popoola *et al*. (2015) and Tokpah (2019). Calcium-rich chicken eggshells were analyzed and found suitable as a soil amendment or calcium fertilizer for tomato growth (Ertürk, 2021). Treatment with 5% eggshell powder resulted in higher seedling vigor and better germination compared to controls. This indicates that calcium influences some seed quality parameters of tomato (Harish *et al*., 2016; Sajid, 2020). Also, the plants treated with 5% eggshell powder also showed improved growth performance in terms of leaf production. This might be explained by different bioactive chemicals found in eggshells, which have been reported to enhance tomato growth, yield, and quality (Taufique et al., 2014). However, treatment with 15% eggshell powder inhibited plant growth and led to stunted growth and fewer leaves, suggesting that higher concentrations of calcium can have adverse effects on plant performance.

CONCLUSION

In conclusion, poultry eggshells are cheap and organic sources of calcium that have potential as amendments for managing bacterial wilt. Chicken eggshells contain a substantial amount of calcium and have potential as an organic soil amendment and moderate levels of chicken eggshell powder can be employed for the control bacterial wilt disease, whereas high concentrations of calcium in tomato plants can cause toxicity and aggravate disease. Further studies to determine a more precise amount of chicken eggshell powder (application rate) that can be added to the soil which will be efficient for combating bacterial wilt disease without harming the plant are important.

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IMPACTS OF Tuta absoluta ON FOOD SECURITY STATUS OF TOMATO FARMERS IN KANO STATE

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ABSTRACT
This study examined the effects of Tuta absoluta on food security status of tomato farmers in selected local governments in Kano state. A sample size of sixty farmers was interviewed for the study through questionnaire. Result shows that the average age of the respondents in the study area is 34 years, 86.0% of the respondents were married, 92% are male, 65.0% had household size of between 6-10 persons and about 42.11% had spent 10-19 years in tomato farming. The logit regression analysis showed that intercept, age and T. absoluta invasion are significant at 1% while age and Tuta invasion are positively related to the food security status. Household size and marital status are also significant at 5% and they are negatively related to the food security status. It could be concluded that the farmers are impacted by infestation of T. absoluta, leading to a reduction in their income generation and a subsequent decline in food security. It is recommended that all stakeholders in the value chain should respond promptly by providing essential support to affected farmers.
Keywords: *Tuta absoluta, Food security, and Tomato farmers*

INTRODUCTION

The continent of Africa is still battling to eliminate hunger by 2030 while according to FAO (2019), the prevalence of food security in terms of African malnutrition has increased to 19.1% in 2019 compared to 17.6% in 2014. The issue of adequate food security in Nigeria has persisted as a crucial matter for attention by numerous government administrations over the years. (Ejikeme, 2017; Osabohien *et al*., 2020). According to FAO (2019), about 75% of the Nigeria population engaged in agriculture and the agricultural sector has about 90% of Nigeria's agricultural output is produced by small scale farmers (Ayinde *et al.*, 2020) while those farmers still depend on traditional system of farming that constrained them to have small level of income, low productivity and live below the poverty line. The low productivity has proven by Abdulazeez et al (2023) is mostly due to fragmented land ownership, over reliance on rain-fed agriculture, climatic change that breeds pests and illnesses, limited access to input, and a weak economic base. There is about one out of every five Nigerians were experiencing hunger 2020 (Osabohien *et al*., 2020). Similarly, Erokhin and Gao (2020) also reported majority of Nigerians live below the poverty level of 1.9 USD. The score of the Global Food Security Index (GFSI) of 2019 showed that out of 113 countries, Nigeria came in at position 94 and this makes the country to the most destitute nation in the world, surpassing India (Ayinde et al., 2020). Low level of food security can be traced to inability to meet the food demand although the larger population engaged in agriculture but the productivity is relatively low due to the damage caused by pests and diseases.

One of the major crops that many farmers cultivated is tomato in the northern part of the country. More than 70% of the tomato production in Nigeria comes from the northern states especially Kano and Jigawa states. Tomato production from these part of the country remains the hope for the country as it attracts high pricing during the dry season and this makes the tomatoes farmers to have high income due to high demand in the recent time, around 2015 when tuta absoluta invasion was experienced in the northern part of the country as the migratory pest that visited the country from the neighbouring country. According Abiola (2020), the estimated loss caused by tuta invasion is as much as total rampage of the tomato farm leaving the farmers with great loses. This study will focus on the effects of T. absoluta on food security status of tomato farmers as major objective. The justification of the study are the source of reference to minimize the possible scarcity of the tomatoes thereby instigating the foreign sourced of tomato from the neighbouring country and this will seriously affect the economic status of the farmers that have been dwelling in abject poverty.

METHODOLOGY

Study area

Kano State is situated between longitude 8° 31' 0.19" and latitude 12° 00' 0.43" north of the equator in Nigeria. About nine million people live there (National Population Commission (NPC), 2006) and the anticipated annual growth rate is 2.27%. (Raimi et al., 2020).

Method of data collection

A well-designed questionnaire was used to gather primary data on the social economic characteristics, demographic information, yield, food expenditure and other relevant information

Sampling procedure

A multiple-stage sampling approach was adopted to choose participants for the study. The first stage involves random choice of two Local Government Areas in Kano State were noted for their noteworthy tomato production. Five villages were chosen at random from the second stage's purpose sampling approach. These communities were; Bunkure town, Zango, Galadanci, Nasarawa, and Kuruma. In the third stage, simple random sampling technique was used select 60 tomato farmers for the study.

Model specification

Coping strategy Index

The Coping Strategies Index (CSI) was used to measures what tomato farmers do when they cannot access enough food due to low income from their tomato production. A simple numeric score is generated from a series of questions about how households deal with a shortage of food for consumption.

Probit model

Logit model will be deployed to the analysis on effects of T absoluta on food security status as one of the independent variables will be measure in binary method

$Y=a+b1x1+b2x2+b3x3+b4x4+b5x5+b6x6+b7x7+b8x8+ b9x9+ b10x10+ b11x11+\mathcal{E}$

Y = food security status (using Coping Strategy Index)
X1= size of the farm (hectares)
X2= Education (years of formal schooling)
X3 = Farming Experience (Years)
X4= Age of head (Years)
X5= Sex (Female = 0, Male = 1)
X6 = Household size (Actual number)
X7= Tuta absoluta infestation (yes = 1, No = 0)
X8= Marital status
ε = Error term

RESULTS AND DISCUSSION

The Table 1 below explains the demographic characteristics of the tomato farmers in the study area. The result revealed that the average age of the tomato farmers in the study area; 34, 92% are male, 86% of the respondents are married, the average household size is 9 persons, 36% of the respondents have primary school education, average farming experience of the respondents is 15 years and average farm size is 3.3 hectares and this revealed that the tomato production is still at small scale based on the specification of FAO (2019) that the commercial agriculture production for crop is about 10 hectares.

Table 1: Socioeconomic characteristics of the respondents in the study area

VARIABLES	FREQUENCY	PERCENT	MEAN
Age (years)			**34**
<20	2	3.33	
20 – 29	10	16.67	
30 – 39	27	45.00	
40 - 49	15	25.00	
50 – 59	6	10.00	
60 - 69	0	0.00	
Total	**60**	**100.0**	
Sex			
Male	55	91.67	
Female	5	8.33	

Total	**60**	**100.0**	
Marital Status			
Single	6	10.00	
Married	52	86.67	
divorce	0	0	
widow	2	3.33	
Total	**60**	**100.0**	
Household size (persons)			
1 - 5	13	21.67	
6 - 10	39	65.00	
11 - 15	6	10.00	
16 - 20	2	3.33	
Total	**60**	**100.0**	
Educational qualification			
No education	8	13.33	
Islamic education	11	18.33	
Primary education	22	36.67	
Secondary education	15	25.00	
Others	4	6.67	
Total	**60**	**100.0**	
Farming experience (years)			**15**
<10	14	23.33	
10 - 19	38	63.33	
20 - 29	5	8.33	
>29	3	5.01	
Total	**60**	**100.00**	
Farm size (Ha)			**3.3**
<1	3	5.00	
1 – 2.5	10	16.67	
2.6 – 5.0	41	68.33	
>5	6	10.00	
Total	**60**	**100.0**	

Table 2 explained the causes and effects of T. absoluta on food security status of the respondents. The R square explain the goodness of fit of the model which is about 85% (0.852) while adjusted R square explained the percentage of dependent variables explained by independent variables. The result showed that intercept, age and T. absoluta invasion are significant at 1% while age and Tuta invasion are positively related to the food security status but the intercept is negatively related. Household size is also significant at 5% and it is negatively related to the food security status while marital status is also significant at 5% but it is also negatively related to the food security status.

Table 2: Effects of Tuta absoluta on food security status of the respondents

Variables	*Coefficients*	*t Stat*	*P-value*
Intercept	-2.6E-18	-5.34581	4.17E-07***
Age	2.65E-20	3.300588	0.00126***
Sex	-1.5E-19	-0.51762	0.605646
Marital status	-3E-19	-2.09201	0.038478**
Household size	-2.4E-20	-2.60765	0.010235**
Educational qualification	-3.1E-20	-0.55725	0.578358
Farming	0	0	1.000000

experience			
Farm size	4.81E-20	1.242197	0.216508
Tuta invasion	0.004167	2.42E+16	0.00000***

CONCLUSION

T. absoluta infestation has been affecting the farmers in terms of their revenue generation which has influenced the level of food security. Despite the declining in food security status of the tomato farmers, the current infestation of T. absoluta does not allow the farmers to produce what is sufficient to meet their need not to talk of having marketable surplus for sales. High loss of tomato will increase the level of poverty of the tomato farmers and farming households. The recommendation are for the swift response from all stakeholders along the value chain to provide the necessary aids for the farmers especially through grant and training of extension agents thereby enlighten farmers on how to prevent the destructive T. absoluta. In as much as crop diversification is not the best but the farmers have to find crop of economic worth so as to absorb the shock in the industries.

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ECONOMIC ANALYSIS OF CITRUS PRODUCTION IN IBADAN FROM 2018 TILL 2022

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ABSTRACT
This paper examines the economic analysis of citrus production in Ibadan, Nigeria from 2018 to 2022. The profitability of orange production is affected by production costs as well as inflation and interest rates over time. Primary data were collected from 100 orange farmers in Ibadan. The average farm size is 4 hectares. Costs of production in Ibadan over 5 years are presented, Revenue per hectare ranged from 3.7 million naira in 2018 to 3.8 million naira in 2022. Using a discount factor (r = 0.11), the discounted revenue declined from 2.7 million naira in 2018 to 1.8 million naira in 2022. The benefit-cost ratio declined from 3.4 in 2018 to 1.5 in 2022. It was concluded that orange production is profitable but profitability declines when taking into account the temporal value of money and inflation. The study recommended that farmers should consider the time value of money for production decisions.

INTRODUCTION
The citrus fruits are part of the same family of fruits as tangerines, oranges, lemons, and limes. In terms of international trade, citrus fruit is the fruit crop with the highest value (Olife et al, 2015). Citrus is one of the most widely grown fruit trees in sub-tropical Africa. Acording to new world encyclopedia, the family which orange belongs to is Rutaceae and it contains various species among which is Citrus sinensis which is also known as sweet orange. Orange reproduces asexually (apomixis through nucellar embryony); Orange variants develop as a result of mutations (Orange fruit, 2018). A region that includes Southern China, Northeast India, and Myanmar is where the orange first appeared, (Talon, 2020). Fresh orange fruit or oranges that have been processed for their juice or fragrant peel can both be consumed (GRIN, 2017). Citrus was introduced to Nigeria and has since fully adapted. It is now a part of the country's cropping systems, notably in areas between latitudes 6oN and 9oN. Nigeria has a huge comparative advantage and the potential to dominate global citrus production and trade due to the variety of ecological and climatic conditions that are favorable for the production of citrus. As of 2020, orange accounted for two-third of citrus production (FAO,2021).
Orange is a perennial crop that fruit two times in a year and it has economic lifespan of 30 years although it can produce for about 100 years (Musasa et al., 2015). In 2021, sweet orange yield for Nigeria was 48,419 Kg per ha (knoema, 2021) Trend of sweet orange yield is on geometry rise for about 20 years after which it will maintain the yield for about five to ten years. Justification of this study is that despite the several works that have been done on profitability but less to no attention has been given to inflation rate and interest rate especially for perennial crops. As the price level of orange is increasing, so as the cost of production but not at the same rate. Objective of this study is to examine the profitability analysis of the sweet orange production in Nigeria. The labour wages have not been increasing in the same proportion with the interest rate and this can be traced to high level of unemployment. According to law of demand, surplus in supply gives room to the decline in the price of labour used in the production of orange. According to IMF (2022), Inflation is expected to reach 11.5 percent on average in 2027. This indicator measures inflation based on the annual change in the average consumer price index, as defined by the International Monetary Fund.

METHODOLOGY
Study area
The study was carried out in Ibadan of Nigeria. The area lies between longitude 7°23′47″N and latitude 3°55′0″E with a total land area of about 77,800 km2 and a projected population of with a total population of 3,649,000 as of 2021 (NPC, 2022).
Method of data collection

Primary data was collected with the aid of a well-structured questionnaire which was administered to the Orange farming household head in particular to collect the social economic characteristics, costs, revenue, and other relevant information.

Sampling procedure

A multistage sampling procedure was used in selecting the respondents for this study. The first stage involved a purposive selection of two (2) local government areas that have large area of farm settlements where orange is being cultivated (Ido and Akinyele local government areas). Stratified sampling method was used in selecting 5 wards from each local government and random selection of 10 orange farming household heads was selected.

Model specification

Time value of the money was captured with discounted factor. The trend of real value of income

$$\frac{Bt \div TC}{(1 + r)\, t}$$

Where r = inflation rate.

t = time.

Bt = revenue from each year

TC = total cost

Trend of cost is on arithmetic progression increase at #5,000 increments in every five years, n making it #1000 rises in labour cost on yearly basis.

Cost for a particular given year will be expressed as:

Cost for year n = a + (n-1)d

Where

a = the first year cost

nth year= year in consideration

d = common difference or yearly rise

RESULT AND DISCUSSION

The table 1 below explain the socio-economic characteristics of the respondents, the result revealed that majority of the respondents of about 89% are male, average age of the citrus orange farmer is about 47 years, the average household size is 4 persons, the average farm size is four hectares and about 57% have post-secondary education experience and this revealed that the citrus production in Ibadan is predominant by educated people.

Table 1: Distribution of the respondents based on their socio-economic characteristics

Variables	Frequency	Percentage
Gender		
Male	89	89.0
Female	11	11.0
Total	**100**	**100**
Age		
20 – 40	17	17.0
41 – 60	58	58.0
61 – 80	25	25.0
Total	**100**	**100.0**
Mean age	**47years**	
Household size		
1 – 5	61	61.0
6 – 10	33	33.0
11 – 15	6	6.0
Total	**100**	**100**
Mean	4 persons	
Farm size (hectare)		
1 – 5	58	58.0
6 – 10	39	39.0
>10	3	3.0

Total	**100**	**100**
Mean	**4**	
Years of education		
No education	6	6.0
Primary	7	7.0
Secondary	30	30.0
Tertiary `	57	57.0
Total	**100**	**100**

Source: 2023 survey

Table 2: Average cost of production

Inputs	Quantity/Ha/year	Per unit cost (#)	Total cost/ha/year
Seedling cost at the first year of production	100	900	90000
Weeding	5	22500	110000
Cutlass	8	2000	16000
Manure	100	100	10000
Sprayer	2	10230	20460
Go-to-hell	10	3500	35000
Security	12	10000	120000
Harvesting cost	20	2500	50000
Transportation	1	18000	18000
Marketing cost		60000	60000
Others		150000	150000
Clearing and stumping	1	150000	150000

Cost across the first five years of sweet orange production

Inputs	1st year total cost	2nd year total cost	3rd year total cost	4th year total cost	5th year total cost
Seedling	3000	3000	3000	3000	3000
Weeding	110000	130000	165000	180000	200000
Cutlass	16000	25000	32000	36000	41000
Manure	10000	12000	15500	23000	26000
Sprayer(deprec.)	4092	4092	4092	4092	4092
Go-to-hell	5000	5000	5000	5000	5000
Security	120000	120000	120000	120000	120000
Harvesting cost	50000	50000	55000	55000	60000
Transportation	150000	170000	200000	210000	220000
Marketing cost	20000	35000	50000	62000	70000
Others	150000	150000	150000	150000	150000
Clearing and stumping	150000	180000	200000	230000	270000
TOTAL	788092	884092	999592	1078092	1169092

Source: 2023 survey

Trend of revenue

Year	Yield (kg)	Revenue (#)	Discounted factor (r=0.11)	Discounted revenue
2018	36784.74	3678474	0.731191	2689667
2019	36895.04	3689504	0.658731	2430391
2020	37005.34	3700534	0.593451	2196086
2021	37115.64	3711564	0.534641	1984354
2022	37225.94	3722594	0.481658	1793017

Source: 2023 survey

The table 3 below revealed that citrus production is a profitable enterprise as the BCR within the trend of times has value greater than 1. It can also be inferred from the table that the BCR is on the decline taking the cognisance of time factor of money into consideration. And the elasticity of citrus is inelastic.

Table 3: Benefit Cost Ratio between the years

Year	Discounted revenue	Total cost	BCR
2018	2689667	788092	3.412885
2019	2430391	884092	2.749025
2020	2196086	999592	2.196982
2021	1984354	1078092	1.840617
2022	1793017	1169092	1.533683

Source: 2023 survey

CONCLUSION

The result of the economy analysis of sweet orange production is profitable although the profit is on the decline as the time value of money makes the increasing nominal revenue to be on the decline while comparing the real ratio of income to cost. Time value of money is a key factor that needs to be considered in analysing the economics of horticultural crops especially the perennial ones. Instead of assuming the nominal value throughout the production cycle, it is very essential to consider the real worth so as to guide the decision making with reference to opportunity cost. Nevertheless, government policy has a key role in determining the inflation and interest rate which influences the time value of money. Recommendation is that people have to take into consideration time value of money while analysing their profitability nature of their orchard before announcing the nominal profit that has not been into existence.

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EFFECT OF HEAVY METAL CONCENTRATION ON PERFORMANCE OF AFRICAN SPINACH 'GREEN' (*AMARANTHUS HYBRIDUS*) GROWN ON BURNT MUNICIPAL WASTE RESIDUE

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ABSTRACT
This study investigated lead and cadmium concentration in African spinach 'Green' grown on Burnt Municipal Waste Residue and the implications on human health. This experiment was conducted at the Screen House in the Department of Agricultural Technology of the Federal Polytechnic, Ado-Ekiti in September, 2019. Thirty plastic buckets were each filled with Burnt Municipal Waste soil obtained from refuse dumpsites in the school yard and Top soil was also collected under fallow vegetation. Ten seeds of Amaranthus were planted per bucket and later thinned to five plants per pots and watered to saturation every two days. Data collection started three weeks after planting. Parameters measured were plant height, number of leaves, Root weight, Root length, days to first inflorescence and Total plant biomass. In this experiment, only two Heavy metals of Cadmium (Cd) and lead (Pb) of human concern were analyzed for each of stem, leaves and roots of African spinach. Using data obtained from chemical extractions, different parameters such as soil-to-plant transfer factor (Plant Concentration Factor), the Health Risk Index (HRI) and the Daily Tolerable Intake (DTI) of sampled heavy metals were employed to assess and/or predict metal uptake by Amaranthus species. From the result, the heavy metal concentration in amaranthus grown on Burnt Municipal waste residue is hazardous and therefore detrimental to human health. It was recommended that Farmers should be educated and encouraged not to cultivate in farmlands around dumpsites since such farms may be polluted by toxic heavy metals.
Keywords: *African Spinach, Burnt Waste Municipal Residue, Heavy metal Concentration*

INTRODUCTION

There is increasing concern about heavy metals in the soil for their high toxicity to crops and aquatic organisms (USEPA, 1986). Heavy metals like Zn, Pb, Cu, Cd and Fe are essential components of many alloys but the metal content of the soil is the results of inputs from organic waste, agro chemicals, parent materials, fertilizers and other sources of pollutants lost through up-take and harvest, leaching and volatilization. Evidence from various studies suggests that daily consumption of vegetables can prevent the development of cardiovascular diseases and some cancers, especially gastrointestinal cancers (Islam 2016). However, the consumption of vegetables grown on heavy metal-contaminated soils can lead to harmful metabolic and physiological effects on human body (Khan *et al* 2015). It is well known that lead (Pb) and cadmium (Cd) are very toxic heavy metals for human health (Nagajyoti, *et al,* 2010, Alam *et al* 2018) that directly or indirectly enter human body. In Nigeria, analysis on heavy metals is rarely carried out in monitoring of vegetable quality before supply despite the incessant contamination of the soil from refuse sites. These metals that are generated as a result of contamination are considered to be toxic and may accumulate gradually in soil sediments which are taken up by plants, animals and by man through food chain. With time, the level or trace elements may become higher than the acceptable limits in human body and may be responsible for some chronic diseases that affect the population that lives around the area (Mahmud *et al*, 2020**,** Mahmood *et al* 2019).

Most plants and animals depend on soil as a growth substrate for their sustained growth and development. In many instances, the sustenance of life in the soil matrix is adversely affected by the presence of deleterious substances or contaminants. The entry of the organic and inorganic form of contaminants results from disposal of industrial effluents (Gowd *et al*., 2010). The contamination of soils with heavy metals or micronutrients in phytotoxic concentrations generates adverse effects not only on plants but also poses risks to human health (Matthews-amune, *et al.,* 2018). Abandoned waste dumpsites have been used extensively as fertile grounds for cultivating vegetables, though research has indicated that the vegetables are capable of accumulating high levels of heavy metals from contaminated and polluted soils. Among the environmental pollutants, heavy metals represent a significant hazard to the environment, being both an ecological and health risk. Adiku, and Okoffo, (2015). These elements are highly persistent and not biodegradable contaminants, therefore, they accumulate in soil, then becoming accessible to plants or leaching to groundwater (Osma *et al*., 2012). The soil contamination by heavy metals can transfer to food and ultimately to consumers. For instance, plants accumulate heavy metals from contaminated soil without physical changes or visible indication, which could cause a potential risk for human and animal (Osma *et al*., 2012).

Based on its persistent and cumulative nature, as well as the probability of potential toxicity effects of heavy metals as a result of consumption of leafy vegetables and fruits, there is a need to test and analyse this food item to ensure that the levels of these trace elements meet the agreed international requirements. An index of metal phytoavailability frequently used in environmental monitoring is the degree to which an extractable solid-phase quantity is correlated with measured tissue concentration (Wang *et al*., 2011). Using data obtained from chemical extractions, different parameters such as soil-to-plant transfer factor, the translocation index, mobility factor and regression models have been used to assess and/or predict metal uptake by Amaranthus species (Chinyere and Madu, (2015). The present study was aimed at examining the effects of different heavy metals particularly Cd and Pb grown on Burnt Municipal Waste Residue as it affects the performance of African Spinach 'Green'.

METHODOLOGY

Site description

This experiment was conducted at the screen house in the Department of Agricultural Technology of the Federal Polytechnic, Ado-Ekiti in September, 2019 to examine the effect of Heavy Metal Concentration on performance of African Spinach 'Green' (Amaranthus hybridus) Grown on Burnt Municipal Waste Residue

Establishment of *Amaranthus hybridus*

Thirty plastic buckets were each filled with Burnt Municipal Waste soil obtained from refuse dumpsites in the school yard where household solid waste was dumped and Top soil was also collected under fallow vegetation. The total plastic buckets used were sixty and these were perforated at the bottom to allow for easy water percolation. The plastic containers were arranged in a randomized complete design with four replications. Seeds of African Spinach were obtained from Agricultural Development Programme. (ADP) at the Seed Processing Unit in the Ministry of Agriculture, Ado- Ekiti. Ten seeds of Amaranthus were planted per bucket and later thinned to five plants per pots and watered to saturation every two days.

Date collection

Data collection started three weeks after planting. Parameters measured were plant height, number of leaves, Root weight, Root length, days to first inflorescence and Total plant biomass. Three plants were randomly selected and tagged from each treatment and counted for data collection. The experiment was terminated at the eleventh week after planting after which the total plant biomass were harvested and weighed. In this experiment, only two Heavy metals of widespread concern to human health were analyzed for each of stem, leaves and roots of African spinach grown on top soil and burnt municipal waste residue**.** Leaf samples were collected from plants grown on top soil and soil obtained from burnt municipal waste residue and analyzed for elemental elements of Ph, N, P, Na, K, Ca, Mg and Organic carbon. Using data obtained from chemical extractions, different parameters such as soil-to-plant transfer factor (Plant Concentration Factor), the Health Risk Index (HRI) and the Daily Tolerable Intake (DTI) of some sampled heavy metals were employed to assess and/or predict metal uptake by Amaranthus species (Ahmad-Mahir *et al*., 2009).

Preparation of Soil and African Spinach samples

A. Digestion of soil sample

1g of soil sample each were weighed into a conical flask and digested in a fumed cupboard with a mixture of 25ml of HNO_3 (Conc) and 4ml of $HClO_4$ for 30min until white fumes were observed. This was filtered using filter paper and funnel into a 100ml volumetric flask and made up to the mark with distilled water. The metals where determined by Atomic absorption spectrophotometer.

B.Digestion of African Spinach sample

0.5g of fine powder of leaf, stem and root samples were weighed into conical flask and digested into 4ml per chloric acid, 25ml Nitric acid and 2ml Sulphuric acid under fume hood. The contents were mixed and heated at low temperature to medium heat on heating mantle. The heating was continued until dense white fumes appeared. The samples were then heated for 30 seconds on the same heating mantle at medium heat after which the solution was cooled and filtered completely in volumetric flasks. The solution was then stored and ready for the determination of metals using Atomic absorption spectrophotometer.

RESULT AND DISCUSSION

Pre-Soil Chemical Properties of Burnt Municipal soil and Top soil at Screen house

Table 1 shows the pre soil chemical properties of Burnt Municipal Waste Residue and Top soil at the screen house. Organic carbon and Nitrogen were higher in Top soil as shown in Table 1 while values of K, Ca, Mg and P were considerably greater in Municipal refuse soil. Organic matter may have been burnt up in Municipal refuse soil. This may have accounted for its low Nitrogen and Carbon content.

Effect of Municipal Waste Residue and Top soil on growth and yield of *Amaranthus hybridus*

The use of Municipal waste significantly increased plant height, root weight and total plant biomass. There was however no significant difference in the values of number of leaves and root length for amaranthus planted on Top soil and Burnt Municipal Waste Residue. Days to inflorescence were however shorter for amaranthus planted on Top soil over Municipal Waste Residue as presented in Table 2

Effect of Municipal Waste Residue and Top soil on Elemental Leaf Nutrient Composition *of Amaranthus hybridus*

The effect of treatments on elemental nutrient composition is presented in Table 3. The result shows that the leaf nutrient composition was significantly higher for P, Ca, Mg and Available P in amaranthus planted on Municipal Waste Residue while Nitrogen was significantly higher in Top soil.

Average Chemical Properties of some heavy metals present in leaf, stem and root of Amaranthus hybridus planted on Burnt Municipal Refuse Soil

Table 4 shows that the high concentration of heavy metals is located in the root region of the vegetable plant both for Cadmium (Cd) and Lead (Pb) respectively (1.725, 6.941). The concentration of heavy metals were however lower in the leaf region for both Cd and Pb. This is because heavy metals are more concentrated in the soil and are therefore easily absorbed into the root zone. These was however Not Detected in amaranthus planted on Top soil as presented in Table 5

Average levels of Cd and Pb present in the soil of Burnt Municipal Refuse Soil and Top soil

Table 6 indicate that the level of Cd and Pb in the soil of Burnt Waste Residue to be 1.604 and 4.887 respectively while these values were detected in Top soil

Tolerable intake value of Cadmium and Lead for Adult (WHO, 2007)

Table 7 shows the WHO (World Health Organization, 2007) provisional tolerance weekly intake (PTWI) of cadmium (0.007mg/kg) and Lead (0.025mg/kg) per body weight. This table was exacted from WHO (2007) fact sheet to compare and contrasts with the result in Table 4 and 5 to know how safe or hazardous is consumption of the leaf of amaranthus harvested from burnt municipal waste soil. The result shows that heavy metal concentration in burnt soil is detrimental to human health. Concentration of Cd and Pb has exceeded the safe level for human consumption in soil containing burnt municipal waste residue.

Provisional Tolerable Weekly Intake (PTWI) in mg/kg per body weight

Means the quantity of heavy metal intake for one kg body weight while mg content for Cd or Pb from this study shows that mg quantity of Cd or Pb that will be found in one kg weight of leaf which is one of the edible part of spinach. Therefore, from WHO, 2004 recommendation of at least 400g of fruit and vegetable intake per day, equivalent to (2800g/person/week), 2.8kg of leaf will be assumed to be the quantity by a person of 1kg body weight will be estimated as follows;

Cadmium leaf content obtained from Table 4 is 0.554, therefore,

Cadmium leaf content (0.4mg/kg) = 1.554 x 0.04 = 0.063mg/kgbw

Lead leaf content obtained from Table 4 is 4.20, therefore,

Lead leaf content (0.4mg/kg) = 4.20 x 0.04 = 0.168 mg/kgbw

Using these values of 0.063mg/kgbw and 0.168 mg/kgbw as probable intake value of cadmium and lead respectively, the values in Table 7 were obtained by dividing these values by the body weight of 10 to 1000kg.

Risk factor assessment

Transfer factor

Metal concentrations in the extracts of soils and plants were calculated on the basis of dry weight. The plant concentration factor (PCF) was calculated as follows:

From Table 4 and 7 values of concentration of cadmium and lead of amaranthus leaf and soil grown on burnt municipal waste residue,

$$PCF = \frac{\text{Concentration of (plant)}}{\text{Concentration of (Soil)}}$$

Where PCF is the plant concentration factor.

For cadmium =1.554/1.604 =0.969

For lead =4.200/4.887 = 0.859

The plant concentration factor for cadmium and lead is 0.969 and 0.859 respectively

(Wang *et al,* 2005)

Health risk index (HRI)

The health risk index (HRI) for the locals through the consumption of contaminated vegetables was assessed based on the food chain and the reference oral dose (RFD) by WHO/FAO standards for each metal. The HRI <1 means the exposed population is assumed to be safe.

Metals of Cd and Pb have been reported with high tendency of binding tenaciously to organic matter contained in the soil. Hence, the organic matter of soil is known to play a major role in determining the bioavailability of heavy metals. (Ahmed *et al.,* 2018). Alam *et al*. (2019) opined that the concentrations of Cd in this study were highly significant. Haque *et al*. (2018) studied on heavy metals in tomato and high concentration of Cu (43.10 mg/kg) was noticed (Ahmed *et al* 2018). Furthermore, the highest concentration of Cr was observed in tomato (380.20 mg/kg). These fruit vegetables were cultivated in industrial waste soil where the average value of Cr was found 79.43 mg/kg which was higher than the world safe limit (70 mg/kg) (Begum *et al.,* 2019). This value was above the safe limit (2.30 mg/kg) recommended by joint FAO/WHO due to the presence of higher concentration of DTPA (Diethylene triamine penta acetic acid) in soil Haque *et al*, 2018, Akram *et al.,* 2015, Rahman *et al*. (2020) determined the heavy metal concentrations in vegetable samples available in Bangladesh. The average value of Mn, Fe, Cu, Zn, Cd, and Pb were measured 30.83, 429.27, 9.91, 32.19, 0.58, and 8.88 mg/kg, respectively in vegetables. It was found that the mean concentrations of Zn (32.19 mg/kg), Cd (0.58 mg/kg), and Pb (8.88 mg/kg) were above the safe limit. Among these metals, the highest amount of Fe was found in red spinach (807.12 mg/kg).

This study also showed that Fe is more abundant in leafy vegetables. The content of Fe in leafy, fruit, and root vegetables were 659.14, 358.60, and 270.07 mg/kg, respectively Rahman and Rahman (2020). The lowest concentration was found for Cd (0.12 mg/kg). The level of all the metals was above the safe limit. As a result, long term exposure to these metals interrupts the biological processes in human body Ahmed *et al* (2018). Islam *et al*. (2015) assessed the heavy metals concentrations in vegetables in the vicinity of industries and observed that the mean concentrations of Ni (3.23 mg/kg), Cu (11.75 mg/kg), as (0.80 mg/kg), and Pb (0.83 mg/kg) were above the reference limits. Islam *et al*. (2016) concluded that the mean values of as (0.24 mg/kg) and Cd (0.06 mg/kg) exceeded the permissible limits

In this study, the average concentrations of the heavy metals were below the safe limit. However, Cd was non-essential element of human health with high biological toxicity which mainly accumulates in surface soil (Iqbal and Khan, 2019). Its concentration should be monitored. High concentration of heavy metals are present in the root of amaranthus hybridus based on Table 7 that showed the provisional Tolerable Weekly Intake (PTWI) of cadmium (0.007mg/kg) and lead (0.025mg/kg) per body weight. WHO (World Health Organization, 2007). From the result, the heavy metal concentration in amaranthus planted on Burnt Municipal waste residue is hazardous and therefore detrimental to human health (Adeyemi *et al*, 2019)

CONCLUSION AND RECOMMENDATIONS

The most adverse effect of heavy metals is that they can be introduced into the food chain and threaten human health. Agricultural products growing on soils with high metal concentrations are represented by metal accumulations at levels harmful to human and animal health as well as to the bio-environment. The concentration of lead and cadmium were high in burnt municipal waste residue. Also the health risk index (HRI) for the locals through the consumption of contaminated vegetables was assessed based on the food chain and the reference oral dose (RfD) by WHO/FAO standards for each metal calculated in the table above using USEPA model is less than 1 means the consumption of these vegetables as food may not pose immediate danger to humans but prolonged consumption could lead to bioaccumulation and adverse health implication especially for Cd and Pb. It is therefore recommended that monitoring of heavy metals in plant tissues is essential in order to prevent excessive build up of these metals in human food chain

It is also suggested that those wastes that pose greater health hazards be properly recycled in order to reduce environmental pollution and/or soil degradation. Sorting of wastes at source and statutory regulations of wastes managements should be encouraged. Farmers should also be educated and encouraged not to cultivate in farmlands around dumpsites since such farms may be polluted by toxic heavy metals.

Table 1: Pre-Soil chemical analysis at experimental site for Top soil and Burnt waste residue

Chemical Properties	**Top soil (Value)**	**Burnt waste (Value)**
PH **(H2O)**	6.90	5.90
Nitrogen (g/kg)	0.42	0.07
Available Phosphorus (mg/kg)	3.73	6.73
Exchangeable Na (cmol/kg)	1.40	2.80
Exchangeable K (cmol/kg)	0.22	4.08
Exchangeable Ca (cmol/kg)	2.27	5.54
Exchangeable Mg (cmol/kg)	3.20	5.50
Organic carbon (g/kg)	5.50	3.10

Table 2: Effect of Municipal Waste Residue and Top soil on growth and yield of *Amaranthus hybridus*

Parameters	Municipal Waste	Top Soil	LSD
Plant Height (cm)	30.60	23.16	4.70
Number of Leaves	16.20	15.90	NS
Root Weight (g)	17.30	13.80	1.20
Root Length (cm)	10.34	11.16	NS
Days to Inflorescence	45	37	5.3
Total Plant biomass (kg)	3.5	2.4	0.53

NS-Not significant

Table 3: Effect of Municipal Waste Residue and Top soil on Elementary Leaf Nutrient Composition of *Amaranthus hybridus*

Parameters	Municipal Waste	Top Soil	LSD
Nitrogen %	2.63	3.59	0.02
Sodium (cmol/kg)	0.51	0.31	NS
Potassium (g/kg)	0.80	0.41	0.25
Calcium (cmol/kg)	3.39	1.56	1.09
Magnesium (cmol/kg)	2.78	1.10	1.36
Available P (mg/kg)	1.21	0.81	0.34

NS-Not significant

Table 4: Average Chemical Properties of some heavy metals present in leaf, stem and root of Amaranthus hybridus planted on Burnt Municipal waste refuse soil

Spinach parts used	Concentration of cadmium (cd) (mg/kg)	Concentration of lead (pb) (mg/kg)
Leaves	1.554	4.200
Stems	1.601	5.522
Roots	1.725	6.941

Table 5: Average Chemical Properties of some heavy metals present in leaf, stem and root of Amaranthus hybridus planted on Top Soil

Spinach parts used	Concentration of cd (mg/kg)	Concentration of pd (mg/kg)
Leaves	ND	ND
Stems	ND	ND
Roots	ND	ND

ND: Not detected

Table 6: Average levels of Cd and Pb presently in Top soil and Burnt Municipal waste residue

Treatments	Concentration of Cd (mg/kg)	Concentration of Pd (mg/kg)
Top soil	ND	ND
Burnt Waste soil	1.604	4.887

Table 7: Showing tolerable intake value of Cadmium and Lead for Adult (WHO, 2007)

Hazard	PTWI (mg/kgbw)
Cadmium (Cd)	0.007
Lead (Pb)	0.025

Table 8: Showing permissible level of heavy metals to human body weight

Body weight (kgbw)	LCd/wk/mg (kgbw)DW	LPb/wk/mg (kgbw)DW
10	0.006	0.0168
20	0.003	0.0084
30	0.002	0.0056
40	0.002	0.0042
50	0.001	0.0034
60	0.001	0.0028
70	0.001	0.0024
80	0.001	0.0021
90	0.001	0.0018
100	0.001	0.0017
PTW1	0.007	0.025

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PROFESSIONALISM, PROFESSIONAL BODY AND LANDSCAPE HORTICULTURE: DEVELOPING TRINITY IN NIGERIA HORTICULTURAL INDUSTRY

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ABSTRACT
The study provides an evaluation of the Nigerian Institute of Landscape Horticulturists as a professional body. The objective was to assess the Institute based on the parameters considered crucial for recognizing a profession. 145 respondents were selected. Data were collected with structured questionnaires; frequency and percentage analysis were used, while significant level ($p \leq 0.05$) was determined by tabulated Chi-square. Study revealed 5 types of the necessary parameters for recognizing a profession: knowledge and training (93.10%); autonomy (91.10%); effectiveness and utility (82.76%); ethical codes (82.07%) and legitimacy (83.45%). The Institute has challenges in area of professional identity and invasion of the profession by allied practitioners. An immediate implementation of the charter is required for the Institute.
***Keywords**: Profession, professionalism, practitioners, ethical codes and landscape horticulture*

INTRODUCTION
Professionalism is a character, spirit and methods that distinguish a profession from an amateur. Professionalism is associated with the development and use of a unique technical language by members. This language is acquired to distinguish it from any other form of activity (Hancock, 1974). A profession is said to be defined within a district body of knowledge which affords its members special and exclusive skills to rendering some societal services. The body of knowledge and skill must be distinct from existing ones. The members possess the special skill after attaining a prescribed level in training. Professionals are therefore adjudged to be capable of providing a certain service better than any other group and so constitute experts in their field (Artur, 2018).
Professional body is an institutionalized collection of practitioners or people, with a specialized skill, bounded together within some ethical codes designed to protect the public and perpetuate the social needs for the skill and services of its members (Fagbayide, 2002 Personal communications). Five parameters are considered crucial for recognizing a profession: knowledge and training, autonomy, legitimacy, ethical codes, effectiveness and social utility (Greenwood, 1957 and Storr, 2012). Rendering the history of an Institute such as that of the Nigerian Institute of Landscape Horticulturists is very vital to the great task of professionalism; the Nigerian Institute of Landscape Horticulturists was founded in 18th March, 1989 at Lagos State University (Durotola, 2000 Personal communications). Therefore, the assessment of the Institute such as the Nigerian Institute of Landscape Horticulturists based on the parameters considered crucial for recognizing a profession is very vital to an understanding of the present study.

METHODOLOGY
This consisted mainly of literature review; it encompassed review of the constitution of various professional bodies such as Nigerian Institute of Landscape Horticulturists, Nigerian Institute of Architects, Council of Registered Engineers of Nigeria, and Nigerian Institute of Town Planners. Journal article on the establishment of school ornamental horticulture, postharvest management of ornamental plants, books of the professional practice of landscape architecture, landscape principles and practices were also consulted (Rogers, 1997; Ingels, 2009 and Alabi, 2022). The data used in this research was obtained from the questionnaires administered around Ilorin metropolis. It also includes the gardens visited and its environs as well as personal interviews with workers and the professionals.
One hundred and forty-five (145) questionnaires were administered to people engaged in landscaping business. All the respondents were randomly selected form Ilorin metropolis; the questionnaires were

designed to gather information on the professionalism of landscape planning and development in Nigeria based on whether some parameters were necessary or not for recognizing a profession. The questionnaires were filled and retrieved on the spot. Data for the study were collected in two stages: primary data collection and secondary data collection. The primary data collection involved the observation of Ilorin metropolis for personal assessment, administration of questionnaires and interview of practitioners of landscape horticulture. The secondary data were obtained from published and unpublished sources. Frequency and percentage analysis were used, while significant level ($p \leq 0.05$) was determined by tabulated Chi-square (X^2).

RESULTS AND DISCUSSION

Assessment of professionalism based on knowledge and training

Table 1 shows that 93.10% of the respondents assessed the professionalism on the bases of knowledge and training as necessary, 5.52% as not necessary, and others like finance, management scores 1.38%. Therefore, the result shows that the Nigerian Institute of Landscape Horticulturists has not satisfied this parameter. Generally, for any professional body to qualify as a professional Institute, it must satisfy parameter such as knowledge and training. The extent to which this parameter is satisfied determines the professionalism of such body.

Table 1: Assessment of professionalism based on knowledge and training

Assessment	Frequency	Percentage (%)
Necessary	135	93.10
Not Necessary	8	5.52
Others	2	1.38
Total	145	100

Significant@X^2 ($p \leq 0.05$) = 5.99

Assessment of professionalism based on autonomy

Table 2 shows that 91.03% of the respondents support that autonomy is necessary for a profession to be recognized, while 8.28% says not necessary, others scored very low percentage. Professions are recognized on the degree of independence they possess in exercise of their professional expertise. Without being sentimental, no discipline is an Island to itself; every discipline has relatedness with others.

Table 2: Assessment of professionalism based on autonomy

Assessment	Frequency	Percentage (%)
Necessary	132	91.10
Not Necessary	12	8.28
Others	1	0.69
Total	145	100

Significant@X^2 ($p \leq 0.05$) = 5.99

Assessment of professionalism based on effectiveness and social utility

Table 3 shows that out of 145 respondents, 82.76% assessed the professionalism on the bases of effectiveness and social utility as necessary, while 15.86% says not necessary, 1.38% of the respondents have other criteria to be considered for recognizing a profession. Therefore, the Institute has to make a significant impact in this area by seeking a synergy with the Horticultural Society of Nigeria (HORTSON). Landscape horticulture as a profession, if not effective in some of places or sectors does not imply that it cannot be made effective. There is no profession that can claim perfect effectiveness. Given that landscape horticulture functions have social utility, what is required from the profession is to seek further for scientific techniques and methodologies apart from the design and planning techniques to make implementation more effective.

Table 3: Assessment of professionalism based on effectiveness and social utility

Assessment	Frequency	Percentage (%)
Necessary	120	82.76
Not Necessary	23	15.86
Others	2	1.38
Total	145	100

Significant@X^2 ($p \leq 0.05$) = 5.99

Assessment of professionalism based on ethical codes

Table 4 shows that 82.07% of the respondents considered ethical codes necessary for recognizing a profession, while those that considered it as not necessary amounts to 16.55% of the respondents. Therefore, for any profession to be recognized, ethical code is one of the crucial parameters to be considered. With regard to ethical codes, the Nigerian Institute of Landscape Horticulturists has a challenge with the effectiveness of this code because of lack of enactment by Federal Government of Nigeria to be chartered professional body.

Table 4: Assessment of professionalism based on ethical codes

Assessment	Frequency	Percentage (%)
Necessary	119	82.07
Not Necessary	24	16.55
Others	2	1.38
Total	145	100

Significant@X^2 ($p \leq 0.05$) = 5.99

Assessment of professionalism based on the legitimacy

Table 5 shows that 83.45% of the respondents confirmed that for any profession to be recognized the issue of legitimacy must be clearly stated and that is why the highest percentage of the respondents ascertained that legitimacy is one of the crucial parameter considered necessary for recognizing a profession, while 13.79% says not necessary, others considered administration, finance and non-chalant attitude as part of the parameters to be examined in professionalism of landscape horticulture. The Nigerian Institute of Landscape Horticulturists can be said to have satisfied this parameter, because they are registered by the Corporate Affair Commission (CAC) of Nigeria.

Table 5: Assessment of Professionalism based on the legitimacy

Assessment	Frequency	Percentage (%)
Necessary	121	83.45
Not Necessary	20	13.79
Others	4	2.76
Total	145	100

Significant@X^2 ($p \leq 0.05$) = 5.99

Assessment of the Invasion of landscape horticulture profession by other allied professionals

Table 6 shows that out of 145 respondents, 67.59% assessed the invasion of landscape horticulture profession by other allied professionals as significant and increasing, while 31.03% gave it significant and diminishing, 1.38% assessed it as not significant. However, in the history of any profession, invasion is customary hence the Nigerian Institute of Landscape Horticulturists is not unique in this sense. Therefore, the Institute has to make a significant impact in the area of reducing the rate of invasion by the other professional bodies.

Table 6: Assessment of the Invasion of landscape horticulture profession by other allied professional bodies

Assessment	Frequency	Percentage (%)
Significant & Increasing	98	67.59
Significant & Diminishing	45	31.03
Not Significant	2	1.38
Total	145	100

Significant@X^2 ($p \leq 0.05$) = 5.99

CONCLUSION

Research results revealed that some challenges are militating against the Nigerian Institute of Landscape Horticulturists. These problems include the problem of professional identity and the invasion of the profession by the allied practitioners such as architecture, engineering and town planning. Other identified problems are those of governmental policies and relatively young age of the Institute. From the findings, the future of the Institute is bright but it has a big task of strengthening its areas of weakness and intensifying its areas of strength. It is in the light of this that recommendations are made in the area of synergy with Horticultural Society of Nigeria in production and practices of horticulture, work towards professional identity, being chartered, application of plant architectural drafting and analysis, botanical science and artificial intelligence in the professionalism of the profession. An immediate implementation of the charter is required for the Institute to be renamed as Nigerian Chartered Institute of Landscape Horticulturists.

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YIELD PERFORMANCE OF OKRA (*Abelmoschus esculentus* L.) AS INFLUENCED BY WEED CONTROL AND INTRA-ROW SPACING AT AFAKA, KADUNA, NIGERIA

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ABSTRACT
A field trial was conducted at the experimental farm site of Federal College of Forestry Mechanization, Afaka, Kaduna to determine the effect of weed control treatments and intra-row spacing on yield and yield components of okra (Abelmoschus esculentus L.). The treatments consisted of three rates of butachlor 1.5, 2.5 and 3.5 kg a.i./ha, supplementary hoe weeding at 6 weeks after sowing (WAS), hoe weeded control at 3 and 6 WAS, weedy check and three intra-row spacings (60 × 15cm), (60 × 30cm) and (60 × 45cm). The treatments were arranged in a randomized complete block design (RCBD), replicated three times. The result showed that weed dry weight, number of fresh okra per stand, weight of fresh okra per stand and yield per hectare responded significantly to weed control treatments. However, intra-row spacing had significant effect on number of fresh okra stand, weight of fresh okra per stand and on yield per hectare. Based on the result obtained, butachlor at 2.5kga.i./ha and hoe weeded control plots with intra-row spacing of 60 × 30cm were suggested for okra production in the study area.
Keywords: *Okra, Performance, Spacing, Weed and Yield*

INTRODUCTION

Okra is native of tropical Africa. It is widely distributed and cultivated in the tropics and subtropics of the world for its tender and delicious green fruits which are cooked, canned and consumed (Falusi *et al*., 2012). The world's greatest producer of okra is India, producing 70% of the total world's production estimated to be 6 million tons per year (FAOSTAT, 2012) followed by Nigeria and Sudan (Vermudy, 2011). In Nigeria, okra ranks third in terms of consumption and production area following tomato and pepper (Odeleye *et al*., 2005).In Nigeria, despite the increase in demand of okra, the yield of okra is still low (2.7t/ha) compared to other countries such as India (10.50t/ha), Sudan (10.2t/ha), Egypt (15.7t/ha), Pakistan (7.6t/ha), Sudan (11.5t/ha) (Oyelade, *et al*., 2003) .The control of weeds only through manual labour has become very expensive, due to high labour cost and their unavailability at critical times (Swardekar and Fugro, 2017). Weed competition caused substantial yield losses (40 – 80%) which depends upon the type of weed flora, their intensity and stages (Sharma and Patel, 2011). Weeds are generally controlled by physical and cultural methods and hand weeding is the most efficient method of weed control. However, these methods are tedious, time consuming and laborious. The easiest way to control weeds is through herbicides which is quicker and cheaper as compared to other methods (Shamla, *et al*., 2017). One of the cultural practices that farmers use in controlling weeds in okra is spacing. When adequate plant spacing is used for planting crops, it enables crops to have a high yield as water and nutrients will be made available to the crops. Ogbaji (2001) reported that plant population obtained by inter and intra – spacing Is one of the factors that determines efficient profitable crop yield and land use. This study is aimed at determining the influence of weed control treatments and intra – row spacing on yield and yield performance of okra.

MATERIALS AND METHODS

The field experiment was carried out at the experimental farm site of Federal College of Forestry Mechanization, located at Afaka, Kaduna at the Northern Guinea Savannah ecological zone of Nigeria (Latitude 10° 37 N and Longitude 7° 17 E). The physical and chemical properties of the soil profile (0 – 15cm) of the experimental site was taken for analysis, prior to land preparation. The treatments consisted of three rates of butachlor 1.5, 2.5 and 3.5 kg a.i./ha, supplementary hoe weeding at 6 weeks after sowing (WAS), hoe weeded control at 3 and 6 weeks after sowing (WAS), weedy check and three intra – row spacing (60 × 15cm), (60 × 30cm) and (60 × 45cm). Giving plant populations of 11.111111, 5.555555556 and 3.703703704 respectively. The treatments were arranged in a randomized complete block design (RCBD) replicated three times. The gross and net plot sizes were 4.05m^2 (1.8m × 2.25m) and 1.35m^2 (1.8m × 0.75m) respectively. The okra seeds were planted in situ according to the different intra – row spacings of (60 × 15cm), (60 × 30cm), (60 × 45cm) with two seeds per hole. The herbicide butachlor was applied pre-emergence (a day after planting) using a knapsack sprayer with a green deflector nozzle at a swath width of 75cm, kept at a pressure of 2.1kg/m^2 to give a spray volume of 250l/ha. Harvesting of okra started two months after planting when the pods were still soft for consumption. Harvesting was done every five days which helped to stimulate more pods.

Data collected includes, weed dry weight, number of fresh okra per stand, weight of fresh okra per stand and yield per hectare. Data collected were subjected to analysis of variance (ANOVA) as described by Snedecor and Cochran (1967). The treatment means were separated using Duncan multiple range test (DMRT) (Duncan, 1955). The most common weed species observed at the experimental site and their intensity of occurrence is shown on Table 2. Broadleaf weeds infested the okra plots more than grasses and sedges. This result is in line with the findings of Mohammed and Suhair (2012), who worked on okra and reported that the weed flora in the experimental site consisted of grassy and broad-leaved weeds, but broad-leaved weeds were predominant.

RESULTS AND DISCUSSION

The physico-chemical analysis of the soil indicated that the soil was a sandy loamy soil, with 0.028 % for total nitrogen, 0.65% for organic matter percent and 1.352 for C.E.C (Table 1).

Weed dry weight g/m^2

Weed control treatments had significant effect on weed dry weight and intra – row spacing had no significant effect on weed dry weight. Weedy check plots recorded significantly higher weed dry weight than all the other weed control treatments. Hoe weeded control plots recorded significantly lower weed dry weight than all the other weed control treatments that were statistically at par to each other. Intra-row spacing had no significant effect on weed dry weight. Adekpe (2006), reported similar findings on garlic (*Allium sativum* L.), that the weedy check plots resulted in significantly higher weed dry weight than the hoe weeded control plots and the other weed control treatments and also reported that intra-row spacing had no significant effect on weed dry weight (Table 3).

Number of fresh okra per plant

Number of fresh okra per plant was significantly influenced by weed control treatments and intra-row spacing. From table 3, butachlor at 2.5kga.i./ha recorded significantly higher number of fresh okra per plants. This was followed by butachlor at 3.0kga.i./ha and hoe weeded control. The rest of the treatments were statistically similar to each other. This result is in line with the findings of Muhhtar *et al*., 2018 on okra, who reported that the herbicide treatments and the weed free treated plots significantly increased fresh okra pod yield as compared to the weedy full-treated plots. Intra-row spacing of 60 × 15cm gave significantly higher number of fresh okra per plants than the other intra-row spacings that were statistically similar to each other. Mahadeen (2008) reported similar findings in his research work that narrow inter-row spacings produced higher yield.

Weight of fresh okra per plant

Weight of fresh okra per stand was significantly influenced by weed control treatments and intra-row spacing. Hoe weeded control plots produced significantly higher weight of fresh okra per plants than the other weed control treatments that were statistically similar to each other. Intra-row spacing of 60 × 15cm and 60 × 30cm gave significantly higher weight of fresh okra per plants than the other intra-row spacing. This result is still in line with the findings of Mahadeen (2008) who reported in his research work that narrow inter-row spacings produced higher yield. (Table 4).

Yield per hectare

Yield per hectare was significantly influenced by weed control treatments and intra-row spacing. Hoe weeded control plots recorded significantly higher yield per hectare than the other weed treatments that were statistically similar to each other. Intra-row spacing of 60 × 30cm recorded significantly higher yield per hectare than the other intra-row spacings that were statistically similar to each other. Similar findings from Moniruzzaman *et al*., 2001 indicated that at the spacing of 60 × 30cm the plants obtained increased seed yield per hectare (Table 4).

CONCLUSION

From the result obtained in the study carried out at the experimental farm site of Federal College of Forestry Mechanization, Afaka, Kaduna, on yield performance of okra (*Abelmoschus esculentus* L.) as influenced by weed control treatments and intra-row spacing, butachlor at 2.5kga.i./ha and hoe weeded control plots, with intra-row spacing of 60 × 30 cm should be suggested for okra production in the study area.

Table 1: Physico-chemical Properties of the Soil (0 - 15 Cm) Depth at the Experimental Site Before Planting During 2022 Rainy Season at Afaka, Kaduna.

Composition	Values
Physical properties	
Sand (%)	74.3
Silt (%)	22.1
Clay (%)	3.6
Textural class	Sandy clay
Chemical properties	
Ph (H_2O)	6.4
Electrical conductivity (ds/m)	0.088
Total nitrogen (%)	0.028
Organic matter (%)	0.65
Organic carbon (%)	0.376
Calcium (Cmol/kg)	0.711
Magnesium (Cmol/kg)	0.055
Sodium (Cmol/kg)	0.05
Potassium (Cmol/kg)	0.025
Exchangeable acidity (Cmol/kg)	0.501
ECEC	1.352

Table 2: List of Common Weed Species and Level of Infestation at the Experimental Site at Afaka, Kaduna During the Rainy Season of 2022.

Types of weeds	Level of infestation
SEDGES	
***Cyperus difformis* Linn**	**[2]
Cyperus esculentus	**
Sataria pomica	**
GRASSES	
Elevine indica	*[1]
Imperata cylindrical	*
Physalis mimica	**
Boerharhaira diffusa	*
***Cynodon dactylon* Linn (pers)**	**
BROAD LEAVED WEEDS	
***Amarantus spinosus* Linn**	**
***Euphobia heterophylla* Linn**	***[3]
Ipoma cornea	**
***Ageratum conizodes* Linn**	**
Euphorbia hirta	**
Sida acuta	*

Ludwigia abysinia	***
Cannabis sativa	**
Solanum nigrum	**
Avena ludoviciana	**
Physalis minisa	**
Eclipta alba	**
Commelina benghalensis	***

Key: Level of infestation
1 – Low infestation
2 – Moderate infestation
3 – High infestation

Table 3: Effect of Weed Control Treatments and Intra-Row Spacing on Weed Dry Weight and Number of Fresh Okra (*Abelmoschus esculentus* L.) Per Plant During Rainy Season of 2022 at Afaka, Kaduna.

Treatments	Rate (kg a.i./ha)	Weed dry weight	Number of fresh okra per plant
Weed control treatments + SHW[2] @ 6 WAS			
Butachlor	1.5	21.08bc[1]	2.37b[1]
Butachlor	2.5	49.86b	4.86a
Butachlor	3.5	32.89bc	3.87ab
Hoe weeded control	-	19.42c	3.38ab
Weedy check	-	96.32a	2.13b
SE (±)	-	7.319	0.479
Intra-row spacing			
60 x 15cm		53.11a	13.93a
60 x 30cm		35.97a	11.53ab
60 x 45cm		42.97a	9.80b
SE (±)		5.669	0.841

[1]Means in the same column of treatments followed by unlike letter(s) are significantly different at p ≤0.05 using Duncan Multiple Range Test (DMRT).
[2]SHW = Supplementary hoe weeding

Table 4: Effect of weed control treatments and intra-row spacing on weight of fresh okra (*Abelmoschus esculentus* L.) per plant and yield per hectare during rainy season of 2022 at Afaka, Kaduna.

Treatments	**Rates (kg a.i./ha)**	**Weight of fresh okra per plant (g)**	**Yield per hectare (kg)**
Weed control treatments + SHW[2] @ 6 WAS			
Butachlor	1.5	6.78b[1]	31.10b[1]
Butachlor	2.5	7.00b	21.37b
Butachlor	3.5	8.22b	19.05b
Hoe weeded control	-	10.44a	44.67a
Weedy check	-	7.78b	25.03b
SE (±)		0.538	3.514
Intra-row spacing			
60 x 15cm		8.53a	22.39b
60 x 30cm		8.80a	43.35a
60 x 45cm		6.80b	19.00b
SE (±)		0.417	2.722

[1]Means in the same column of treatments followed by unlike letter(s) are significantly different at p ≤0.05 using Duncan Multiple Range Test (DMRT).
[2]SHW = Supplementary hoe weeding

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MARKET INTEGRATION OF MELON (*Cucumis melo)* IN RURAL AND URBAN MARKET OF KWARA STATE

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ABSTRACT
The study assessed market integration between urban and rural markets of shelled and unshelled melon in Kwara state. Data on yearly retail price from 2010-2021 were collected from Kwara State Agricultural Development Programme and analyzed using trend analysis, augmented Dicker-Fuller, Johansen maximum likelihood test and Granger causality tests. Findings showed that rural and urban shelled melon prices were co-integrated, indicating some long-run relationship, while unshelled melon prices were not co-integrated. Granger causality test found no evidence of short-run price transmission between rural and urban of shelled and unshelled melon markets. Findings also showed that the shelled market has some spatial integration but the unshelled market remains weakly integrated, implying inefficiencies in price transmission from urban to rural market. The study recommends promotion of adequate market information for price updates to improve linkages and thus free flow of market prices.
Keywords: *Market integration, shelled melon, unshelled melon, market linkages, price transmission*

INTRODUCTION

Cucumis melo, a fruit vegetable of economic importance, is a rich source of vitamins and minerals, consequently improving nutrition (Manchali *et al*., 2021), high in demand in urban markets (Ibironke and Oyeleke, 2014). In many parts of the world, including Kwara State, Nigeria, melons are an essential agricultural commodity. Rural areas of Kwara produce both shelled and unshelled melons, which are sold in urban markets, significantly contributing to the livelihoods of smallholder farmers (Oladimeji *et al*., 2016). Thus, efficient marketing of the commodity is imperative. Market integration refers to the degree of interrelation of prices for a specific commodity, such as melons, across geographically distinct markets (Rapsomanikis, 2015). By analyzing the co-movement of melon prices and the speed of price transmission, it is possible to gauge the level of market integration and efficiency of the supply chain (Ogundari and Ojo, 2018). Despite the market-oriented reforms implemented in Nigeria since the 1980s, market integration between rural and urban areas remains limited (Arowosegbe and Adedeji, 2006). Various studies have identified high marketing costs, underdeveloped infrastructure, and institutional constraints as key hindrances to greater rural-urban market integration (Liverpool-Tasie *et al.*, 2017). In a study conducted by Adeoye *et al*. (2013) in South-western Nigeria, it was found out that there is quick transmission of prices between urban and rural markets for Amaranthus and Corchorus, whereas there is slow transmission of prices information between urban and rural markets for okra because the flow of information regarding okra is not efficient.

However, limited research inquiry has been directed towards scrutinizing the market linkages that exist between rural areas that produce melons and urban wholesale and retail markets in Nigeria. Evaluating the spatial integration of melon markets would offer valuable proof regarding the areas that suffer from information flow deficiencies or coordination issues between rural producers and urban purchasers. The study therefore assessed the level of market integration between rural melon-producing areas and urban markets in Kwara state to provide useful insights into the efficiency of price signals along the supply chain.

MATERIAL AND METHODS

The study was carried out in Kwara State, Nigeria. Data on average yearly retail prices of *Cucumis melo* from 2010 to 2021 were obtained from the Kwara State Agricultural Development Programme. The study made use of trend analysis, augmented Dickey-Fuller (ADF) statistics, co-integration and Granger causality procedures to analyze the data. Trend analysis was used to examine the movements of the prices based on the historical data; this can be used to predict the future price movements. The augmented Dickey-Fuller (ADF) statistics was used to test for stationarity; this is done to avoid the problem of spurious regression. Johansen maximum likelihood test was used to test for co-integration to determine the number of co-integrating vectors present and finally Granger causality test was used to know the direction of causality.

RESULTS AND DISCUSSION

Trend analysis of shelled melon and unshelled melon

Price trend analysis of shelled melon in (figure 1), shows that the highest price at the rural market was observed in 2019 (N394.08/kg), similar trend was also observed in the urban market for the same year (N428.93/kg). Lowest price in shelled melon was observed in 2010 for the urban and rural market prices. For the unshelled melon in (figure 2), highest price was also observed in 2019 at the rural and urban market. Generally, there is fluctuation in the market prices of shelled and unshelled melon in both the rural and urban market. The higher prices in 2019 may be due to reduced supply in the market.

Augmented Dickey-Fuller (ADF) statistics for stationarity test

Stationarity test in (Table 1) shows that rural and urban prices for unshelled melon were not stationary at level l (0) but stationary at first difference l(1). However, the prices for the shelled melon were stationary at level l (0). Therefore, the null hypothesis for non-stationarity were accepted for the unshelled melon prices while it was rejected for the shelled melon prices. These are in line with the findings of Yusuf *et al*. (2006), who reported that commodity prices are stationary at first difference. Chirwa (2000) emphasized that without spatial price analysis of markets, price signals will not be transmitted from food-deficit to food-surplus areas, prices will be more volatile, agricultural producers will fail to specialize according to the long-term comparative advantages and the gain from trade will not be realized. When a time series is stationary, it means that certain attributes of the data do not change over time. However, some time series are non-stationary, whereby values and associations between and among variables do vary with time.

Co-integration Test for Shelled and Unshelled melon

The co-integration results (Table 2) using the Johansen maximum likelihood test showed that here is co-integration between rural and urban shelled melon prices, therefore null hypothesis of no co-integration was rejected indicating that there is connection between the rural and urban shelled melon prices in the market. However, there is no co-integration between the rural and urban market prices for unshelled melon, therefore, null hypothesis of no co-integration was accepted meaning that there is no link between rural and urban market prices for unshelled melon.

Granger causality test for Shelled and Unshelled melon

The results in (Table 3) indicates that the null hypothesis of rural prices of shelled and unshelled melon does not Granger Cause urban and rural prices of shelled and unshelled melon respectively were accepted, indicating that there was no causal relationship between rural and urban market prices for shelled and unshelled melon, i.e. price changes in one market did not result to price response in the other market.

CONCLUSION AND RECOMMENDATION

Rural and urban shelled melon prices are co-integrated while the unshelled melon prices are not co-integrated implying no market linkages. There is no evidence of short-run Granger causality of price transmission between the rural and urban market for either shelled or unshelled melon. The shelled melon market exhibits some degree of spatial integration, the unshelled melon market remains weakly integrated. The study recommends promotion of adequate information for price updates to improve linkages and thus free flow of market prices.

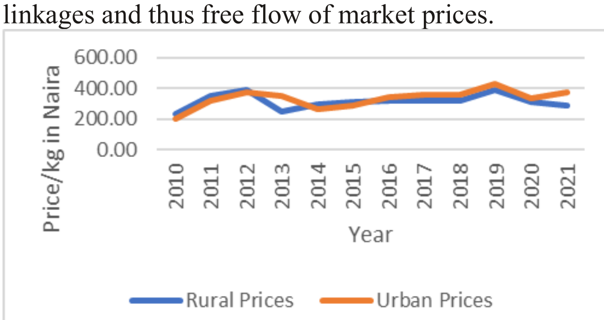

Figure 1: Price trend analysis of shelled melon

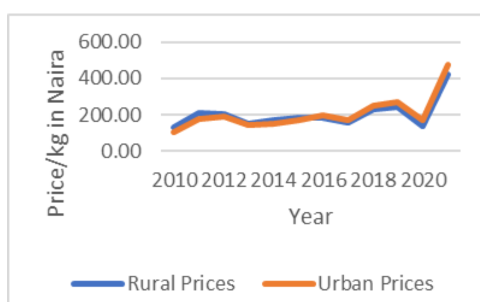

Figure 2: Price trend analysis of unshelled melon

Table 1: Result of the stationarity test for unshelled and shelled melon price series

Market price series	Level form I(0)		First difference I(I)	
Unshelled melon	ADF statistics	Remarks	ADF statistics	Remarks
Rural market	-0.546	Non-stationary	-4.611***	Stationary
Urban market	-1.284	Non-stationary	-4.065**	Stationary
Shelled Melon				
Rural market	-4.181	Stationary	-	-
Urban market	-3.398	Stationary	-	-

Source: Kwara ADP (2023)

Table 2: Result of Johansen maximum likelihood test for rural-urban market for shelled and unshelled melon

Market pairs	Hypothesized No of CE(s)	Eigenvalue	Trace statistics	5% CV
Rural-urban shelled melon	None*	0.939	33.139	15.494
markets	At most 1*	0.399	5.097	3.841
Rural-urban unshelled melon	None	0.717	12.812	15.494
markets	At most 1	0.018	0.186	3.841

*(**) denotes rejection of hypothesis at 5% (1%), CV-critical value
Source: Kwara ADP (2023)

Table 3: Granger causality test for melon shelled and unshelled

Null hypothesis	Observation	F-statistic	Prob.	Decision
RUPMS does not Granger Cause URPMS	10	0.378	0.703	Accept H_0
URPMS does not Granger Cause RUPMS		0.686	0.545	Accept H_0
RUPMU does not Granger Cause URPMU	10	1.854	0.249	Accept H_0
URPMU does not Granger Cause RUPMU		1.701	0.273	Accept H_0

Source: Kwara ADP (2023)

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EFFECT OF PLANT RESISTANCE ACTIVATORS ON GROWTH AND FRUIT YIELD OF TOMATO (*Solanum lycopersicum* L.)

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ABSTRACT
Tomato is the world most highly consumed vegetable. In order to fulfill customer's demand, it is essential to enhance tomato fruit output. The experiment was conducted to determine the effect of plant resistance activators on growth and fruit yield of two varieties of tomato (Perfect Pee, Pp and Roma round, Rr). The experiment was conducted in the DELPHE research screen house and Teaching and Research Farm of Federal University of Agriculture, Abeokuta, Nigeria. The plant resistance activators (Acibenzilar – S – Methyl, ASM, β- Aminobutyric acid, BABA, Salicyclic acid, SA and Acetyl Salicyclic acid, ASA) were applied at four levels (0, 25, 50, 75 µg/ml) by foliar spraying. Results of the study revealed that Pp and Rr treated with ASA at 50 µg/ml had the tallest plant heights ***(133 and 152.2 cm)*** *and (145.3 and 156.7cm) as well as number of leaves* ***(39.5 and 45.2) and (40.4 and 46.5)*** *in the screen house and on the field respectively. Also, Pp and Rr treated with 50 µg/ml in the screen house and on the field produced significantly higher (103g/plant and 34.4 ton/ha) and (116g/plant and 38.7 ton/ha) yield respectively. The study concluded that application of ASA at 50 µg/ml improved the growth and fruit yield of tomato and is therefore recommended to the farmers.*
Keywords*: Acibenzilar – S – Methyl, β- Aminobutyric acid, Salicyclic acid and Acetyl Salicyclic acid*

INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is native to tropical America, now grown all over the world (Arah *et al*., 2015). World annual production of tomato was 186.82 million metric tons (FAOSTAT, 2020). Nigeria is 14^{th} world and second largest producer of tomato in Africa with 3.69 million total tomato production after Egypt with 6.77 million metric tons (FAOSTAT, 2020). Tomato has become an important cash and industrial crop in many parts of the world (Ayandiji *et al*., 2011) not only because of its economic importance, but also due to its nutritional value to human health. (Popoola *et al.,* 2012).

Plant resistance activators (PRA_S) are agents that leads to improved protection against pathogen attacks by inducing the plant's own defense mechanism (Waiters *et al.,* 2013). PRA_S can be chemical compound as well as microbial or plant extracts. However, they seldom lead to full pathogen control (Waiter and Fountaine, 2009).

Poor yield resulting in low supply to meet the market demand, is a major constraint to tomato cultivation as a result of many factors which include increased incidence of microscopic phytopathogens such as bacteria, fungi and virus (Dennis, 2006). These microscopic organisms can be noticed in plants only when the symptoms manifest. However, there is dearth of information on the application of these chemical compounds in enhancing the performance of plants rather than a preventive measure against incidence of pathogens/diseases. Hence, the objective of this research work was to determine the performance and the appropriate concentration of plant resistance activator that will enhance growth and improve yield of tomato.

MATERIALS AND METHOD

Experimental sites

A screen house and field experiments were conducted at the DELPHE research screen house, Abeokuta and Federal University of Agriculture (FUNAAB) Teaching and Research Farm in Abeokuta, Ogun State, Nigeria respectively.

Experimental materials, treatments and experimental designs

The two tomato accessions, Roma round and Perfect pee, were obtained from the Plant Tissue Culture Laboratory, FUNAAB. Four Plant Resistance Activators; Acibenzilar – S- Methyl (ASM), Acetylsalicyclic acid (ASA), β- aminobutyric acid (BABA) and Salicyclic acid (SA) were sourced from Libertas store, Abeokuta, Nigeria.

Completely Randomized Design was used for the screen house experiment with three replications while Randomized Complete Block Design was used for the field experiment with three replications. The experiment consisted of two tomato accessions (Roma round and Perfect pee) at three levels (25, 50, 75 µg/ml) each of the four plant resistance activators (ASM, ASA, SA and BABA) and a control (where there was no application of PRAs)

Soil sterilization, Nursery establishment and Transplanting

A sandy loamy soil was collected and steam sterilized at 100 ºC for three hours. Before usage, the sterilized soil was placed inside sacks and allowed to cool for two weeks. Fifteen grams (15 g) of the sterilized soil was weighed and loaded in the nursery trays and tomato seedlings were grown and nurtured for four (4) weeks before transplanting. Four weeks old tomato seedlings were transplanted to plastic pots containing 9 kg sterilized soil and placed in the screen house. Two tomato seedlings were transplanted into each pot which was later thinned to one. There were seventy-eight pots altogether for the screen house experiment. Transplanting of tomato seedlings on the field was done on the already prepared land. The experimental plot size was 3 x 2 m^2 with 1 m border. Tomato seedlings were transplanted at 75 m x 50 cm spacing between and within rows. There are seventy-eight plots with sixteen plants per plot.

Preparation and application of plant activators

Each activator (ASM, ASA, SA and BABA) at three different concentrations of 25, 50 and 75 µg/ml was weighed and dissolved in sterile distilled water. Application of PRA_S was carried out at 4 days after transplanting and at weekly intervals for 4 weeks by foliar method. Control pots and plots received no treatment.

Data collection and analysis

Data collected on growth and yield parameters were subjected to analysis of variance (ANOVA), using Statistical Analysis System (SAS), 9.1 package. Means were separated using Duncan's Multiple Range Test ($p \leq 0.05$).

RESULTS

Effect of plant resistance activators on plant height of tomato

Table 1 shows the effect of plant resistance activator application on plant height of tomato in the screen house and on the field at six and eight weeks after transplanting (WAT). The screen house and field experiments' findings showed that tomato accession (Perfect pee) at concentration of 50 µg/ml of Acetyl Salicyclic Acid (ASA) were the tallest plants with the heights of (133 and 152.2 cm) which were significantly different ($P < 0.05$) from the control with the least plant heights (65.6 and 70.3 cm) in the screen house and field respectively at 8 WAT. Also, Roma round tomato variety treated with 50 µg/ml ASA has the highest plant heights (145.3 and 156.7 cm) which was significantly different ($P< 0.05$) from the least plant heights (72.9 and 79.3 cm) recorded for the control in the screen house and field respectively at 8 WAT.

Effect of plant resistance activators on number of leaves of tomato

Table 2 shows the effect of plant resistance activator application on number of leaves of tomato in the screen house and on the field at 6 and 8 WAT. The screen house and field experiment's findings revealed that Tomato accession Pp treated with50 µg/ml ASA gave the highest number of leaves (39.5 and 45.2) which was significantly different ($P < 0.05$) from the control with the least number of leaves in the screen house (19.2) and field (22.8) respectively at 8 WAT. Also, the Roma round tomato variety treated with ASA 50 µg/ml concentration had the highest number of leaves (40.4 and 46.5) which was significantly different ($P< 0.05$) from the least number of leaves (22.3 and 24.8) recorded for the control in the screen house and field respectively at 8 WAT.

Effect of plant resistance activators on fruit yield of tomato

Table 3 reveals the effect of plant resistance activator application on fruit yield of tomato in the screen house and on the field. The screen house and field experiment's findings revealed that Tomato accession Pp at 50 µg/ml ASA produced the highest fruit yield (103g/plant and 34.4 tons/ha) which was significantly higher ($P < 0.05$) compared to the least fruit yield (29.7g/plant and 16.6 tons/ha obtained from control in the screen house and field respectively. Similarly, Roma round (Rr) tomato variety treated with 50 µg/ml ASA produced significantly ($P< 0.05$) highest fruit yield (116 g/plant and 38.7

tons/ha) in comparison to the least fruit yield (38.9 g/plant and 19.6 tons/ha) recorded for the control in the screen house and field correspondingly.

DISCUSSION

The results obtained showed that all tested concentrations of ASM, BABA, SA and ASA have positive effect on tomato growth and fruit yield compared to the control experiment. However, 50 µg/ml ASA produced significantly higher ($P< 0.05$) growth and fruit yield compared to other activators used and the untreated experiment in both screen house and under the field condition correspondingly. This effect might be attributed to the fact that ASA diffuses more easily through the growth medium than others which are less water soluble. This supported the findings of Abd-El – Kareem (2002) who reported that spraying potato plant with ASA increased its growth and fruit yield. Similarly, El – Gamal *et al*. (2003) reported that foliar spray of bean with ASA at different concentrations resulted in a yield increase.

CONCLUSION AND RECOMMENDATION.

Application of 50 µg/ml Acetyl Salicyclic Acid (ASA) boosted tomato growth and yield more than any other PRAs. Therefore, application of 50 µg/ml ASA is recommended to farmers in order to boost tomato fruit yield and for farmers to meet the growing market demand of tomato fruits.

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Table 1: Effect of Plant Resistance Activators (PRA) on Plant Height of Tomato

Tomato varieties	PRA	Concentration (µg/ml)	Plant Height (cm)			
			Screen house 6WAT	Field 6 WAT	Screen-house 8 WAT	Field 8 WAT
Perfect pee	ASM	25	110.2ab	123.6a	125.7ab	134.3abc
		50	115.9ab	118.5a	127.7ab	131.0abc
		75	84.2b	101.7ab	110.0a-c	122.3abc
	BABA	25	99.0ab	102.4ab	110.6a-c	124.4abc
		50	91.1ab	106.7ab	122.0a-c	133.4abc
		75	110.3ab	122.4a	127.7ab	132.8abc
	SA	25	95.7ab	116.7a	130.7ab	136.4ab
		50	112.3ab	121.0a	129.7ab	135.4ab
		75	107.0ab	118.0a	126.7ab	131.3ab
	ASA	25	109.0ab	108.0ab	119.7abc	129.7abc
		50	96.6ab	111.7a	133.0a	152.2a
		75	97.0ab	112.3a	119.0abc	128.2abc
	Control	0	42.1c	59.3c	65.6bc	70.3c
Roma round	ASM	25	117.4a	131.3a	144.2a	143.4ab
		50	113.6ab	126.3a	133.2a	138.4ab
		75	110.3ab	126.1a	134.4ab	133.9ab
	BABA	25	124.5a	126.7a	135.6a	145.9ab
		50	108.4ab	117.0a	125.7ab	135.3abc
		75	107.0ab	118.2a	128.0ab	129.5abc
	SA	25	103.7ab	113.3a	122.7abc	125.9abc
		50	85.7b	102.3ab	111.7abc	124.9abc
		75	109.7ab	124.0a	131.7ab	134.7ab
	ASA	25	118.7a	126.0a	135.0a	144.3ab
		50	119.0a	127.9a	145.3a	156.7a
		75	104.7ab	123,0a	129.7ab	133.7abc
	Control	0	54.8c	75.0bc	72.9bc	79.3bc

Means along the same column with different alphabets are significantly different **(**$P \leq 0.05$) according to Duncan Multiple Range Test.
PRA- Plant Resistance Activator, ASM- Acibenzilar – S – Methyl, BABA- β- Amino-Butyric Acid, SA- Salicyclic Acid, ASA- Acetyl Salicyclic Acid

Table 2: Effect of plant resistance activators on number of leaves of tomato

Tomato varieties	PRA	Concentration µg/ml	Number of Leaves			
			Screen house 6WAT	Field 6 WAT	Screen-house 8 WAT	Field 8 WAT
Perfect pee	ASM	25	26.4 a-d	33.3ab	35.3ab	37.9abc
		50	25.9a-d	29.5abc	35.6ab	38.7abc
		75	23.4b-e	24.5bc	28.8ab	33.2abc
	BABA	25	29.5abc	31.5abc	31.2ab	37.8abc
		50	27.5abc	28.4abc	33.2ab	39.3abc
		75	29.8abc	29.3abc	38.2ab	43.5abc
	SA	25	26.5a-d	25.6bc	39.4a	42.8abc
		50	22.4b-e	25.4bc	31.3ab	35.4abc
		75	28.6abc	27.1bc	35.3ab	37.9abc
	ASA	25	27.6abc	26.5bc	34.8ab	37.2abc
		50	32.2abc	31.5abc	39.5a	45.2ab
		75	26.4a-d	33.4abc	38.7ab	39.2abc
	Control	0	14.5e	20.5c	19.2b	22.8c
Roma round	ASM	25	23.7b-e	31.3abc	36.8ab	37.2ab
		50	29.3abc	21.0abc	36.7ab	37.3ab
		75	24.3a-d	29.3abc	32.4ab	35.4ab
	BABA	25	22.0cde	30.4abc	38.5ab	38.3ab
		50	23.4b-e	26.5bc	31.4ab	35.6abc
		75	27.1a-d	28.4abc	31.7ab	35.6abc
	SA	25	25.8a-d	27.9abc	29.3ab	33.8abc
		50	21.9cde	27.2abc	30.5ab	38.5abc
		75	27.9abc	29.2abc	35.9ab	38.3ab
	ASA	25	25.2a-d	31.6abc	34.7ab	35.7abc
		50	34.5a	39.2a	40.4a	46.5a
		75	23.3cde	29.4abc	31.2ab	33.7abc
	Control	0	17.5de	21.2bc	22.3ab	24.8bc

Means along the same column with different alphabets are significantly different ($P \leq 0.05$) according to Duncan Multiple Range Test

PRA- Plant Resistance Activator, ASM- Acibenzilar – S – Methyl, BABA- β- Amino-Butyric Acid, SA- Salicyclic Acid, ASA- Acetyl Salicyclic Acid

Table 3: Effect of plant resistance activators on fruit yield of tomato at 8 WAT

	PRA	Concentration μg/ml	Yield	
			Screen house (g/plant)	Field (tons/ha)
Perfect pee	ASM	25	90.8ab	32.2ab
		50	52.8d-h	18.3d-h
		75	68.6b-g	23.8b-g
	BABA	25	68.2b-g	21.9b-g
		50	71.4a-g	23.4a-g
		75	78.9a-f	25.9a-f
	SA	25	81.7a-d	16.5d-h
		50	52.0d-h	27.2a-d
		75	60.3c-h	21.2c-h
	ASA	25	75.7a-e	26.3a-g
		50	103.0abc	34.4 abc
		75	67.3b-g	22.4b-g
	control	0	29.7fgh	16.6d-h
Roma round	ASM	25	29.7f-h	9.7f-h
		50	6.0d-h	12.2d-h
		75	42.9d-h	12.9d-h
	BABA	25	69.6b-g	22.2b-g
		50	28.7gh	9.6gh
		75	72.4a-e	25.7a-e
	SA	25	31.4e-h	10.9e-h
		50	13.7h	4.6h
		75	49.7d-h	16.6d-h
	ASA	25	35.7d-h	11.9d-h
		50	116.0a	38.7a
		75	33.1d-h	14.5f-h
	control	0	38.9d-h	19.4d-h

Means along the same column with different alphabets are significantly different ($P \leq 0.05$) according to Duncan Multiple Range Test

PRA- Plant Resistance Activator, ASM- Acibenzilar – S – Methyl, BABA- β- Amino-Butyric Acid, SA- Salicyclic Acid, ASA- Acetyl Salicyclic Acid.

USE OF HERBICIDES IN CASSAVA PRODUCT AMONG SMALL SCALE FARMERS IN KABBA/BUNU LOCAL GOVERNMENT AREA OF KOGI STATE, NIGERIA

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ABSTRACT
This study examines the perception of the use of Herbicides in cassava production in Kabba/Bunu Local Government Area of Kogi State, Nigeria. Data collected for the study were obtained from one hundred and twenty (120) respondents, the study employed the use of questionnaires to elicit information from respondents. Measure of central tendency such as mean, frequency and percentage as well as Likert scale analysis were used. Result from the analysis shows that the model age of the cassava farmers is between 41 – 50years (50%), with a mean age of 47years, majority (75.83%) of the cassava farmers sampled were literate holds certificates. Majority (75%) of the respondent had between 11 – 30years experience with a mean farming experience of 28years, more than half (62.50%) of the respondents had between 1-5 household size with a mean of 5 persons. Most (70.83%) of the respondents had between 1- 2ha farm size with a mean of 2ha. Access to credit distribution shows that majority (75%) of the respondents had no access. Most (70.83%) of the respondents had no contact with extension agents. Perception of farmers on the use of herbicides in cassava production revealed that majority (75%) of the respondent used herbicides and had perception on the use of herbicides and they do so as to increase output, control weed and control pests and diseases, etc. Major concerns or constraints of the cassava farmers on the use of herbicides includes inadequate credit, low technical knowledge due to extension contact, poor access to market in formation, price fluctuation, inadequate inputs, illiteracy, expensive and harmful chemical respectively and if addressed will enhance productivity of cassava production in the study area. It is therefore recommended that farmers should be sensitized on the need for them to farm more cooperative societies so that cassava farmers can use the opportunities it proffers to accesses farm inputs.
Keywords: *Herbicides, Cassava, Farmers, Kabba/Bunu, Kogi*

INTRODUCTION

Nigeria is said to be one of the largest producer of cassava, it is yet to meet the potential demand both in the local and international markets (olumide,2004). This is as a result of limiting factors in cassava production includes it cultivate by small scale, low resource farmers high cost of agro-chemical (herbicides), fertilizer, pests, and diseases, perception of farmers towards the use of herbicides, inadequate capital, weed management, unfavorable weather and climate, high costs of labour, land tenure, market constraints little or no extension contact, (Nweken,2004) fertility of the soil. Low technical know – how, inadequate land for cultivating among others. Stemming from the foregoing, the aim of this study is to access the use of herbicides in cassava product among small scale farmers in Kabba/Bunu Local Government Area of Kogi State, Nigeria. The following specific objectives describe the socio – economic characteristics of the cassava farmers in the study area; examine the perception of farmers on the use of herbicides in cassava production in the study area identify the constraint associated with cassava production in the study area and solution to constraints associated with herbicides in cassava production in the study area.

MATERIAL AND METHOD

Study Area

This is being conducted in Kabba/Bunu Local Government Area of Kogi State. The study is within the northern Guinea Savannah Ecological zone of Nigeria. It lies between latitude $7^{0}49^{1}$N and 37.88^{11}N and longitude of $6^{0}04^{1}$E and 30.07^{11}E of the equator within area of 2.70km2 and a population of 145,446 (NPC, 2006), they have two distinct seasons in a year, the wet and dry seasons. The wet season spans between middle of March to October, while the dry season is between the months of November to

March, the area has an average maximum temperature of 210c with annual rainfall between 1,100mm and 1, 300mm. The main crops grown in the area are cassava, oil palm, maize, Yam, Melon, Plantation, and Vegetable. Animal husbandry is also practiced in the area. In terms of sampling size and procedure, ten (10) villagers were selected using convenience sampling from Kabba and Bunu districts (Five from each district). Based on their predominance of cassava farming in the area, with three hundred and twenty-five (325) members. Taro Yamani's formula was used to determine the number of respondents to a total of 120 respondent's primary data for analysis was generated through the administration of structured questionnaire while secondary information was obtained via journals, newspapers, Internet, Literature, and State Official website. Generated data were analyzed with descriptive statistics,and 4-point Likert scale rating were used to achieved the objectives of the study.

Two Yamani's Formula

Formula: - n = s/1 + N^2 where: - N = 668,5 = 325,

e = 0.05, n = 325 / 1 +668 $(0.05)^2$ = 325/2.70

= 120.37. With the above calculation one hundred and two (120) questionnaires distributed.

To get a true representative sample of the target population, the Taro Yamane (1964) formula for sample size determination was used thus:

$$N = \frac{S}{1 + N(e)^2}$$

Where:

S = Sample Size

I = Constant

N = Population Size

e = Margin of Error, usually 5% (0.05)

In applying the formula, these figures were obtained as follows:

N = 668

S = 325

$1 + 668\,(0.05)^2$

Therefore, the sample size is 120

RESULTS AND DISCUSSION

Socio – Economic Characteristics of the cassava farmers in the study area;

Table 1: Show that (75%) of the respondent were males while 25% were females. The model age of the cassava farmers is between 41 – 50 years (50%), with a mean age of 47years. (77%) of the respondents were married, (22%) were single, widow/widower and divorced. (75%) of the cassava farmers were literate, (62%) of the respondents had between 1 – 5 household size with a mean of 5 persons. (70%) had between 1 – 2 farm size with a mean of 1 – 5ha. (62%) had between 100,000 – 200,000 with a mean annual cassava production income of 197,000. (75%) had no access to credit while (25%) has access to credit. (70%) had no contact with extension agents while (29%) had contacts.

Perception of farmers on the use of Herbicides in Cassava Production in the study area:

Table 2: Shows that (66%) of the respondents used family labour, (8% usedhired labour while (25%) used both labour. (75%) used herbicides while (25%) do not used herbicides. (91%) had good perception on the use of herbicides while (8%) had perception on the use of herbicides in cassava production in the study area. The result of the mean ratings of the responses by the cassava farmers on the extent why they use herbicides in study area showed that the three (3) items had mean value that ranged between 3.54 to 3.81 which are greater than the cut – off point value of 2.50 on 4 – point rating scale. This indicated that the cassava farmers agreed that the three identified items in the table are the reasons why they use herbicides in the study area.

Constraints Associated with Herbicides in Cassava production in the study area.

Table 3 show that the mean rating of the responses by the cassava farmers on the constraints associated with the used of herbicides in cassava production in the study area showed that the eight (8) constraining items had mean values that ranged between 2.61 to 3.54 which are greater than the cut – off point value of 2.50 on 4 – point rating scale. This indicated that the cassava farmers agreed that the eight (8) identified items in the table are constraints facing the usage of herbicides in cassava production in the study area.

Solution to constraints associated with Herbicides in cassava production in the study area.

Table 4: Show that the mean ratings of the responses by the cassava farmers on the possible solutions on the constraints associated with the used of herbicides in cassava production in the study area showed that the eight (8) possible solution items had mean values that ranged between 2.61 to 3.54. this indicated that the cassava farmers agreed that the eight identified items in the table are the possible solution facing the usage of herbicides in cassava production in the study area.

CONCLUSIONS

Based on the findings, it was concluded that majority of the respondents used herbicides in cassava production and had a possible perception on the use of herbicides. Major concerns of the cassava farmers on the use of herbicides include inadequate credit, low technical knowledge due to no extension contact, poor access to market information, prize fluctuation, inadequate inputs, illiteracy, expensive and harmful respective and harmful respectively and if addressed will enhance productivity of cassava production in the study area.

RECOMMENDATION

Based on the conclusion, it was recommended that the Agricultural Development Project (ADP) should ensure regular contact with farmers to expose them with relevant information on improve agricultural practices especially on agro – chemicals in order to increase the farmer's productivity level. Farmers should be enlightened on how to apply herbicides and the importance of herbicides application to crops basically cassava. This will assist farmers to meet up with their production target without much labour and capital.

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Table 1: Socio – Economic Characteristics of the Cassava Farmers in the Study Area

Variable	Frequency	Percentages (%)	Mean	Total
AGE				
20 – 30	20			
31 – 40	25	20.83		
41 – 50	60	50.00	47	
51 – 60	10	8.33		
61 and above	5	4.17		
SEX				
Male	90	75.00		
Female	30	25.00		
Marital Status				
Married	93	77.50		
Not Married	27	22.50		
Educational Level				
Educated	91	75.83		
Not Educated	29	24.17		
Cassava Farming Experience (Years)	20	16.67		
1 – 10				
11 – 20	40	33.33	28	
21 – 30	50	41.67		
31 – and above	10	8.33		
Household Size (IN number)				
1 – 5	75	62.50		
6 – 10	35	29.17	5	
11 and above	10	8.33		
Farm Size (ha)				
1 – 2	85	70.83		
2.1 – 4	30	25.00	2	
4.1 and above	5	4.17		
Annual Cassava Production Income	75	62.50		
100,000 – 200,000				
201,000 – 400,000	30	25.00		
401,000 – 600,000	10	8.33	197,	
601, 000 and above	5	4.17	000	
Access to Credit				
Yes	30	25.00		
No	90	75.00		
Extension Contact				
Yes	35	29.17		
No	85	70.83		

Source: Field Survey, 2022

Table 2: Perception of Farmers on the use of Herbicides in Cassava Production in the Study Area.

VARIABLE	FREQUENCY	PERCENTAGES (%)	MEAN	SD
Do you use herbicides				
Yes	90	75.00		
No	30	25.00		
			47	
Perception on the use of Herbicides				
Good	110	91.67		
Bad	10	8.33		
Extent on the usage of Herbicides				
Weed Control	110	91.67	3.81	1.92
Pests and Disease control	105	87.5	3.54	1.89
Increase Output	105	87.5	3.54	1.89

Source: Field Survey, 2022

Table 3: Constraints associated with Herbicides in Cassava production in the Study Area.

Constraints	Mean	SD	Remarks
Inadequate Credit	3.54	1.89	SA
Low Technical Knowledge due to no Extension Contact	3.25	1.80	A
Poor Access to Market Information	2.61	1.62	A
Price Fluation	3.54	1.89	SA
Inadequate Inputs	2.81	1.68	A
Illiteracy	3.81	1.92	SA
Expensive	3.54	1.89	SA
Harmful	3.25	1.80	A

Source: Field Survey, 2022.
Strongly Agree = (SA), Agree = (A), Disagree = (D), and Strongly Disagree = (SD)

Table 4: Solution to Constraints Associated with Herbicides in Cassava Production in the Study Area.

Solutions	Mean	SD	Remarks
Access to credit Facilities	3.50	1.93	SA
Technical Knowledge through more Extension Contact	3.20	1.85	A
Access to Market Information	2.59	1.64	A
Needs for stable Price	3.53	1.90	SA
Needs for adequate Inputs	2.80	1.69	A
Education and Knowledge	3.78	1.95	SA
Need for reduction in Expenses by Govt.	3.53	1.90	SA
More Training for farmers to reduce Harmful	3.21	1.84	A

Source: Field Survey, 2022
Key - Strongly Agree = (SA), Agree = (A), Disagree = (D), and Strongly Disagree = (SD)

A REVIEW ON NUTRITION AND SOIL FERTILITY MANAGEMENT OF COCOA IN NIGERIA

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ABSTRACT
Majority of the soils in Nigeria are exposed to leaching effects due to incessant rainfall that leads to low organic matter and nutrients contents. The importance of cocoa nutrition cannot be exaggerated because nutrition affects the size and cocoa bean quality. This study was carried out to review nutritional conditions and fertility status of soils for cocoa production in Nigeria. It was revealed that most soils under cocoa production in Nigeria are moderate to marginally suitable in fertility status. However, some of the soil contents for the nutrients needed for high cocoa yield were below critical levels. Therefore, good management practices that would replenish lost nutrient elements in the soil were considered necessary. Recommended rates of organic and inorganic fertilizers for cocoa cultivation are highlighted in this paper.
Keywords*: Nutrition, Soil fertility, Management, Cocoa, Nigeria.*

INTRODUCTION

Still called the "food of the gods", the cocoa tree (*Theobroma cacao* L.), of the Malvaceae family, is a tropical plant cultivated for its beans, from which cocoa powder and butter are extracted. There are three varieties of cocoa: "Forastero", usually yellow but occasionally red when the pod is ripe, "Criollo", more sought after and more expensive, whose pods are red-orange when mature, and "Trinitario", which is hybrid of the two preceding varieties. "Forastero" is the most commonly grown variety in West and Central Africa, but its flavour is not as good, as that of the other two varieties (Kokou Edoh Adabe and Lionelle Ngo-Samnick, 2014). Cocoa is a major source of income for about 5 million small-scale farmers (Poelmans and Swinnen 2016). Cocoa is produced within 10^o N and 10^o S of the equator where the climate is suitable for growing cocoa trees. West Africa has been the centre of cocoa cultivation for many decades, as two-thirds of the world's cocoa is produced in West Africa. Approximately 74% of the global production originates from four countries in West and Central Africa: Côte d'Ivoire, Ghana, Cameroon and Nigeria (ICCO 2020), where the cocoa plantations are among the least productive in the world (Oomes *et al.,* 2016). This is less than one-tenth of the potential yield of cocoa in West Africa (Zuidema *et al*., 2005). A considerable part of the cocoa in the world is produced by smallholders, and the International Cocoa Organization (ICCO) estimates that approximately 14 million people are directly involved in cocoa production.

Cocoa ranked first amongst agricultural export crops in its contribution to foreign earnings (Tijani *et al*. 2001). It is a crop of economic importance with more than 650,000 ha being cultivated in Nigeria (Sanusi and Oluyole 2005) Cocoa has generally enhanced the economy of Nigeria over the years. It is exported either as raw cocoa beans or cocoa products. Some 70% of Nigeria's annual cocoa exports are to Europe with a further 10% to the United States of America and up to 15% to Eastern Europe. Nigeria is currently the 4th largest producer of cocoa in the world. However, the gross production of cocoa has decreased since 2010 because of declining yields per hectare that started in the early 1990s (FAOSTAT, 2020). Because of the limited availability of land, productivity per hectare will need to increase if Nigeria is to contribute to the increasing global demand for cocoa. In Nigeria, most of the Cocoa plantations are old and less productive (Ayoola 2000). Most soils under Cocoa plantations and adaptable areas in Nigeria are marginal to moderately suitable in fertility status. The soils are well drained, thoroughly leached and deeply weathered. Cocoa is exceptionally demanding in its soil requirement (Smith, 1975). Wessel (1971) showed steady decline in almost all nutrients with length of cultivation. Omotoso (1975) reported that a crop of 1000 kg dry Cocoa beans removed about 20 kg N, 41 kg P and 10 kg K from the soil. It has been reported by Ogunlade *et al*. (2009) that most Nigerian Cocoa farmers don't use fertilizers on their farm.

Soil fertility often deteriorates on cocoa farms (Adeniyi *et al*., 2017). Typically, cocoa trees planted on a freshly cleared forest initially benefit from high fertility due to high organic matter levels and well-developed soil structure. However, the subsequent removal of the harvested pods and beans can reduce nutrient levels (Boyer, 1973; Fassbender *et al.,* 1988; Hartemink, 2005; Thong & Ng, 1978; Van Vliet *et al.,* 2015), and soil fertility declines if they are not replenished with organic or mineral/inorganic fertilizers (Aikpokpodion, 2010; Hartemink, 2005). Degradation can also occur due to the acidification of the soil from the use of acidifying fertilizers, like urea, organic matter decay, the removal and leaching of basic cations (Goulding, 2016), and an increased availability of toxic elements (Lal *et al*., 1989). To maintain soil fertility, farmers typically apply amendments and fertilizers to replenish nutrients stocks and correct soil acidity. Few peer-reviewed studies have evaluated their effects both on cocoa productivity and soil properties, and where there is research, it often focuses on short-term effects on seedlings or young cocoa trees (Ahenkorah *et al.,* 1987; Van Vliet *et al*., 2015; Wessel, 1971). Verlière (1981) reported that only a few fertilizer experiments with cocoa had provided significant results, and there was a need to determine the interactions between shade management, cocoa nutritional needs, and productivity. Low levels of adoption of good cocoa farming practices, pest and disease attacks, ageing plantations, and poor and decreasing soil fertility contribute to poor average yields (Wessel and Quist-Wessel 2015). Whereas reported yields at farm level vary from 300–400 kg ha^{-1} (Beg *et al*. 2017; Wessel and Quist-Wessel 2015) to 700–900 kg ha^{-1} (Jagoret *et al*. 2017; Jagoret *et al*. 2018), cocoa yields can reach >3000 kg ha^{-1} (Van Vliet and Giller 2017; Yin 2004) in on-station trials.

Crop simulation models suggest that the potential yield of cocoa exceeds 4000 kg ha^{-1} (Zuidema *et al*. 2005). Poor soil fertility is considered to be an important cause of the prevailing cocoa yield gap in Africa (Van Vliet and Giller 2017). Soil fertility refers to the degree to which soils support plant growth. When forests are initially cleared for cocoa plantations, the soils are fertile and can sustain cocoa production for several years, referred to by Ruf and Zadi (1998) as the 'forest rent.' Continuous harvesting of cocoa with no additional fertilisers leads to a decline in soil fertility (Appiah *et al.* 2000; Van Vliet and Giller 2017). The decline of cocoa yields (WCF 2018) contributes to deforestation due to expansion of cocoa farming (Ruf and Zadi 1998). Maintenance and enhancement of soil fertility are essential to increase cocoa production with minimum negative environmental impact (Liniger *et al*. 2011; Vanlauwe *et al*. 2010; Vanlauwe *et al.* 2015). Several scholars cited by van Vliet and Giller (2017) have reported increased cocoa yields in response to fertilisation. For instance, in Ghana, the gross yield of fertilised plots was 61% to 116% higher compared with unfertilised plots (Appiah *et al*. 2000). During fertiliser experiments, yield response was stronger when cocoa was cultivated without shade (Van Vliet and Giller 2017). Besides mineral fertilisation, soil fertility enhancement can be achieved through the application of organic fertilisers or lime, and inclusion of legumes in the cropping system, or a combination of these (Hartemink 2006; MINADER 2018; Vos *et al*. 2003). The implementation of these practices requires farmers' recognition that declining soil fertility is a problem. Understanding the logic and rationale that underpin current farmers' management of soil fertility is essential for designing interventions to enhance yields. The paper reviewed nutritional conditions and fertility status of soils for cocoa production in Nigeria.

SOIL AND LAND REQUIREMENTS

Cocoa requires deep and well-drained soil for easy penetration of the roots. Poorly drained soil is inimical to this crop. It is predominantly grown on clay loam and sandy loam soils. It thrives well on wide range of soil types with pH ranging from 4.5-8.0 with optimum being 6.5-7.0 (CPCRI, 2006). To achieve high productivity, cocoa requires a soil abundant in nutrients (Wessel 1971). The importance of other soil characteristics, such as pH, is largely due to their influence on the availability of nutrients. Cocoa needs a soil containing coarse particles and with a reasonable quantity of nutrients, to a depth of 1.5m to allow the development of a good root system. Below that level it is desirable not to have impermeable material, so that excess water can drain away. Cocoa will withstand waterlogging for short periods, but excess water should not linger. The cocoa tree is sensitive to a lack of water, so the soil must have both water retention properties and good drainage. The chemical properties of the topsoil are most important, as the plant has a large number of roots for absorbing nutrients. Cocoa can grow in soils with a pH in the range of 5.0-7.5. It can therefore cope with both acid and alkaline soil, but excessive acidity (pH 4.0 and below) or alkalinity (pH 8.0 and above) must be avoided. Cocoa is tolerant of acid soils, provided the nutrient content is high enough. The soil should also have a high content of organic matter: 3.5% in the top 15 centimetres of soil. Soils for cocoa must have certain anionic and cationic balances. Exchangeable bases in the soil should amount to at least 35% of the total cation exchange capacity (CEC), otherwise nutritional problems are likely. The optimum total nitrogen|total phosphorus ratio should be around 1.5 (International Cocoa Organization, 2020). In Nigeria, most of the Cocoa plantations are old and less productive (Ayoola 2000). Most soils under Cocoa plantations and adaptable areas in Nigeria are marginal to moderately suitable in fertility status. Cocoa can be grown in arecanut and coconut gardens as a mixed crop. It can also be planted in forest lands by thinning and regulating the shade suitably (Hamzat, 2005; Aroyeun *et al*., 2006).

COCOA NUTRITION

Cocoa plant requires adequate nutrients for optimum production. Both macro and micro nutrients are needed. Nitrogen (N), Phosphorus (P) and Potassium (K), Magnesium (Mg), Calcium (Ca), are required in large quantities while Zinc (Zn), Copper (Cu), Boron (B), Iron (Fe), Manganese (Mn), Molybdenum (Mo), Sulphur (S) and Chlorine (Cl) are required in small quantities. Quantities of these elements in the soil and plants are determined through soil and leaf sample analysis. Nutrients application is done to replenish those that are lost. Thus, fertilizers are needed to be applied in the necessary amount. UCDA, (2019) suggested that for proper and effective use of fertilizer, both soil and cocoa leaves should be sampled and analysed once in a year to determine the present status of nutrients and pH of such cocoa plantation. This would make for proper understanding of the nutrient recycling and management of fertilizer for optimum production of cocoa. Adejobi *et al*., (2011) reported from a research carried out in Ibadan, Nigeria that the use of both chemical (NPK, Ca and Mg) and organic fertilizers significantly enhanced cocoa growth parameters, fresh, dry matter and dry cocoa bean yield.

The need to fertilize cacao (*Theobroma cacao* L.) emerged at the very beginning of the establishment of high-yielding commercial cacao plantations. Results of fertilizer trials were first published in a study conducted in Cameroon in 1910, quickly followed by Java, Trinidad and Ghana, among others (Verlière, 1981). The objective of these studies was to evaluate the effect of each nutrient supplied separately on cocoa yields. The results showed that phosphorus (P) and potassium (K) have always had positive effects on cacao yields. Although calcium (Ca) and magnesium (Mg) have also had positive effects on yields, the responses were much more variable and the quantities were dependent on the environmental condition. The variability of yield responses to nutrients pointed to the need to link the nutrients with each other or with other factors, in particular with soil, climate and topography. In the case of nitrogen (N), a significant effect on yields was rarely observed, except when the intensity of shading is reduced (Evans and Murray, 1953). There are three reasons for the contrasting effects of N (positive, neutral or negative) and its relationship to shading. First, due to the high vigor of the hybrid cacaos, the supply of nitrogen promotes vegetative growth at the expense of the production of pods (Alvim, 1977; Bastide *et al*., 2003). Consequently, the positive effect of N on yields is only visible when the yield of pods is high and nutrient requirements are consequently high, which is more frequently the case when cacao is grown without shade.

Second, since cacao is cauliflorous, the fruits grow directly on the trunk and primary branches (at the base of the tree), while leaf production is concentrated in the apical branches (at the top of the tree). As N promotes vegetative growth, cacao uses the products of photosynthesis to produce more branches at the expense of flowering and fruiting. By increasing the amount of shade over the fruiting area, N can thus have a rather negative effect on production unless shading is controlled (Wessel, 1985).Third, when nitrogen deficiency occurs in the soil, the need for N may emerge and it becomes a limiting factor for other nutrients, which is quite a common phenomenon in soils with low organic matter content (Snoeck *et al.*, 2016). However, our study also showed that when cacao is grown under shade trees, recycling of organic matter increases soil N content, which improves soil quality with age, thus reducing the need for N in older plots. Nitrogen management should therefore aim for a balance between soil poverty and shade intensity. Based on the findings that P and K are always important and most often the only nutrients required, many governments recommend only one P–K–Ca–Mg-based fertilizer formula for their countries. The same formula may even be recommended in several other countries (e.g. Côte d'Ivoire, Ghana, Togo and Cameroon). Only a few countries (particularly, Brazil and Malaysia) have more specific recommendations, where fertilizer formulas are calculated based on critical N, P and K levels in the soil (Chepote *et al.,* 2013; Ling, 1984; Malavolta, 1997). This simplification, which consists in using very few formulations or even only one for a whole country, goes against the principle of nutrient management of the soil–plant system, which is based on two observations:

Each species has unique nutritional requirements and its own mechanisms underlying soil nutrient absorption. The specific nutrient requirements of cacao were deduced from the results of many trials conducted in many countries (Jadin and Snoeck, 1985).

Each soil can only supply what it contains, and the availability of each nutrient in the soil varies with the type of soil in interaction and with the properties of the soil–root interface. In particular, pH may be a determining factor for P (retrograded forms) content and cations.

Thus, the objective of nutrition management is to correct the soil so that the cacao plant can find the nutrients it needs in optimal quantities and ratios. The fertilizer formula is determined by physical-chemical analyses of a sample of soil taken from each plot to be corrected. A plot corresponds to a map unit with the same soil and climatic conditions and homogeneous farming practices.

FERTILIZER MANAGEMENT

Nigerian soils are generally low in quite a number of essential nutrients due to various factors such as erosion, leaching, bush burning, low activity clay among others, hence, these must be provided to foster good and optimum cocoa yield. Large quantities of human, agricultural, forestry and industrial wastes are produced annually which are not being effectively utilized. However, because of increasing costs of chemical fertilizers coupled with disposal problems posed by these wastes, their use as means of maintaining organic matter level and boosting agricultural productivity has become an economic proposition. Studies have shown that ash derived from wood, cocoa pod husk, saw dust, oil palm bunch and other plant sources increased availability of nutrients in the soil and crop respectively thereby causing a significant increase in yield of food crops such as vegetables, maize, yam, cassava e .t .c (Olomilua, *et al*., 2007; Ojeniyi *et al.*, 2007; 2010; Ezekiel *et al.,* 2009b and Ayeni *et al*., 2008a).

Akanbi *et al*., (2014) reported from there trial that Oil palm bunch ash (OPA) contained Ca, Mg and other essential micro nutrients in addition to N, P, K. Similarly, its addition enhanced cocoa seedling growth, dry matter accumulation and improved the soil nutrient status. Therefore, it could be recommended as soil amendment for a depleted soil.

Ogunlade *et al*. (2004) reported a superior performance of neem leaf, its availability all year round unlike the seasonal nature of neem seed production, neem leaf can be considered for organic fertilizer amendment towards the up-grading their N contents.

Ogunlade and Adeoye (2006) reported that the fortification of cocoa pod husk with neem is a release precursor for nitrogen and correction of soil acidification, which are critical factors in soil fertility and plant nutrition evaluation in low acidity clay soils. They also report a higher soil pH of the amended soil which was probably due to supply of basic cations into the soil system by mineralization of the organic materials. Cocoa pod husk fortified or not fortified with neem seed or neem leaf and NPK gave similar values of height, number of leaves and stem diameter of cocoa seedlings. Fertilizer rates have significant effect on the growth and dry matter yield (DMY) of cocoa seedling. Both organic fertilizer and NPK applied at 10 kg N ha^{-1} significantly enhanced the height, number of leaves, stem diameter and dry matter of cocoa in Ibadan, South West Nigeria. Ipinmoroti *et al.* (2005) reported that manures were better nutrient sources than NPK fertilizers for cocoa seedlings, while formulation from urea + rock phosphate + mutilate of potash mixture was better than other NPK mixtures.

Available phosphorus in Nigeria cocoa soils is low and considered inadequate for good growth and production of cocoa, nutrient imbalance also exists. Low yield of cocoa in Nigeria can be attributed to soil fertility problems among others as clearly shown in an experiment carried out by Ogunlade and Aikpokpodion (2006). The main achievement of the third Nigerian breeding programme are the selection of 10 Nanay and 4 Parinary hybrids and the subsequent development and testing of the new CRIN varieties, all from among the Trinidad introduction population (Ojo and Sanwo, 1981). Amazon cultivars have been shown to respond very favourably to boron fertilizer and foliar applications, increasing the yield by about 30% (Ojeniyi, Egbe and Omotoso, 1981; Olaiya, 2005a). Ojeniyi (1981) reported a response to N (31-35 kg ha^{-1}) and P (36-207 kg ha^{-1}) in a N^4, P^2, K^2, B^2 fertilizer trial on 12-year Amazon cocoa. This result confirmed that phosphorus is the most limiting of all nutrient elements for cocoa production in Nigeria. The micronutrients requirements of cocoa have received considerable attention and of various micronutrients, boron, zinc and copper deficiencies have been found in both cocoa nurseries as well as in matured plantations (Olatoye *et al*., 1987). Chude and Obigbesan (1983) detected that 5 ppm B applied, as solubor, was required to raise the leaf B level of six-month-old cocoa seedlings from deficiency to sufficiency level. Foliar application of boron was also recommended to reduce cherelle wilt in old cocoa plantation (Olaiya, 2005a).

Ogunlade *et al*. (2008) reported that the soil pH of their selected site (Ikoromaja cocoa farming community), Osun State was 5.8 fell within the ideal pH range of cocoa. While available P and exchangeable K, Ca and Mg were below the critical values of 10 mg kg ha^{-1}, 0.3, 5.0 and 0.9 cmol kg ha^{-1} soil respectively required by cocoa, the nitrogen, phosphorus and potassium contents of the organic materials indicated similar nitrogen content for both neem leaf and *Chromolena odorata*. All the fertilizers used in the experiment increased dry bean yield compared with control, pod yield was highest (though not significantly) under NPK fertilizer treatment probably due to higher rate of nutrient release compared to other fertilizers (cocoa pod husk based organic fertilizer and organ mineral fertilizer). In another study it was reported that cocoa pod husk compared favourably with the inorganic fertilizer (NPK) on growth parameter such as plant height at 3 and 4 months after transplanting (MAT). This could be an indication that cocoa pod husk could serve as an alternative nutrient source for cocoa seedlings.

Soils of moribund cocoa plantation or previously cropped lands with low soil available phosphorus 16 kg P (37 kgP_20_5) ha^{-1} could be applied. The use of Sokoto rock phosphate could be beneficial for longer period on the field for tree crops such as cocoa (Iloyanomon, 2008).

A trial was conducted at the experimental plot of cocoa research institute of Nigeria Ibadan to study the comparative effect of organically sourced cocoa pod husk ash (CPHA) and urea fertilizer application on soil properties and growth performance of cocoa seedlings in 2010 where the final results of the trial indicated that 25 t ha^{-1}, 30 t $ha^{-1}$and 20 t ha^{-1} of CPHA applications increased the soil, leaf N, P, K, Ca, Mg, soil pH, organic matter and also plant height, stem diameter, number of leaves, leaf area, fresh and dry shoot weights of cocoa seedlings. It was concluded from the experiment that CPHA could serve as a good fertilizer and liming material for the cocoa seedlings (Adejobi *et al*., 2010).

Adejobi *et al.,* (2011) reported that the different combinations of organo-mineral fertilizer and cocoa pod husk ash are effective sources of organic matter, N, P, K, Mg and Ca for cocoa seedlings. Their application to soil increased growth or cocoa seedlings and uptake of nutrients. Cocoa pod husk can therefore be utilized to the maximum as organic fertilizer supplement and its combination with organo-mineral fertilizer enhance its performance to increase the growth of cocoa seedlings and nutrient uptake.

Having reviewed the beneficial effects of applying the different sources of organic and inorganic fertilizers in the cultivation of cocoa in Nigeria. Agbeniyi *et al*., (2010) reported a Lacuna on the usage of fertilizers in cocoa production where they found out from their study that majority of cocoa farmers are not using fertilizer for cocoa production in the study area. They are doing this with the view that their soil is rich enough forgetting that there is a need to replenish the lost nutrients due to pod harvest from time to time.

CONCLUSION AND RECOMMENDATIONS

They study reviewed nutritional conditions and fertility status of soils for cocoa production in Nigeria. It was revealed that Nigerian soils are moderate to marginally suitable for cocoa production and will require good management practices to obtain optimum productivity. Therefore, deficient nutrients should be supplied through the use of appropriate organic and inorganic fertilizers which has been reported to increase cocoa productivity. In another twist, majority of cocoa farmers are not using fertilizer for cocoa production in Nigeria. They are doing this with a view that their soil is rich enough forgetting that there is a need to replenish the lost nutrients due to pod harvest from time to time. Due to this problem, the following recommendations are made:

a) Farmers should be trained on the relevance of soil test to know the fertility status of their cocoa farms. This is very important in view of the fact that some farmers were claiming that their farms were fertile enough and did not require fertilizers application.

b) Government and other stakeholders should encourage the production of cocoa pod husk fertilizer in as much that cocoa farmers are ready to use it to grow their crops. Apart from the fact that the fertilizer will boost cocoa production, it will also reduce the disease infestation that is likely to result due to compilation of cocoa pod husk constituting nuisance on farms.

c) Farmers should be encouraged to improve their level of education. This is quite imperative in as much that level of education was found to have affected the use of fertilizer for cocoa production. Illiterate farmers could be encouraged to undergo adult literacy programme.

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EVALUATION OF GROWTH AND NUTRIENTS UPTAKE OF TEA GROWN UNDER VARIED LIGHT INTENSITIES

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ABSTRACT
The medicinal and economic benefits of tea beverage make it the most consumed beverage worldwide. Tea production is however, limited by high light intensity which can be mitigated with shading. Therefore, a field experiment was conducted in Ibadan and Owena, southwest Nigeria to evaluate the response of tea plant to three levels of light intensity (45%-4.57x10^4lux, 65%-6.75x10^4lux and 100%-1.04x10^5lux) using different layers of palm fronds. The treatments were applied under randomized complete block design in four replicates. Data were obtained on number of leaves (NL), number of branches (NB) and leaf area (LA) as well as Nitrogen, Magnesium and Iron uptakes. Data were analyzed with Analysis of Variance at $\alpha_{0.05}$. The 45% light enhanced the highest NL, NB and LA in Ibadan and Owena; while the least values were caused by 100% light. The N, Mg and Fe contents were 43.53, 3.63 and 0.64 (mg/g), respectively under 100% light and 108.73, 9.26 and 1.77 (mg/g), respectively under 45% light at Ibadan. The highest N, Mg and Fe contents were obtained under 45% light, and the least nutrient uptake was obtained under 100% light in Owena. In conclusion, 45% light enhanced the growth and nutrient uptake of tea plant in Ibadan and Owena.
***Keywords**: Growth, Light intensity, Nutrient uptake, Tea plant*

INTRODUCTION

Consumption of tea beverage is popular in many countries of the world due to its medicinal and nutritional properties. Research has shown that tea beverage possesses powerful antioxidants which help to prevent heart diseases and cancer (Aroyeun *et al*., 2013; Pen Medicine, 2023). Besides, tea production is the economy mainstay of many countries of the world. Its cultivation has contributed to the foreign exchange and rural development of many countries (Hajiboland, 2017). Tea beverage is made from tea plant after infusion of its leaves in hot water. Tea plant (*Camellia sinensis* (L.) O. Kuntze) is cultivated in many countries. After its discovery in China in 1700BC (Oi, 2004; Famaye *et al*., 2006), its cultivation has spread to 50 countries in all the five continents of the world with major producers being China, India, Kenya, Sri Lanka, Vietnam, Turkey, Indonesia and Iran (FAO, 2014).

Light is an absolute requirement for plant growth and ultimate energy source for photosynthesis (Yue *et al*., 2021). It is the most imperative factor among all the ecological factors (Ghasemzadeh and Ghasemzadeh, 2011). Light intensity exerts direct and indirect effect on guard cells that control the opening and closing of stomata. According to Janendra *et al*. (2007), stomata conductance is affected by light intensity as its opening is sensitive to light intensity. When excessive light intensity is incident on leaf surface, it precipitates photo-inhibition; it increases leaf temperature and transpiration rate which precipitates low leaf water potential, making the guard cells to lose turgor and collapse. The collapse of the guard cells implies stomata closure which leads to poor stomata conductance and consequent blocking of CO_2 diffusion into the leaf.

Tea is a light sensitive plant. Light is one of the important abiotic factors affecting tea production around the world. Photosynthesis, respiration, transpiration, translocation of photo assimilate and development are some of the important physiological processes in *Camellia sinensis* affected by light intensity (Janendra *et al*., 2007; Too *et al.,* 2015). Various trials around the world have shown the beneficial effect of reduced light intensity for enhanced tea production (Sysoever *et al.*, 2010). Shading, either natural or artificial, has been used severally in many tea ecologies of the world to reduce light intensity for optimum tea production.

Shade reduced photo inhibition by increasing stomata conductance and thereby channeling a greater proportion of excited energy towards carboxylation when sunlight is excessive (Janendra *et al*., 2007). Mohotti and Lawlor (2002) have shown that seedlings of tea were consistently taller under shade as compared to un-shaded ones. Iremiren *et al*. (2010) reported that extra shade from erected palm fronds and plantain resulted in higher survival count of tea cuttings. However, determination of the optimum light reduction by shading that could enhance tea growth and nutrient uptake by tea plant is a challenge in southwest Nigeria. Therefore, this trial evaluated the effects of varied light intensities on the growth and nutrient uptake of tea.

MATERIALS AND METHODS

This field trial was undertaken at the experimental plots of the Cocoa Research Institute of Nigeria stations in Ibadan, Oyo State, (Latitude 07º 10' N and Longitude 03º 52' E) and Owena, Ondo State, Latitude (07º N and longitude 05º 7'E). Both locations are in the tropical rain forest belt of Southwest Nigeria. The treatments comprised three levels of light intensity, 45%, 65% and 100% lights determined by sheds of different layers of palm fronds (Adeosun *et al*., 2019) laid out in randomized complete block design with four replicates. The light intensities (lux) were predetermined using Lux meter, model LX1010BS. Each block of the experiment contained two sheds of 8 x 3 x 2 m dimension. The sheds were erected with bamboo poles and palm fronds covering the top and sides of the sheds. The 65 and 45% light intensities ($6.75x10^4$ and $4.57x10^4$ lux, respectively) were achieved with 2 and 1 palm fronds layers, respectively. The 100% light intensity ($1.04x10^5$lux) plot had no shed cover.

The experimental site was cleared of all vegetation manually. After land clearing, the plot was demarcated into four blocks. Each block was 24 m long and 3 m wide. A gap of 2 m was allowed between the blocks and between the plots in each block. Clonal materials (14 months old) of tea cultivar 143, obtained from CRIN Station in Mambilla, Taraba State were transplanted. Planting holes (20 cm long, 20 cm wide and 25 cm deep) were dug. The tea plants were planted in the dug holes at a spacing of 100 x 60 cm. For the plants inside the sheds, a space of 1 m was allowed between the shed wall and the tea plants.

At 3 MAT (months after transplanting), two tea plants per treatment per replicate were randomly tagged in each row of tea plants for data collection. Morphological parameters: number of leaves, number of branches and leaf area were measured on monthly basis. At 15 MAT, plant samples used for morphological data were uprooted. The uprooted plants were partitioned into root, stem and leaves. The roots were washed in clean water to remove soil particles. The fresh weight of the plant parts was measured. The plant parts were packaged in paper envelopes, oven dried at 70ºC for 48 hours to constant weights and their dry weights measured. Both the fresh and dry weights were measured with the KERRO Electronic Compact Scale. The dried leaf samples were assayed for determination of N, P, K, Mg and Fe in the Soil and Plant Nutrition Laboratory of CRIN following standard procedures. Data were analyzed with Analysis of Variance (ANOVA) and significant means were separated with Tukey's Honest Significant Difference (HSD) Test (P=0.05)

RESULTS AND DISCUSSION

In Ibadan, 45% light intensity increased number of leaves from 29 to 84, 65% light from 27 to 67, and 100% light from 36 to 57.; while the number leaves under 45% and 65% lights were significantly higher than that under 100% light. Similarly, at Owena, number of leaves under 45 – 100% lights increased from 3 MAT to 12 MAT. However, number of leaves under 45% and 65% lights were significantly higher than that under 100% light (Table 1). Similar trend was observed for number of branches in both locations especially at 12 MAT. However, the light intensities were not significantly different except at Owena (9 – 12 MAT) where 45 and 65% lights were significantly better than 100% light in enhancing branching in tea plants (Table 2). The different light intensities significantly influenced the leaf area of tea plants in Ibadan and Owena. In both locations, 45% light caused the highest leaf area throughout the sampling periods. At Ibadan, the highest leaf area was caused by 45% light (2885.75), followed by 65% light (1660.59) and 100% light (660.38). However, at Owena, both 45 and 65% light were not significantly different; but both engendered significantly higher leaf area than 100% light (Table 3).

The better performance of 45% light in enhancing number of leaves, number of branches and leaf area of tea plants might probably be as a result of subdued light precipitating optimal condition for photosynthesis by regulating leaf and canopy temperature (Janendra *et al*., 2007). This is in consonance with Sadgheti *et al.* (2018) who reported an increased leaf size of Sage (*Salvia officinalis* L.) under 50% light intensity, and Yue *et al*. (2021) who posited that under shade, tea plants produce large leaves. The 45% light was superior to 65 and 100% lights in enhancing nutrient uptake of tea plants (Table 4). In both locations, 45 and 65% lights were better than 100% light in enhancing the nutrient uptake. The highest N, P, K, Mg and Fe were caused by 45% light while the least were found in tea plants under

100% light. The P and K uptake at Ibadan as well as P and Fe uptake at Owena enhanced by 45% light was significantly higher (P=0.05) than that of 65 and 100% lights. The 45 and 65% lights were not significantly (P>0.05) different in enhancing N, Mg and Fe at Ibadan, and N, K, and Mg at Owena; but both were significantly (P=0.05) better than 100% light in the uptake of these nutrients. This might be because reduced lights precipitated conducive edaphic environment for easy absorption of this nutrients. This corroborates the work of Ogawa *et al.* (2010) who submitted that reduced light intensity enhanced the accumulation of amino acids in tea leaves.

Table 1: Effect of light intensity on number of leaves of tea plants on the field at Ibadan and Owena

Treatments	Ibadan				Owena			
Light intensities (%)	3 MAT	6 MAT	9 MAT	12 MAT	3 MAT	6 MAT	9 MAT	12 MAT
45	29.07b	41.05a	64.00a	84.07a	22.39a	34.61b	61.60a	87.74a
65	26.81b	34.05a	61.40a	66.50ab	26.50a	42.96a	72.09a	77.49a
100	35.86a	40.73a	39.55a	57.03b	22.39a	27.01c	43.65b	53.80b
Mean	30.58	38.61	54.98	69.20	23.92	34.86	59.11	73.01

Means followed by the same letters along a column are not significantly different by HSD (P=0.05); MAT = Months after transplanting

Table 2: Effect of light intensity on number of branches of tea plants on the field at Ibadan and Owena

Treatments	Ibadan				Owena			
Light intensities (%)	3 MAT	6 MAT	9 MAT	12 MAT	3 MAT	6 MAT	9 MAT	12 MAT
45	5.62a	10.02a	14.00a	15.86a	4.65a	7.90b	13.56a	20.02a
65	5.02a	8.16b	14.08a	16.40a	5.81a	9.42a	15.69a	20.72a
100	5.97a	11.26a	10.97a	15.20a	5.60a	7.52b	9.26b	14.44b
Mean	5.54	9.81	13.02	15.83	5.35	8.28	12.83	18.39

Means followed by the same letters along a column are not significantly different by HSD (P=0.05); MAT = Months after transplanting

Table 3: Effect of light intensity on leaf area (cm^2) of tea plants on the field at Ibadan and Owena

Treatments	Ibadan				Owena			
Light intensities (%)	3 MAT	6 MAT	9 MAT	12 MAT	3 MAT	6 MAT	9 MAT	12 MAT
45	1207.87a	1387.51a	1595.12a	2885.75a	684.67ab	1257.08a	2155.61a	3627.47a
65	1017.55a	1087.14b	1200.58b	1660.59b	860.58a	1484.91a	1877.44a	2879.53a
100	986.82a	814.16c	374.88c	660.38c	572.33b	710.41b	620.00b	1366.04b
Mean	1075.75	1096.27	1056.86	1735.57	705.86	1150.80	1551.02	2624.35

Means followed by the same letters along a column are not significantly different by HSD (P=0.05); MAT = Months after transplanting

Table 4: Effect of light intensity on nutrient uptake (mg/g) in the leaves of tea plant at 15 MAT on the field at Ibadan and Owena

Treatments	**N**	**P**	**K**	**Mg**	**Fe**
Light intensities (%)			**Ibadan**		
45	108.73a	1.14a	9.82a	9.26a	1.77a
65	75.01ab	0.64b	5.72b	6.57ab	1.21ab
100	43.53b	0.50b	3.15b	3.63b	0.64b
Mean	75.76	0.76	6.23	6.49	1.21
			Owena		
45	130.90a	1.91a	9.23a	10.00a	3.50a
65	96.46ab	1.37b	7.19ab	8.53a	2.28b
100	66.91b	0.77c	4.57b	5.41b	1.53b
Mean	98.09	1.35	7.00	7.98	2.44

Means followed by the same letters along a column in each location are not significantly different by HSD (P=0.05), MAT = Months after transplanting

CONCLUSION

Tea grown under 45 and 65% light intensities performed better than those grown in 100% light. However, the best performance was observed in tea grown under 45% light intensity. Therefore, it could be concluded that tea can be successfully grown in Ibadan and Owena, Southwest Nigeria under reduced light intensity of 45%.

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SELECTION OF SUITABLE CULTIVARS FOR HIGH TUNNEL TOMATO PRODUCTION IN IWOLLO, USING RANK SUMMATION INDEX

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ABSTRACT
Tomato is a highly valued horticultural crop that has high nutritional and economic benefits. It's production in Iwollo, Southeast Nigeria is low. High Tunnel is a less expensive greenhouse-like structure that is used to improve tomato production. A study to determine the cultivar best suitable for high tunnel tomato production in Iwollo was carried out at the Teaching and Research Garden of the Department of Horticultural Technology, Enugu State Polytechnic, Iwollo, Southeast Nigeria. High yielding tomato cultivars viz; Roma VF, BHN-1021, Supremo, Pomodro, Money maker and Iwollo local were evaluated. Completely Randomized Design with three replications was used for the study. Data were collected on some agronomic characters of interest and were analyzed using Analysis of Variance at 5% level of probability. The characters that showed significant differences among the cultivars were ranked and summed up to get the Rank Summation Index of the cultivars. The results showed that there were significant differences (p<0.05) among the cultivars in plant height, number of leaves per plant, number of branches per plant, days to maturity, number of fruits per plant, average fruit weight and fruit weight per plant. The Rank Summation Index showed that Supremo cultivar had the best score (18) and could be selected for high tunnel tomato production in Iwollo, Southeast Nigeria.
Keywords: *Rank Summation Index, Selection, Southeast Nigeria, Tomato cultivars*

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) belongs to the family *Solanaceae*. It originated in Mexico and it is widely grown all over the world as a garden or field crop (Rogers and Wszelaki, 2012). It is an important horticultural crop that is grown for both nutritional and economic benefits in Nigeria. It is palatable and succulent and used in preparing various types of dishes in Nigeria. Tomato is rich in vitamins, minerals, sugar, essential amino acids, dietary fibers and antioxidants (Enujeke, 2013). Despite the nutritional and economic benefits of tomato, production in Nigeria is low especially in South East Nigeria where yield is low due to unfavourable climatic factors that affect its yield in open field rain-fed production, among other factors. The bulk of the tomatoes consumed in the study area are from Northern Nigeria and they are expensive because of high cost of transportation and spoilage in the process.

The reliable way of controlling unfavourable environmental conditions in tomato production is through close production system. The well documented close production system in Nigeria is the use of greenhouse. However, greenhouse is very expensive making it unaffordable by most of the farmers in Southeast Nigeria. High tunnel is a greenhouse-like structure that creates micro-climate that impact biotic and abiotic factors and influences plant growth and development (Rogers and Wszelaki, 2012). It is a less expensive alternative to a true greenhouse and can be constructed with improvised material like bamboo making it even less expensive and affordable by small-holders farmers who contribute more to the production and availability of horticultural produce in the Nigerian food market. High Tunnel provides controlled environment against adverse climatic condition. It improves yield and fruit quality by reducing wind damage and injury from insects, diseases, birds, and rodents (Rogers and Wszelaki, 2012; O'Connell *et al.*, 2012; Martinez-Blanco *et al.*, 2011). Hunter *et al.*, (2012) noted that high tunnel can be used to extend growing season in tomato farming thereby increasing production.

Tomato cultivars have varied responses to environment in expression of the traits they possess. Mesbah *et al.* (2014) reported varied performance of some tomato varieties grown under high tunnel conditions. Schonbeck *et al.*, (2006) noted that decision on the choice of tomato cultivars to plant is a complex one. Warren *et al.* (2015) stated that cultivar selection remains a critical component to successful tomato production, and many important traits contribute to cultivar performance in all growing environments, including high tunnels. According to Bertini *et al.*, (2010), cultivars selection should not be based on single factor as cultivars with economic potential have multiple traits that control productive performance; adaptability and stability.

Rank Summation Index proposed by Mulamba and Mock (1978) is a widely used multiple-trait selection tool that allows superior and adaptive cultivars to be selected by combining several attributes (Coutinho *et al*., 2019). It involves ranking the performance of cultivars in respect to the desired agronomic characters and summing the ranks of several characters for each cultivar, with lower score suggesting better performance (Teixeira *et al*., 2012; Coutinho *et al*., 2019). Rank Summation Index has been applied by Okoli (2021) and Onwubiko *et al.* (2018) for the selection of superior genotypes in maize and bambara groundnut, respectively. There is dearth of information on the suitable tomato cultivars for high tunnel production in the study area; hence, evaluation of tomato cultivars with high horticultural potential for high tunnel production using Rank Summation Index that factors multiple traits became necessary to improve tomato production in Iwollo, Southeast Nigeria. The study was therefore aimed at evaluating some high yielding tomato cultivars namely; Roma VF, Supremo, Pomodro, Money maker, BHN-1021 and Iwollo local using Rank Summation Index to determine the best suitable cultivars under high tunnel conditions for improved tomato production in Iwollo, Southeast Nigeria.

MATERIALS AND METHODS

The experiment was carried out at the Research and Teaching Garden of the Department of Horticultural Technology, Enugu State Polytechnic, Iwollo, Southeast, Nigeria, located within Latitude 06016.834' N and longitude 007016.834' E. A high tunnel of 7m high by 5m wide by 9m long was constructed using bamboo sticks. The high tunnel was covered with a blue polyethylene film. High yielding tomato cultivars *viz*; Supremo, BHN-1021, Roma VF, Money maker, Pomodro and Iwollo local were used for the experiment and were sourced from the Department of Horticultural Technology, Enugu State Polytechnic, Iwollo. The experiment was carried out in a Completely Randomized Design (CRD) having three replications. The six tomato cultivars which served as treatments were randomly assigned to the experimental unit. Wooden boxes of 0.25m high, 1.5m long and 0.5m wide, each filled with top soil mixed with 1kg of poultry manure were used as growth media. Healthy tomato seedlings from the nursery for each cultivar were transplanted into the wooden boxes four weeks after sowing in a single row using a spacing of 0.5m between plants giving a total of 3 plants per box. The plants were watered as at when due. Weeding was done manually using small hoe. The plants were protected against nematodes using Carbofuran (5G) incorporated into the soil one week before transplanting. Lambda cyhalothrin was used to control insect pest while Cabendazem and Mancozeb were used to control fungal diseases.

Observations were made on number of leaves per plant, number of branches per plant, plant height, days to 50% flowering, disease severity, days to fruit maturity, number of fruits per plant, average fresh fruit weight and fresh fruit weight per plant using the procedures described by Adinde *et al.* (2016). The data collected were subjected to Analysis of Variance (ANOVA) at 5% level of probability using Genstat Release 10.3DE software (GenStat, 2011). Rank Summation Index was used to rank the cultivars for their overall performance with respect to characters that varied significantly ($p<0.05$) among the cultivars, using the Rank Summation Index model:

$Ij = \sum nij$, where Ij is the index for cultivar j and nij is the ranking number of character i for cultivar j. The cultivars were first ranked for each of the characters they showed significant difference using the mean values and the ranks were summed up to get the Rank Summation Index score for each of the cultivars.

RESULTS AND DISCUSSION

The results of the analysis of variance of some agronomic characters of the tomato cultivars evaluated showed that there were significant differences ($p<0.05$) among the cultivars in plant height, number of leaves per plant, number of branches per plant, days to fruit maturity, number of fruits per plant, average fruit weight and fruit weight per plant (Table 1). This was in agreement with Mesbah *et al.* (2014) who reported varied growth and yield performance of some tomato cultivars grown under High Tunnel. Bento (2008) also noted that tomato cultivars available today have a wide range of characteristics and observed that tomato cultivars are specifically adapted to a particular environment. There was non- significant difference among the cultivars in disease severity. This probably suggest that High Tunnel provides protection against disease by wading off insect and protecting the crop against rain splashes that aid spread of fungi disease in tomato farms. Orzolek *et al.* (2002) opined that Tomato Production under High Tunnel could provide more economic return compared to field production.

Determining the performance of the cultivars through ranking using parameters that varied significantly among the cultivars namely: plant height, number of branches per plant, number of leaves per plant, days to fruit maturity, number of fruits per plant, average fruit weight and fruit weight per plant, the results showed that the lowest Rank Summation Index value was obtained in Supremo tomato cultivar (18) followed by Money maker cultivar (22); Roma VF (25) and the highest was in Iwollo local cultivar (34) (Table 2). The lower the Rank Summation Index score the better the performance. Thus, Supremo cultivar was the best performer under High Tunnel conditions followed by Money maker and the least was Iwollo local. Supremo cultivar probably has superior multiple traits that control productive performance, adaptability and stability for high tunnel production. Clark *et al*. (1997) attributed differences in varietal performances to variations in genetic structure, mineral concentration and potentials to transport photosynthetic materials. Elings (1999) noted that crop performance is determined by the interaction between it's genetic makeup and the environment where it is grown. A cultivar can express its genetic potential under optimal environmental conditions. Supremo cultivar probably had superior productive genotype and environmental interaction under High-tunnel compared to the other cultivars evaluated.

Table 1: Mean values of some agronomic characters of the tomato cultivars

Cultivars	PHT (cm)	NLVS	Number of branches	D50% F	DS	DFM	NFRPP	AFW (g)	FWTPP (kg)
Roma VF	55.00	58.33	8.83	45.67	1.33	95.20	14.83	50.74	0.75
Supremo	67.00	58.03	7.17	44.67	2.33	68.10	8.33	119.86	1.00
BHN -1021	76.19	58.20	5.33	43.67	2.00	72.00	8.17	102.50	0.84
Iwollo local	64.10	49.50	7.33	41.00	1.33	96.00.	14.67	40.02	0.58
Pomodro	66.19	48.20	7.20	42.67	2.33	78.20	12.42	97.50	0.81
Money maker	65.20	49.80	7.54	43.00	2.00	75.10	14.92	60.20	0.77
	P<0.05	P<0.05	P<0.05	ns	Ns	P<0.05	P<0.05	P<0.05	P<0.05

P<0.05= probability value is less than 0.05. ns =non-significant. PHT=Plant height (cm); NLVS=Number of leaves; NBR=Number of branches; D50%F= Days to 50 percent flowering. DS= Disease severity; NFRPP=Number of fruits per plant; AFW= average fruit weight(kg); DFM= Days to fruit maturity and FWTPP=Fruits weight per plant (kg)

Table 2: Rank Summation Index of the tomato cultivars

Cultivar	Plant height (cm)	Number of leaves	Number of branches	Days to fruit maturity	Average fruit weight (g)	Fruit weight per plant (kg)	Rank summation index
Roma VF	6	1	1	5	2	5	25
Supremo	2	3	5	1	5	1	18
BHN-1021	1	2	6	2	6	2	21
Iwollo Local	5	5	3	6	3	6	34
Pomodro	3	6	4	4	4	3	27
Money Maker	4	4	2	3	1	4	22

CONCLUSION

The findings of the study showed that there were significant variations on some agronomic characters among the cultivars under High Tunnel conditions. Rank Summation Index of the cultivars showed that Supremo cultivar had the best score and could be best suited for high tunnel tomato production in Iwollo, Southeast Nigeria. Other cultivars especially BHN-1021 and Money maker could be considered for selection for improvement using High Tunnel Tomato Production. Further studies should consider widening the number of tomato cultivars for evaluation and study areas to develop a horticultural protocol for High Tunnel Tomato Production in Southeast Nigeria towards improving tomato production in the zone.

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EFFECT OF ORGANIC FERTILIZER RATES ON GROWTH OF OKRA (Abelmoschus Esculentus l.) VARIETIES IN KANO STATE, NIGERIA

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ABSTRACT
Field trials were conducted during 2020/2021 dry season at Research Farm of Faculty of Agriculture and Agricultural Technology, Kano University of Science and Technology Wudil (110 58'N, 80 25'E and 450m above seas level) and Institute for Agricultural Research, Kadawa (110 39'N, 80 27'E and 500m above seas level). The experiments were laid out to investigate the effect of different rates of organic manure (Poultry Manure) 4 t/ha (3.6 kg/plot), 6 t/ha (5.4 kg/plot), control (0 t/ha/plot) on growth and yield of three okra varieties (Jokoso, NHAe-47-4 and local variety yarballe). Treatments were allocated in a randomized complete block design (RCBD) in three replications. Data were collected on growth parameters (Plant height, number of leaves per plant, leave area index, seedling vigor, days to 50% flowering). Results obtained indicated that poultry manure positively influenced growth and yield of okra. Poultry manure positively increased Plant height, number of leaves per plant, leaf area index, seedling vigor, days to 50% flowering. Based on the findings of the experiments it could be deduced that poultry manure seems to promote higher growth of okra, hence, application of poultry manure of 6 t/ha and 4 t/ha significantly influenced better growth and development of okra compared to control by supplying adequate nutrients which increased its growth and development. Jokoso and NHAe47-4 were improved varieties that performed better than the local variety of yarballe in the study areas.
Keywords: *Okra, Growth, Yield, Organic Manure*

INTRODUCTION

Okra (*Abelmoschus esculentus* L. moench) is a fruit vegetable belonging to the family malvaceae. (Awurum and korie, 2011). It is an important vegetable cultivated in the tropical and subtropical region of the world. It can be found in almost every market in Africa (Schippers 2000). It is a good source of minerals, calories and amino acid found in seeds and compared favorably with those in poultry, egg and soybean. (Thompson 1949; and scippers, 2000). The crop is used as soup thickener which may also be served with rice and other food types (Eke *et al*, 2008). Okra is a perennial often cultivated as annual in temperate climates and often grows to around 2 m tall. It is related to such species as cotton, cocoa and hibiscus. The leaves are 10 cm -20 cm long and broad, palmately lobed with 5-7 lobes. The flowers are 4-8 cm in diameter, with a red or purple spot at the base of each petal. The fruit is a capsule up to 18 cm long with pentagonal cross-section containing numerous seed. Abelmoschus esculentus is cultivated throughout the tropical and warm temperature of the world for it fibrous fruits or pods containing round white seeds, it is among the most heat and drought-tolerant. It is now widely distributed in the tropics including Nigeria. It is an important vegetable crop occupying a land area of 277,000 hectares with a production of 731,000 metric tons worldwide and productivity of 2.63 t ha-1 in Nigeria.

Use of organic manures as a means of maintaining and increasing soil fertility has been advocated (Rodale, 1984; Smil, 2000). Poultry manures, when efficiently and effectively used, ensure sustainable crop productivity by immobilizing nutrients that are susceptible to leaching. Poultry manure is an excellent organic fertilizer, as it contains high nitrogen, phosphorus, potassium and other essential nutrients (Oyewole and Oyewole, 2011). Nutrients contained in manures are released more slowly and are stored for a longer time in the soil ensuring longer residual effects, improved root development and higher crop yields (Sharma and Mittra, 1991; Abou El Magd *et al.*, 2006). Manures are usually applied at higher rates, relative to inorganic fertilizers. When applied at high rates, they give residual effects on the growth and yield of succeeding crops (Makinde and Ayoola, 2008) Improvements of environmental conditions as well as the need to reduce cost of fertilizing crops are reasons for advocating use of organic materials (Bayu *et al*., 2006). Organic manures improve soil fertility by activating soil microbial biomass (Ayuso et al., 2008). Application of manures sustains cropping system through better nutrient recycling (El-Shakweer *et al*., 2009). Manures provide a source of all necessary macro- and micro-nutrients in available forms, thereby improving the physical and biological properties of the soil (Abou El-Magd *et al*., 2006). Chemical fertilizer could cause problems not only to the soil health but also to the human health and physical environment.

In spite of the potential of okra as a food security vegetable crop, yields are generally low in the tropics due to growing population and attendant pressure on land resulting in more intensive agriculture and declining soil fertility (Mbagwu and Skwealor 2006). The scarcity of inorganic fertilizer associated with high cost has created a lot of problem in arable crop production in Nigeria. In the past, farm yard manure has been used to improve and supplement soil nutrient (Adeyele *et al* 2010). This research was conducted to assess the effect of poultry manure on growth parameters of okra.

MATERIALS AND METHODS

Study Area

Field trials were conducted at Research Farm of Faculty of Agriculture and Agricultural Technology, Kano University of Science and Technology Wudil (110 58'N, 80 25'E and 450m above seas level) and institute for Agricultural Research, Kadawa (110 39'N, 80 27'E and 500m above seas level).

Treatment and experimental design

The experiments were laid out in a randomized complete block design (RCBD) with nine treatments combination and replicated three times. The treatments were three levels of poultry manure 4 t/ha (3.6 kg/plot) and 6 t/ha (5.4 kg/plot), control 0 t/ha and three varieties of okra (Jokoso, NHAe47-4 and local variety yarballe.

Experimental Materials

Three (3) varieties of okra (Jokoso, NHAe47-4 and local variety yarballe obtained from Department of Agronomy, Faculty of Agric., ABU Zaria was used to determine their response to different levels of poultry manure i.e 3.4 kg/plot (4 t/ha), 5.4 kg/plot (6 t/ha) and control (0 t/ha). Ploughing and harrowing was done to obtain a fine tilth soil and ridges of 75 cm apart was made. Three seeds of okra per hole was sown with inter and intra row spacing of 75 cm × 25 cm respectively. Organic fertilizer application was done two weeks before planting using drilling method at the rate of 3.6 kg and 5.4 kg where by the ridges was drilled open at the centre and the organic manure applied based on the experimental rate and covered with soil. Weeding was carried out three times, at three (3) and six (6) weeks after planting using hoe and one supplementary hand weeding. Fruits were harvested after its maturity by cutting off the fresh fruit with knife from the plant, harvesting was done at the interval of four days.

Data Collection

Data were collected for the following parameters

Plant Height (cm), Number of Leaves, Number of Days to 50% Flowering, Number of Days to maturity, Leaf Area (cm2), Number of Fruit/Plant, Fruit Length (cm), Fruit Diameter (cm), Number of Flowers per Plant and fruit yield (kg/ha)

Data Analysis

Data recorded were subjected to analysis of variance (ANOVA) using GENSTAT (17 edition), the treatment means that were significantly different were compared using fisher's LSD

RESULTS AND DISCUSSION

Plant Height

The effect of rate of organic fertilizer on plant height of okra varieties at Wudil and Kadawa during 2021 dry season is presented in table 1. The result shows that Plant height was significantly ($P<0.05$) affected by different rate of poultry organic manure in both locations across 3, 6 and 9 weeks. At Wudil 6 t/ha and 4 t/ha were significantly the same and produced the tallest plants across the period of sampling compared to control. Likewise, at Kadawa the same trend was observed at 3, 6 and 9 wap. The positive effect of organic manure on plant height could be due to the contribution made by manure to fertility status of the soils. Manure when decomposed increases both macro and micro nutrients as well as enhances the physico-chemical properties of the soil. This could have led to its high vegetative growth. Aniefiok et al. (2013) agrees with this finding in which they reported that organic manure, especially poultry droppings could increase plant height and number of leaves. Also from the Table 1, it was observed that the effect of poultry manure rate significantly affected the variety of okra with improved varieties of Jokoso and NHAe47-4 having significantly (P≥0.05) similar performance across 3 and 9 wap performed better than the local variety of yarballe, while there was no significant difference at 3wap among the varieties tested. The reason for this might be that the yield potential of these varieties were genetically improved since genetic makeup of an individual affects its performance generally, report from IAR (1985) indicated that plant height of okra is genetically determined. The interaction of variety and poultry manure rates was not significant (P≥0.05) in both locations.

Number of Leaves

The effect of rate of organic fertilizer on number of leaves of okra varieties at Wudil and Kadawa during 2021 dry season is presented in table 2. The poultry manure rates at Wudil location significantly (P≥0.05) affected number of leaves of okra at 6 wap only where 6 t/ha and 4 t/ha have statistically the highest number of leaves compared with control treatment while at Kadawa there were significant difference (P≥0.05) among the poultry rates at 6 and 9 wap only where 6 t/ha and 4 t/ha were statistically the same and have the highest mean values compared to control rates that possess the lowest mean values. This may be attributed to the increase rate of poultry manure which resulted in a corresponding increase in both vegetative traits in okra compared to control, this indicates that an increase in nitrogen promotes vigorous plant growth. The increase in number of leaves per plant with organic fertilizer application stressed its importance during the vegetative growth of crop plants (Tindall, 1992). This agrees with the study of John et al. (2004) who reported that poultry manure contains essential nutrients which are associated with high photosynthetic activities that promote root and vegetable growth. This agrees with the work of Dauda et al. (2008). Table 2 also shows that varieties of okra significantly influenced (P≥0.05) number of leaves across the two locations, at Wudil, there was no significant difference between varieties at 3wap, but significant difference (P≥0.05) at 6 and 9wap with improved variety Jokoso having the highest number of leaves compared to local variety of Yarballe that possessed the least number of leaves. While at Kadawa there were also no significant difference at 3wap, but significant difference existed at 6 and 9wap where the two improved varieties (Jokoso and NHAe47-4.) possessed the highest mean values of number of leaves and are statistically similar compared to local variety of Yarballe that possessed the lowest number of leaves. Significant difference (P≥0.05) does not exist between the interaction of variety and poultry manure rates in both locations.

Days to 50% Flowering, Leaf Area Index and Seedling Vigor

The effect of rate of organic fertilizer on Days to 50% flowering, leaf area index and seedling vigor of okra varieties at Wudil and Kadawa during 2021 dry season are presented in Table 3. Days to 50% flowering of okra was significantly affected by different rate of poultry manure across the locations, at Wudil, application of 6 t/ha of poultry manure exhibited the earliest date to flowering compared to the 4 t/ha and control application that were statistically the same and produced the longest date to flowering. Also, Application of 6 t/ha of poultry manure at Kadawa exhibited the earliest date to flowering compared to control that delayed the flowering period. Earlier production of flower and fruit may be due to excellent release of macro and micro-nutrients from the poultry manure. This finding agrees with Garge and Bahla (2008) who reported that poultry manure readily supply phosphorous to plants than other organic sources. Also similar observation was made by Tu et al. (2006) and Ayuso et al., (2008) that microbial biomass and activities were higher in organically managed soils compared to conventional soil amendment with synthetic inorganic fertilizer.

There were significant influences among the varieties on the date to 50% flowering at both locations. At Wudil, Jokoso and NHAe47-4 were found to be statistically the same and exhibited the least days to 50% flowering compared to local variety of yarballe that had a prolong days to 50% flowering. While at Bagauda, Jokoso variety possessed the least days to 50% flowering compared to local variety of yarballe that bear the longest days to 50% flowering. There was no interaction between variety and poultry manure rates that was significant (P≥0.05) in both locations. The result of this study as presented in table 3 revealed that there was significant difference (P≥0.05) among the different rates of poultry manure applied with regard to leaf area index at both locations, at Wudil. The rates of 6 t/ha and 4 t/ha were statistically similar and produced the highest leaf area index compared to the control that produced the lowest leaf area index. While at Kadawa, the rate of 6 t/ha influence the highest leaf area index compared to control rate that has the lowest leaf area index. There was no significant difference among the varieties tested across the locations. The interaction of variety and poultry manure rates was not significant (P≥0.05) in both locations.

Table 3 also indicated that seedling vigor was significantly affected (P≥0.05) by different rates of poultry manure at both locations. The rates of 6 t/ha and 4 t/ha were statistically similar and were found to possessed the highest seedling vigor compared to control treatment which possessed the lowest seedling vigor This could also be related to low C:N ratio, lignin and lignin/N values These attributes of poultry manure will lead to fast mineralization and early release of nutrients to a short gestation crop like okra, hence there was a boost in the morphological growth of the plant which translate to greater yield (Aruna O. A. *et. al,* 2020). There was no any significant difference among the varieties tested across the locations also the interaction of variety and poultry manure rates was not significant (P≥0.05) in both locations.

CONCLUSION

Based on the finding from this study, it can be concluded that application of poultry manure at 6 t/ha and 4 t/ha significantly influenced better growth and development of okra compared to control by supplying adequate nutrients which increased its growth and development. Jokoso and NHAe47-4 were improved varieties that performed better than the local variety of yarballe in the study areas.

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Table 1: Effect of Rate of Organic Fertilizer on plant height of Okra (Abelmoschus esculentus L.) Varieties at Wudil and Kadawa during 2021 dry season.

Treatments	Locations					
Poultry manure	Wudil			Kadawa		
	PLHT3	PLHT6	PLHT9	PLHT3	PLHT6	PLHT9
6t/ha	8.20a	21.11a	52.89a	14.87a	24.72a	64.9a
4t/ha	7.29a	17.72ab	44.59ab	11.42b	17.39ab	57.29a
Control (0t/ha)	5.98b	14.66b	35.5b	7.87c	11.43c	40.94b
SE±	1.01	3.93	9.57	1.19	3.25	9.31
Variety						
Jokoso	7.60a	20.56a	49.89a	12.19	21.22a	60.49a
N.H.E.A-47	6.93ab	19.04ab	47.44a	11.71	18.88ab	58.44a
Local yarballe	6.18b	15.44b	37.87b	10.26	14.44b	42.87b
SE±	1.37	4.58	9.34	3.26	4.93	9.73

Table 2: Effect of Rate of Organic Fertilizer on Number of leaves of Okra (*Abelmoschus esculentus L.*) Varieties at Wudil and Kadawa during 2021 dry season.

Treatments	**Locations**					
Poultry manure	**Wudil**			**Kadawa**		
	3WAP	6WAP	9WAP	3WAP	6WAP	9WAP
6t/ha	4.78	10.67a	18.22	4.78	12.67a	22.11a
4t/ha	4.67	9.89a	18.11	4.67	10.67b	17.89b
Control (0t/ha)	4.33	7.33b	15.33	4.33	8.00c	13.44c
SE±	0.5	1.6	3.04	0.5	1.59	2.52
Variety						
Jokoso	4.67	10.89a	20.33a	4.67	12.11a	20.33a
N.H.E.A-47	4.67	9.22ab	16.89b	4.67	10.22ab	17.89ab
Local yarballe	4.44	7.78b	14.44c	4.44	9.00b	15.22b
SE±	0.53	1.75	2.06	0.53	2.23	4.05

Table 3: Effect of Rate of Organic Fertilizer on Days to 50% flowering, Leaf area index and sidling vigor of Okra (***Abelmoschus esculentus L***.) Varieties at Wudil and Kadawa during 2021 dry season.

Treatments	**Locations**					
Poultry manure	**Wudil**			**Kadawa**		
	Days 50%flw	LAI	SDL_VGR	Days 50%flw	LAI	SDL_VGR
6t/ha	49.22a	1.72a	1.889a	48.44a	1.943a	1.33ab
4t/ha	55.33b	1.488ab	1.333ab	50.67b	1.14b	1.11a
Control (0t/ha)	59.56b	1.229b	1.111b	54.78c	0.629c	1.89b
SE±	5.22	0.34	0.59	2.17	0.2	0.59
Variety						
Jokoso	49.44a	1.713	1.78	61.56a	1.40	1.70
N.H.E.A-47	54.33a	1.477	1.33	55.00b	1.23	1.29
Local yarballe	60.33b	1.247	1.22	50.89b	1.09	1.21
SE±	5.0	0.35	0.64	5.32	0.61	0.63

CONSTRAINTS AFFECTING CASHEW PRODUCTION IN OYO STATE, NIGERIA

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ABSTRACT
The constraints of cashew farmers in the production of cashew were analysed in this study. Data were collected using a well-structured questionnaire administered to sixty (60) respondents selected through a multi-stage sampling techniques. The data collected were analyzed with descriptive statistics and multiple linear regression. The result revealed that the age of cashew farmers and the cost of weeding significantly (P<0.05) affect cashew production positively while household size and cost of chemicals (P<0.05) have a negative effect on cashew production. Also, all the respondents (100%) in the study area ranked inadequate credit (finance) and unstable price of produce as the most severe constraints. Incentives such as soft loan should be provided for cashew farmers to alleviate the constraints of inadequate credit in order to increase their level of income which will thereby promote cashew production.
Keywords: *Cashew Production, Constraints, Oyo State, Nigeria*

INTRODUCTION

Cashew is one of the most important agricultural commodities in Africa. It has contributed to Gross Domestic Product (GDP), National Income (NI) and foreign exchange earning of many cashew producing States in Africa (Oluyole et al, 2015). The studies at Cocoa Research Institute of Nigeria (CRIN) have created the capabilities of exploiting the apple to produce juice, wine, vinegar, jam and so on while whole cashew kernels when roasted plain or salted are eaten up as desert fruit. However, cashew kernels grounded are mixed with cocoa to produce cashew chocolate and the cracked ones are made into cashew butter (Olunloyo, 1999). Most of the constraints militating against cashew production results from damages from different stages of production thereby leading to high loss of yield. Therefore, considering the effects the various constraints are having on farmers' productivity, it is quite imperative that this study which investigates the constraints in cashew production among cashew farmers in the study area is carried out.

Cashew production in Nigeria, most especially in Oyo State are faced with many constraints. Akinwale and Ayodele (1999) identified some constraints of cashew production as land acquisition (about 60% of Nigeria cashew nut production are small-scale farmers who used between 2-4ha of cashew farm), unavailability of labour, lack of processing technology, high cost of production, unstable market system, high interest rate, low funding, inadequate infrastructural facilities such as rural roads, electricity, water supply and poor exit services. Inadequate availability of good planting material and prevalence of Powdery Mildew Disease (PMD) are also major constraints to cashew production. Although recent studies by Oluyole et al (2015) have identified various constraints militating against cashew production which varies from one place to the other in Southwestern Nigeria, it is necessary to carry out similar study in Oriire and Surulere local government areas to corroborate existing research findings. This necessitates this research work on the constraints of cashew production among farmers in Oyo State.

The main objectives of the study are to:

(i) describe the socio-economic characteristics of cashew farmers in the study area;
(ii) examine the farm inputs affecting cashew production in the study area;
(iii) analyze the constraints affecting cashew production in the study area; and

MATERIALS AND METHODS

Sampling Procedures or Techniques

Multi-stage sampling procedure was used to sample the respondents from the agricultural zones in Oyo state. Oyo state has four (4) agricultural zones, namely Ibadan/Ibarapa zone, Oyo zone, Ogbomoso zone and Saki zone. In the first stage, Ogbomoso zone was purposively selected based on the intensity of cashew production. The second stage involved purposive selection of two local government areas (Surulere and Oriire) from Ogbomoso zone. The last stage involved the random selection of thirty cashew farmers from each of the local government areas giving a total of sixty (60) respondents that was used for the study. Well-structured questionnaires were administered to the respondents in the study area. Data collected were analysed with descriptive statistics and multiple linear regression.

Method of Data Analysis

Multiple Linear Regression

The multiple linear regression model for the factors affecting cashew production are presented in equation (1). The result of the analysis is shown in Table 2. Also, Thusyanthini et al (2019) used multiple linear regression to achieve the objectives of the factors affecting cashew production.

$Yi = \beta o + \beta 1x1i + \beta 2x2i + \dots\dots\dots + \beta nxni + ei$ ……………………………… (1)

Where: Yi = Total cashew output of the farmer in kilogram per hectare (kg/ha)

β1 to βn = coefficients relating the n explanatory variables to the variables of interest

X1 = Age of cashew farmers, X2 = Years of farming experience

X3 = Level of education, X4 = Household size, β0 = Constant term

X5 = Farm size, X6 = Cost of weeding, X7 = Cost of chemical

ei = Random error which are assumed to be independently and identically distributed.

RESULTS AND DISCUSSION

Table 1 below shows the socio economic characteristics of the cashew farmers in the study area. The results revealed that 68.30% which constitute the majority are male cashew farmers with females being 31.70%. This corroborate with what was reported by Uwagboe et al. (2010) that there is male dominance in cashew farming in Oyo State probably because females were allowed to cultivate arable crops on their husband's farm plots while access to permanent crop production is usually restricted to men (Abubakar, 2003). Majority of them (36.70%) have primary education while 15.00% were university graduates indicating that the farmers are fairly educated which would enhance their farming activities and level of awareness of new technology as well as the ability to quickly adopt new technology. Further analysis shows that the mean age of the farmers was 56 years and its standard deviation was 12.24, this implied that cashew farming is being practiced by middle age farmers who are still strong to carry out farming activities. The mean year of cashew farming experience was at 26 years and its standard deviation was 12.02. Most (96.70%) of the farmers were married. This indicates a higher chance of involving family labour in cashew production. The mean household size is at 8.00 while its standard deviation was 3.49. Most (97.00%) of the farmers have between 1 - 10 hectares or more of cashew farm size while 3.30% of the farmers have less than 1 hectare of cashew farm size and its mean is 4.00.

Table 1: Socio-economic characteristics of cashew farmers in Oyo State

Variables	Frequency	Percentage (%)	Mean	Standard Deviation
Gender				
Male	41	68.30		
Female	19	31.70		
Total	60	100.00		
Age (years)				
35 – 45	15	25.10		
46 - 56	14	23.30		
57 – 67	19	31.70	56	12.24
68 – 78	10	16.90		
79 – 89	2	3.00		
Total	60	100.00		
Years of cashew farming experience				
<10	1	1.70		
10 – 20	24	40.00		
21 – 30	18	30.00	26	12.02

31 – 40	9	15.00		
41 and above	8	13.30		
Total	60	100.00		
Marital Status				
Single	2	3.30		
Married	58	96.70		
Divorced	0	0.00		
Widowed	0	0.00		
Total	60	100.0		
Level of Education				
None	5	8.30		
Primary	22	36.70		
Junior High School	8	13.30		
Senior High School	15	25.00		
Tertiary	9	15.00		
Adult Education	1	1.70		
Total	60	100.00		
Household size (persons)				
<5	1	1.70		
5 – 9	51	84.90		
10 – 14	5	8.30	8	3.49
15 – 19	1	1.70		
20 -24	2	3.40		
Total	60	100.00		
Size of cashew farm (ha)				
<1	2	3.30		
1 – 2	8	13.30		
2 – 4	20	33.30	4	
4 – 6	11	18.30		
6 – 8	9	15.00		
8 – 10	3	5.00		
>10	7	11.70		
Total	60	100.00		

Source: Field survey, 2022

The results presented in table 2 shows the various constraints affecting cashew production in the study area. The result analysis shows that the coefficient of determination - R2 is 0.9734 which indicated that 97.34% of the variation in the dependent variable is explained by the independent variables included in the model. The result further shows an F- statistical value which is significant at 1% level. This indicates that the model used for the analysis is of a good fit. Also, the result in table 2 shows that the age of the farmers, household size and the cost of weeding are significant at 5% level of probability. These are critical variables affecting cashew production. Age of the cashew farmers has a positive effect indicating that the mean age of the farmers (56 years) has a positive effect on cashew production. Household size has an inverse relationship with cashew production, this is however against the a priori expectation, however, this could be as a result of the fact that majority in the household are juvenile who cannot be used for labour work on the cashew farm. Furthermore, the cost of weeding has a direct impact on the production of cashew showing that the more cost incurred on weeding the better the cashew production. Cost of chemicals was found to have an inverse relationship with cashew production indicating that a unit increase in the cost of chemical will give a corresponding decrease of 22% in cashew production.

Table 2: Farm Inputs affecting cashew production in Oyo State

Farm Inputs	Coefficient	Standard Error	T	P>|t|	[95% Confidence	Interval]
Age	25.162	8.112	3.100	0.021**	5.313	45.011
Years of farming experience	-2.121	8.086	-0.260	0.802	-21.906	17.663
Level of education	25.116	44.540	0.560	0.593	-83.869	134.102
Household size	-105.093	41.609	-2.530	0.045**	-206.906	-3.279
Farm size	94.452	54.317	1.740	0.133	-38.458	227.360
Cost of weeding	0.105	0.043	2.440	0.051**	-0.000	0.209
Cost of chemical	-0.220	0.094	-2.340	0.058***	-0.450	0.010

R^2 = 97.34 Prob > F = 0.0003

Note: *, ** and *** denote t-test significant at 1%, 5% and 10% levels respectively.

Source: Field Survey, 2022

Constraints experienced by cashew farmers

Table 3 reveals that all the respondents ranked inadequate credit and unstable price of produce as the most severe constraints while land tenure problem and inadequate rainfall were ranked as the least constraints (60%). This implies that cashew farmers in the study area find it difficult to obtain loan from banks due to collateral needed to enhance increase in their cashew production which would increase their level of income. This finding is in consonance with Uwagboe et al (2010) study which revealed that inadequate capital was ranked the most severe constraints faced by cashew farmers in Oyo State. Land tenure problem and inadequate rainfall are seen to be the least constraints due to the fact that land could easily be accessible by the cashew farmers. Also, cashew is drought tolerant so rainfall may not be a major constraint.

Table 3: Constraints Faced by Cashew Farmers in Oyo State

Constraints	Frequency	Percentages	Ranking (%)
Inadequate credit	60	100.00	1
Unstable price of produce	60	100.00	2
High cost of labour	57	95.00	3
Lack of improved planting materials	55	91.70	4
Skill acquisition	54	90.00	5
Difficulty in accessing extension services	52	86.70	6
High cost of transportation	51	85.00	7
Poor road network	48	80.00	8
High cost of fertilizer	38	63.30	9
Land tenure problems	36	60.00	10
Inadequate rainfall	36	60.00	11

Source: Field survey, 2022

CONCLUSION AND RECOMMENDATION

This study concludes that the major constraints affecting cashew production are age of the cashew farmers, household size of the farmers, cost of weeding as well as the cost of chemicals. Inadequate access to credit facilities and unstable price of cashew are also major constraints to cashew production in the study area. It is recommended that government should provide loan to the cashew farmers to enable them to acquire the necessary farm inputs in order to alleviate the constraints of inadequate credit (finance).

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CONSUMERS' PERCEPTION AND PREFERENCE FOR DRIED PINEAPPLE SLICES IN IBADAN METROPOLIS

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ABSTRACT
This research investigates consumers' perception and preference for dried pineapple slices as a value-added agricultural product. Drying fruits, including pineapples, is a popular preservation method that enhances shelf-life and nutritional value. Understanding consumers' perceptions and preferences regarding dried pineapple slices can provide valuable insights for producers, marketers, and policymakers in the agricultural sector. The study utilizes a combination of quantitative surveys and qualitative interviews to explore factors influencing consumers' attitudes towards the product, such as colour, texture, aroma and general appearance, which were found to significantly affect consumers' preference, suggesting improving sensory attributes could increase consumer acceptance. A survey of 60 consumers found 68.3% preferred dried to fresh pineapple. Over 85% felt drying could reduce perishability and off-season scarcity. Respondents perceived dried pineapple as nutritious and were willing to purchase it off-season. Dried pineapple chips have good market potential. The study recommends further research on processing perishable fruits to enhance shelf life and meet consumer demand. In summary, drying pineapples into slices could curb postharvest losses, satisfy consumer preferences, and provide off-season availability through superior texture, color, aroma and appearance.
Keywords*: Dried pineapple slices, Fruits, Consumers' perception, Food preference, Preservation.*

INTRODUCTION

Pineapple, a tropical fruit, has been identified as the third most valuable fruit globally, following bananas and citruses such as grapefruit, limes, lemons, and oranges (Olayinka, 2013 and Esiobu *et al*., 2014). In Nigeria, pineapple farming is a significant source of income for a considerable number of farmers. However, Nigeria's pineapple production is relatively low compared to other producing countries, with a productivity rate of 7.9 tons/ha (Adegbite and Adeoye, 2015). Pineapple, apart from being a delicious fruit with an excellent flavor, is a rich source of dietary fiber, vitamins A, B, B6, C, E, and sugar (15%) (Portia *et al*., 2017; Iwuchukwu *et al*., 2017; Enibe *et al*., 2018). Nigeria ranks seventh globally as a pineapple producer, accounting for 1.42 million metric tons or 5.8% of the world's output at 7,778T/ha (Akhilomen *et al*., 2015).

Pineapple is regarded as an excellent source of vitamins A, B, C, along with calcium, magnesium, potassium, and iron. Additionally, it is a valuable source of bromelin, a digestive enzyme. Pineapple can be consumed either fresh or in the form of juice, jam, squash, saturated fats, and cholesterol, all while providing a rich source of fiber (Wilcox *et al*., 2015). According to Hossain (2016), pineapple production is carried out on more than 2.1 million acres in over 82 countries worldwide, including Thailand, Brazil, Costa Rica, India, Nigeria, Kenya, Indonesia, Mexico, Hawaii, Philippines, Australia, South Africa, Puerto Rico, Cuba, and Formosa. Among these countries, Nigeria ranks seventh globally and first in Africa in pineapple production. Enibe *et al*. (2018) conducted a study on pineapple marketing in Anambra State and found it to be profitable, recommending its exploration by potential traders and entrepreneurs. Iwuchukwu *et al*. (2017) investigated the problems and prospects associated with pineapple production in Enugu State. However, there still exist research gaps on the crop that warrant further investigation.

The marketing of pineapples is primarily distinguished by the challenge of perishability, among other factors. In many instances, marketers find themselves obligated, if not coerced, to sell their produce at a significantly reduced price in order to prevent substantial wastage or complete loss, thereby diminishing their marketing margins and efficacy (Ugwu, 2018). A comprehensive examination of the National Health and Nutrition Examination Survey (NHANES) in the United States has revealed that the consumption of dried fruits has been linked with increased intake of essential but under-consumed nutrients, heightened overall energy intake, and enhanced diet quality among adults. This finding suggests that dried fruits can potentially aid in the fulfillment of nutritional requirements and the promotion of overall dietary health. In light of this, the present study aims to conduct a consumers' preference for pineapple chips as this may be a way to reduce the post-harvest losses incurred by the farmers during the period when the fruit is in season and also create for an avenue to have the fruit available even during the off-season of the fruit.

MATERIALS AND METHODS

Study Area

The study area was Ibadan North West Local Government area of Oyo state. Ibadan North West has an average population of 153,000 people according to the 2006 National Population Census. The major occupation of the people is trading where two-third of the population are engaged while others are engaged in public service like teaching, manufacturing, publishing, etc.

Sampling Procedure and Sample Size

A two-stage sampling technique was used to select the respondents for this study. The first stage of the sampling involved a purposive selection of Ibadan-North East Local government of Oyo state because there was a training program at the National Horticultural Research Institue which had in attendance 80 trainees, from which there was a random selection of 60 pineapple consumers.

Methods of Data Analysis

Descriptive statistics was used to analyze the socio-economic characteristics of the respondents and to know consumers' preference and perception of dried Pineapple slices. Probit regression analysis was used to analyze the factors that determine the consumers' preference for the dried pineapple chips.

RESULTS AND DISCUSSION

This section presents the findings of the research. It describes the socio-economic characteristics of the respondents, their preference, perception and factors that determine their preference for dried Pineapple slices.

Table 1: Socio-economic characteristics of the respondents.

Variables	Category	Frequency	Percentage	Mean
Gender	Male	19	31.7	
	Female	41	68.3	
Marital status	Single	15	25.0	
	Married	42	70.0	
	Divorced	1	1.7	
	Widow	2	3.3	
Age	≤ 30	9	15.0	
	31-40	19	31.6	44
	41-50	13	21.7	
	51-60	16	26.7	
	> 60	3	5.0	
Household size	1-6	48	80.0	
	7-12	10	16.7	6
	≥13	2	3.3	
Education level	No formal education	2	3.3	
	Secondary education	11	18.3	
	Tertiary education	47	78.3	

Source: Field survey, 2023

The result revealed that most of the respondents were female (68.3%), married (70%), and of age group 31-40 years (31.6%). The mean age of the respondent was 44 which signifies that they are in active age group and may be willing to try a new product. The study by Hettich *et al*. (2019) which stated that older consumers tend to resist innovation due to reduced product-related information processing was however not in line with this finding. The household has a mean size of 6 persons. Majority of the respondents had tertiary education level (78.3%) which could be of a great factor to their preference for dried pineapple chips.

Table 2: Consumers' preference for dried pineapple slices

Prefer processed to fresh	Frequency	Percentage
No	19	31.7
Yes	41	68.3
Total	60	100.0

Source: Field survey, 2023

Majority of the respondents (68.3%) preferred dried pineapple slices to the fresh. This is a good indicator as more consumers preferred dried pineapple slices which has a great potential of being acceptable and surviving in the market, especially during the off-season production and thus create market for value addition actors in pineapple production chain.

Table 3: Consumers' perception for the dried Pineapple chips

Respondents' Perception	**Yes (percentage)**	**No (percentage)**
Reduce perishability Problem	86.7	13.3
Reduce scarcity problem during off-season	90.0	10.0
Will buy during off-season	86.7	13.3
Dried pineapple is nutritious than fresh pineapple	45.0	55.0

Source: Field survey, 2023

The results showed that respondents' perception in reducing perishability during production season and scarcity problem during off-season had higher percentage of 86.7 and 90.0 respectively, which revealed that the respondents believed that the problem of pineapple perishability will reduce through processing into dried slices, thus reduce post-harvest losses and be made available and accessible to consumers all year round. 86.7% of the respondents would be willing to buy dried pineapple chips during the off-season if available and finally, 45.0% of the respondents recorded that dried pineapple slices is nutritious than the fresh which is an indicator of consumers' positive review in the value addition of pineapple into dried slices.

Table 4: Factors that determined the Consumers' preference for dried Pineapple slices

Consumers' pref.	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
Sex	0.091491	0.467099	0.2	0.845	.8240066	1.006988
Marital status	-0.13321	0.371251	-0.36	0.72	.8608489	.5944294
Age	0.022196	0.022558	0.98	0.325	.0220167	.0664088
Edu. Level	0.22718	0.337074	0.67	0.5	.4334726	.8878326
Consumption	-0.09888	0.424803	-0.23	0.816	-.931478	.7337173
Taste	0.645119	0.448501	1.44	0.15	.2339273	1.524165
Color	-1.0091	0.605651	-1.67	0.096*	2.196151	.1779556
Texture	0.528605	0.268172	1.97	0.049**	.0029981	1.054213
Aroma	0.880889	0.518896	1.7	0.09*	-.136129	1.897906
General appearance	-0.85431	0.458639	-1.86	0.063*	1.753222	.0446101
_cons	-1.52529	1.995649	-0.76	0.445	5.436693	2.386108

Source: Field survey, 2023
Number of obs = 60
LR chi2 (10) = 13.39
Prob > chi^2 = 0.2028
Pseudo R^2 = 0.1787
Log likelihood = -30.765758

An examination of the regression analysis yields various significant findings concerning the determinants that impact consumer preferences. The demographic factors such as gender, marital status, age, and educational attainment did not exhibit a substantial correlation with preferences in this particular sample, as the p-values for these coefficients were all greater than 0.05. Additionally, the frequency of product consumption did not emerge as a significant predictor in the model. Nevertheless, numerous sensory and aesthetic attributes of the products displayed noteworthy associations with overall consumer preferences. Notably, taste preferences displayed a positive correlation with preferences at the $p<0.15$ level, implying that taste strongly influences preference. Furthermore, texture exhibited a highly significant positive association with preference ($p=0.049$), indicating that consumers tend to favor products with smoother, finer textures. The relationship between aroma and preference was found to be positive and marginally significant at a significance level of $p<0.10$. This suggests that consumers have a tendency to prefer products that possess more alluring scents and fragrances. On the other hand, color showed a negative association with preferences, indicating that consumers have a preference for options with lighter hues. Additionally, the coefficient for general appearance was negative, implying that consumers have a preference for products that have a visually pleasing appearance. These sensory factors, such as texture, aroma, color, and appearance, appear to have a stronger influence on consumer preferences compared to demographic factors in this particular sample. Notably, taste and texture emerge as attributes that could significantly enhance preferences. Consequently, the marketer should concentrate on emphasizing the texture, fragrance, taste, and aesthetic appeal of the products in order to better cater to consumer preferences. By enhancing these sensory and visual elements, there is the potential to increase the favorability of the product.

CONCLUSION

Finding reveals that consumers' preference for dried pineapple slices is high and their perception about the problem of pineapple slices ability to address a problem of perishability and scarcity are also high. 86.7% of the respondents will buy dried pineapple slices during off season if made available. A probit regression analysis of the preference determining factors indicates that color, texture, aroma and general appearance influence consumers' preference for the dried pineapple slices. Further improvement on these attributes will increase its attractiveness to the consumers.

RECOMMENDATION

Based on empirical findings of this study, it is recommended that further studies should be conducted on value addition on other perishable fruits and vegetables in order to increase their shelf life and acceptability by consumers.

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EFFECT OF PLANT POPULATION DENSITY ON YIELD OF COLEUS POTATO (*Coleus Rotundifolius* p. a. Chev & Perrot) IN ZURU, NORTHERN GUINEA SAVANNA ZONE OF NIGERIA

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ABSTRACT
Field experiment was conducted during 2019/2020 rainy season at the Teaching and Research Farm of the Federal University of Agriculture, Zuru (Lat, 11^0 35'N; Long, 4^0 45' E;) 394 meters above sea level. The study aimed to determined appropriate plant population density on and yield components of two coleus potato land races in study area. Factorial combination of four intra-row spacings (15, 20, 45, and 60 cm), giving rise to 89,285, 66,666, 29,673 and 22,222 plants/ha^{-1} respectively) and two land races of Coleus Potato (ex-Zuru Black and ex-Zuru Brown respectively) Treatments were laid out in a randomized complete block design (RCBD) replicated three times. The results showed that land race Ex-Zuru Black recoded highest yield and yield components than Ex-Zuru Brown. On the other hand widest population density of 60cm x75cm recorded highest mean tuber number per stand, tuber diameter, tuber weight, tuber weight per stand, marketable yield, and unmarketable yield and yield ha^{-1} than the other plant population densities. The study therefore concludes by recommending 60cmx70cm population density and variety Ex-Zuru Black for higher yield.
Keywords- *Population Density, Coleus Potato land races, Ex- Zuru Black, Ex-Zuru Brown*

INTRODUCTION

Coleus Potato (*Coleus rotundifolius* P.), closely related to the Coleus plants widely cultivated as ornamentals and is now again placed in the genus *Coleus*, after being placed in the defunct genus *Solenostemon* and in *Plectranthus*. (Paton *et al.*, 2019). Coleus Potato, popularly known as *Hausa Potato, Tumuku or Somo (C'Lela)* is a tropical, multipurpose minor tuber crop. It has been reported to be one of the best staple tuber crops in terms of its distinctive fragrance, peculiar taste, medicinal, nutritional and economic values (Namena *et al.,* 2009). The crop is a perennial herbaceous plant of the mint family (Lamiaceae) native to tropical Africa [National Research Council (NRC, 1983)]. Coleus Potato is cultivated for its edible tubers primarily in West Africa as well as more recently in parts of Asia, especially India, Sri lanka, Malaysia and Indonesia *(Blanch, 2006)*. Although it is not widely cultivated as food crop in Africa. However, it is still popular in Nigeria especially on Jos Plateau, Kaduna, Borno and Adamawa States (Aniedu and Agugo, 2010). The plant is a perennial herb with prostrate or ascending habits and can grow as tall as 30 cm. The distinctive fragrant or pungent aroma is due to volatile oils contained in the glands or sacs found in the leaves and other parts. The stem is succulent and it has thick leaves with serrated margins (Enyiukwu *et al.,* 2011). Coleus Potato is one of the tuber crops grown in the guinea savanna region of Nigeria especially in Jos Plateau, Kaduna, Borno and Adamawa States (Aniedu and Agugo, 2010).

Coleus Potato is grown by smallholder farmers, most especially women. It is regarded as food security crop because of its ability to provide a higher yield per unit area. Its production could be extended to other agro -ecological zones ranging from forest to the northern guinea savanna regions, thereby contributing sources of income, food security, solving malnutrition problem and diversification of the local food base and sustaining livelihoods. Information on the economic importance and agronomic practices of Coleus Potato is limited and has suffered research neglect for several years (Enyiukwu *et al*., 2014). Concerted efforts of conserving, documenting and promoting the dynamic use of Coleus Potato is now required (Olojede *et al.,* 2005). Evidently, agronomic researches on Coleus Potato are scanty and more are needed before any meaningful advancement of the crop can be made. Although there are coordinated efforts by the National Root Crops Research Institute (NRCRI), Nigeria, to improve the cultural and agronomic production, therefore more research is required in multiple locations and with different experimental treatments. Despite the important benefits of Coleus Potato, average yield in

Nigeria is relatively low (3-5 t/ha^{-1}) compared to Ghana (10 t/ha) and South Africa (19 t/ha^{-1}) (Nkansah, 2004).

The reason for low yield in Nigeria has been attributed to research neglect as the crop is often considered among the neglected tropical crops, low yielding varieties and poor agronomic practices such as nutrients supplies, spacing (Akinpelu *et al.*, 2011). Coleus Potato production could be increased by improving the inherent genetic potential of the crop coupled with adoption of better agronomic management, such as use of optimum plant population density. Most farmers that grow Coleus Potato give less regard to optimal plant population density and fertilizer application (Bayorbor and Gumah, 2007; Akinpelu *et al*. 2011). Farmers in Nigeria most often use spacing below the recommendation and sometimes under dose or over dose the crop with nutrients. Inappropriate plants density affects growth and yield because of competition among plants for growth resources. The most common population density for Coleus Potato in Nigeria ranges from 33,333 - 66,000 plants per hectare (NRC, 2006; Ogedebe *et al.* 2015). Adequate population density and soil fertility influence dry matter production, leaf area index and increase yield (Carl, 2003). The study aimed to determined appropriate plant population density on yield and yield components of two coleus potato land races and to recommend the best plant population density and coleus potato land race for higher yield in the study area.

MATERIALS AND METHODS

Field experiment was conducted during 2019/2020 rainy season at the Teaching and Research Farm of the Federal University of Agriculture, Zuru (Lat, 11^0 35'N; Long, 4^0 45' E; 394 meters above sea level (masl) in the Guinea Savanna Zone of Nigeria (field data). Rainfall ranged from 690-885 mm per annum, distributed over a period of 4-6 months (April-October) Minimum and maximum temperature ranges were 18-29^{0}C and 30-38^{0}C, respectively Minimum and maximum solar radiation ranges were 3.52wm^{-2} – 4.46wm^{-2} and 844.17wm^{-2} - 976.840wm^{-2}, respectively. The relative humidity ranged from 26% to 39% and wind speed ranged between 1.9 to 5 ms^{-1}. (Field data, 2019). Random soil samples was collected from the experimental site, using auger before land preparations at depths of 0-20cm and 20-40cm. Factorial combination of four intra-row spacings (15, 20, 45, and 60 cm), giving rise to 89,285, and 66P,666, 29,673 and 22,222 plants/ha^{-1}) and two lands race of Coleus Potato (ex-Zuru Black and ex-Zuru Brown).

Treatments were laid out in a randomized complete block design (RCBD) replicated three times. Seed tubers for two local land races of Coleus Potato (named after their skin colour) were sourced from farmers (ex-Zuru Black) in Dongo area and (ex-Zuru Brown) in Ribah and Girmache areas, spread across Zuru communities in Kebbi State. The ex-Zuru Brown belongs to early maturity (95-110 days) while ex-Zuru Black belongs to late maturity of (110-125 days). Glyphosate (phosphonomethyl) glycine) was sprayed at 20ML^{-1} of water against weed and allowed for 3 weeks before ~~to~~ ploughing. The land was ploughed and ridged using oxen. Gross plots measuring 6 m x 4.5 m (27.0 m^2) consisted of six (6) ridges 75 cm apart and about 40 cm high was ~~was~~ manually constructed. The net plots measuring 6 m x 2.5 m (12.5 m^2) consist of two middle rows. Fresh and healthy tubers were selected for planting. The seed-tubers were dressed with fungicide (dithiocarbamate) powder at 2.0 g kg^{-1}) a day to planting and the latter were done at the depth of about 5 cm as per the intra-row spacing treatment. Compound fertilizer (NPK 15:15:15) was used ~~as~~ per treatment at the rates of 300 kg NPK ha^{-1}.

The fertilizer was applied in two equal splits doses; the first dose was applied 4WAP and second split doses were applied 8WAP. The fertilizer was applied 10cm away from stand and 5cm deep and covered. The plots were weeded manually at 5, 9, and 13 WAP ~~9~~ after planting to control weeds. They were earth up at 3 weeks after planting to keep the tubers from being exposed to sunlight. Karate (Lamdacyhalothrin) was spray at 4ML^{-1} of water against insect pests. Harvesting was done manually using hoe from the net plot at physiological maturity by uprooting the whole plant. Data collected on number of tuber per stand, tuber weight per stand (g), mean tuber diameter (cm), mean tuber weight (g), tuber yield and percent marketable and unmarketable yield (%) were subjected to Analysis of Variance (ANOVA) using Statistical Analysis System package, version 9.3 (SAS 2012), treatment means were separated using Duncan's new Multiple Range Test (DMRT) at 5% Probability.

RESULTS

Results on table 2 revealed significant effect ($P<0.05$) on two tested land races of coleus potato significantly differed in tuber number per stand and Mean tuber diameter (cm). Variety Ex-Zuru Black produced more tuber Number per stand and mean tuber diameter than Ex-Zuru Brown. On the other hand, significant difference was also recorded amongst the plant population densities. Plant population density of (75cm x 60cm) and (45cm x 60cm) recorded the highest tuber number per stand and mean tuber diameter (cm) than the other population densities.

Results in table 3 Showed significant difference ($P<0.05$) was observed among the two tested land races of coleus potato significantly. Ex-Zuru Black produced the highest mean tuber weight (g) and tuber weight per stand (g) than Ex-Zuru Brown. On the other hand, significant differences were also recorded amongst the plant population densities. Widest plant population density (75cm x 60cm) produced the highest mean tuber weight (g) and tuber weight per stand (g) than the other population densities.

Results in table 4 Showed significant difference ($P<0.05$) was observed among the two tested land races of coleus potato significantly. Variety Ex-Zuru Black produced the highest marketable yield, unmarketable yield and yield ha^{-1} than Ex-Zuru Brown. On the other hand, significant differences was also recorded amongst the plant population densities. Widest plant population density (75cm x 60cm) and (45cm x 60cm) produces more marketable yield, unmarketable yield and yield ha^{-1} than the other population densities.

Table 1: Physical and Chemical Properties of Soil of the Experimental Site in 2019/2020 rainy Season.

Soil test	0-20cm	20-40cm
Chemical properties		
pH(water)	6.29	5.51
pH(cacl$_2$)	5.60	5.22
Organic carbon gkg-1	6.00	5.4
Total nitrogen	0.68	0.32
Available phosphorus	2.13	1.12
Physical Properties		
Sand gkg^{-1}	561	356
Silt gkg^{-1}	314	311
Clay gkg^{-1}	150	120
Textural class	Sandy loam	Sandy loam
Exchangeable Bases		
Cation (cmol/kg)		
Ca	0.93	0.75
Mg	0.57	0.33
K	0.97	0.58
Na	1.13	1.00
CEC	33.4	33.6

Table 2: Effect of Plant Population Density on Tuber Number per stand and Mean Tuber diameter of two Land Races of Coleus Potato in 2019/2020

	Tuber number per stand	**Mean tuber diameter (cm)**
Land Races	**Mean**	**Mean**
EX-Zuru Black	30.20a	3.55a
Ex –Zuru Brown	28.37b	3.14b
SE±	**3.35**	**0.83**
Population Density	**Mean**	**Mean**
75cm x 60cm	33.08a	3.97a
45cm x 60cm	31.33a	3.72a
20cm x 60cm	27.00b	3.17ab
15cm x 60cm	25.75b	2.52b
SE±	**1.29**	**1.18**

Means followed by the same latter(s) within a column in each treatment are not significantly different at 5% using DMRT

Table 3: Effect of Plant Population Density on Mean Tuber per stand and Mean Tuber Weight of Two Coleus Potato Land Races in 2019/2020

	Mean tuber weight (g)	Tuber weight per stand (kg)
Land Races	**Mean**	**Mean**
EX-Zuru Black	6.16a	67.14a
Ex –Zuru Brown	5.32b	61.37b
SE±	**1.43**	**3.00**
Population Density	**Mean**	**Mean**
75cm x 60cm	7.89a	75.93a
45cm x 60cm	5.67b	64.84b
20cm x 60cm	5.05bc	61.43b
15cm x 60cm	4.34c	54.82c
SE±	**1.05**	**2.12**

Means followed by the same latter(s) within a column in each treatment are not significantly different at 5% using DMRT

Table 4: Effect of Plant Population Density on Marketable yield, Unmarketable yield and Yield h^{-1} Two Coleus Potato Land Races in 2019/2020

	Marketable yield	Unmarketable yield	Yield/ h^{-1}
Land races	**Mean**	**Mean**	**Mean**
Ex-Zuru Black	253.12a	39.21a	2.04a
Ex-Zuru Brown	182.85b	25.31b	1.48b
SE±	**5.73**	**6.36**	**0.74**
Population Density			
75cm x 60cm	233.70a	38.70a	2.33a
45cm x 60cm	225.08a	36.91a	2.00a
20cm x 60cm	218.50b	29.20b	1.36c
15cm x 60cm	194.66b	24.62c	1.35c
SE±	**4.05**	**6.36**	**0.75**

Means followed by the same latter(s) within a column in each treatment are not significantly different at 5% using DMR

DISCUSSION

The yield of potatoes and many crops is dependent on many factors like the amount of minerals in the soil, plant spacing, cultivars etc (Beukema & Vanderzaag,1990). Increasing the plant population density can increase the yield in three ways. First, the green leaves will cover the soil earlier and will absorb more sunlight which will lead to more assimilation. Second, few lateral shoots will grow and the third is growth of tubers will start earlier (Beukema & Vanderzaag, 1990). The Potato variety influences yield through the size of the foliage, its time of tuber initiation, length of time of foliage remains alive and photosynthesis after tuber initiation, maturity regime and response to environmental conditions (Okonkwo *et al.,* 1995).The significant differences amongst the coleus potato land races is an indication these land races possessed inherent genetic qualities that enhance development than the other land races Ogedengbe et al. (2015). The greater mean tuber diameter of Ex- Zuru Black over Ex- Zuru Brown was due to the variation in tuber shape. The tubers of Ex-Zuru Black are morphologically rounded while the tubers of Ex-Zuru Brown are oblong or oval is shape. This has agreed with Keneth and Brain (2000), who reported potato variety, is genetically controlled, but can be influenced by other external factors such as fertilizer, water, spacing, pest and diseases. The higher mean tuber weight and tuber weight per stand recorded in Ex-Zuru Black than Ex-Zuru Brown could be link to their SDW and CGR which enhanced their rate of tuber bulking, hence dry matter content which consequently attributed to heavier tubers. Generally, low yield and other yield components in this study confirms poor yield in the coleus potato. Many tubers are produced per plant, but are small in size perhaps, this has indicated poor translocation of assimilates from the source to the sink.

Plant response to spacing varies from species to species and is highly dependent on environmental condition as well as soil characteristic and climatic condition of the site (Chopra and Chopra, 2004). It was also observed that the population density has significant influence on coleus potato land races, the widest population of 60cm x75cm record the highest yield components of the coleus amongst the parameters measured this could be attributed to less competition for available resources between the plants in the wider spaced plots, this results in efficient utilization of water, and light interception which collectively enhance effective photosynthesis and consequently translocation hence higher yield component. This has agreed with Squire (1990) appropriate plant population density increase light interception by the plant chloroplast which enhances photosynthesis upon which yield of the crop is totally and directly controlled. Adequate population density and soil fertility influence dry matter production, leaf area index and increase yield (Carl, 2003). Hailu and Sue (2011) reported planting with spaces between each plant develop root and shoot of tuber plant. Total tuber yield was generally low in all the land races, contrary to the findings of Enyiukwu et al. (2014) and Nkansa (2004) who reported average tuber yields of between 5 and 19 ha^{-1} It has been observed that more dry matter could be left in the above- ground portion (leaves and stems) than in the roots at the end of the cropping season, suggesting, perhaps, a lack of balance between the source potential and sink capacity. Namo et al., (2005)

CONCLUSION

From the findings of the study coleus potato land race variety (Ex-Zuru Black) proved to be robust in terms of yield and yield components than varieties (Ex-Zuru Brown). The findings further show that planting at the widest plant population density of 60cmx75cm produced the highest yield component in the two land races varieties and will be recommended to the farmers. Further research is ongoing to determine effects of Plant Population Density, Npk Nutrition and Variety on Growth and Tuber Yield of Coleus Potato (*Coleus Rotundifolius* P. A. Chev & Perrot) In Northern Guinea Savannah Zone of Nigeria.

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EFFECT OF DIFFERENT MULCH MATERIALS AND DENSITIES ON THE GROWTH OF *Cleopatra mandarin* ROOTSTOCK IN A CITRUS NURSERY

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ABSTRACT
A pot experiment was conducted at the screen house of National Horticultural Research Institute (NIHORT), Ibadan, to evaluate the impact of different mulch materials and densities on growth of Cleopatra mandarin. The treatments consisted of Sesbania pachycarpa mulch (2cm depth; 4cm depth), Panicum maximum mulch (2cm depth; 4cm depth), Sawdust mulch at 2cm depth and no mulch as control. The experiment was laid in completely randomized design in 5 replications. Four months old Cleopatra mandarin were transplanted into containers 18 cm height and a diameter of 16 cm containing 3kg each dry soil. Data such as number of leaves, plant height (cm) and stem diameter (cm) were taken on the Cleopatra mandarin seedlings, weed densities and frequencies were also obtained to compute Relative Importance Value (RIV) of the emerged weeds. Results obtained revealed that plants mulched with Sesbania pachycarpa clippings to a 4cm depth had a significantly (p<0.05) higher plant height of 53.4 cm. The control treatment recorded more diverse weed species number. Plant-based mulches, are effective in improving crop growth and weed control.
Keywords: *Cleopatra mandarin, Plant height, Mulch materials, Weed control*

INTRODUCTION
Mulching can be classified as organic mulch (cover crop, inter-crop, green manure crop, compost, etc.) and in-organic mulch (polyethylene, paper, etc). The use of biodegradable mulches (organic mulch) is a widespread and common practice for weed control on organic farms, though it is usually considered to be economical only for high value or perennial crops or on small acreages (Runham and Town, 1995). Biodegradable mulches such as straw, leaves, wood chips or compost have been documented to offer advantages such as conservation of soil moisture, reduced soil erosion, weed and disease suppression (Singh, 1992). For example, Mbagwu (2000) recorded 40% increase in maize grain yield when 2 t/ha film mulch were added and of 80% when 4 t/ha mulch were placed on an Ultisol in Nigeria. Mulching in agriculture provides a safe yet equally profitable method of enriching and fertilizing the soil planted with crops. Unlike synthetic fertilizers and herbicides, these organic mulches pose little damage to the soil and crops. Usually defined as the use of organic and biodegradable materials to give plants the nutrients they need. Therefore, the study was set up to assess the advantages of mulching of *Cleopatra mandarin*.

MATERIALS AND METHODS
The pot experiment was carried out at National Horticultural Research Institute screen house in Ibadan. The treatments were: *Sesbania pachycarpa* mulch (2cm depth), *Sesbania pachycarpa* mulch (4cm depth) *Panicum maximum* mulch (2cm depth) *Panicum maximum* mulch (4cm depth) Sawdust mulch (2cm depth) and the Control (no mulch). Four months old *Cleopatra mandarin* seedlings were tested with the six treatments above and replicated five times in a completely randomized design. The treatments were applied 4 weeks after transplanting. Data were taken every 4 weeks for a period of 12 weeks on growth parameters like number of leaves, plant height (cm), stem diameter (cm). The effect of the mulches on weed suppression was also studied. Weed samples that emerged from the pots were collected for assessment; this is to study the effects of the various treatments on weed species diversity and abundance, this was used to compute Relative Importance Value (RIV). The number of plants of each species recorded in each pot was used to calculate the (RIV) as:
$[(RD + RF)/2] \times 100$ (Kent and Coker, 1992)
where RD=Relative Density and RF= Relative Frequency
Absolute Density (D) is the number of individuals of a particular species per unit area.
Relative Density (RD) is the percentage value of density of a weed species relative to the total density of all species.

RD=d/D X 100. where d = the density of species; D = total density of all species.

Absolute Frequency (F) is the measure of the chance of finding a species within a pot. That is, the number of pots that has a particular species in relation to the total number of pots sampled.

Relative Frequency (RF): The frequency of a species relative to the total frequency of all species.

RF=f/F X 100, where f = frequency of a species and F = total frequency of all species.

RESULTS AND DISCUSSION

Growth parameters of *Cleopatra mandarin* rootstock

The results revealed that different types of mulching materials influenced the growth parameters of the citrus plants. At 4 WAT, sawdust mulch at 2 cm had the highest plant height though it was not significantly different from, *Sesbania pachycarpa* mulch at 2 cm, *Panicum maximum* mulch at 2cm depth and control, but was significantly higher ($p<0.05$) than *Sesbania pachycarpa* mulch at 4 cm and *Panicum maximum* mulch at 4 cm. This may be attributed to the mulch decomposition. As the mulch decomposes, carbon levels gradually decline and the microbes release or mineralize nitrogen back to the soil, making it available again for plants uptake. *Sesbania pachycarpa* mulch at 2 cm had the highest number of leaves but was significantly different from all other treatments except *Sesbania pachycarpa* mulch at 4 cm. *Panicum maximum* mulch at 4 cm had the highest stem diameter but was not significantly different from all other treatments.

At 8 WAT, no significant difference was recorded for stem diameter and number of leaves though saw dust mulch recorded bigger stem diameter. At 12 WAT, the *Sesbania pachycarpa* mulch at 4 cm had the highest plant height and this was significantly higher than the control. *Sesbania pachycarpa* mulch at 4 cm and *Panicum maximum* mulch at 2cm depth, had the highest number of leaves but was not significantly different from other treatments. *Panicum maximum* mulch at 2cm depth and *Panicum maximum* mulch at 4cm depth had the highest stem diameter but was not significantly different from other treatments. Since organic mulches decompose under appropriate water and temperature levels, nutrients are released to the soil and become available for root uptake suggesting that soil mulching stimulates plant growth. Scharenbroch, (2009) also reported that organic material could be beneficial for tree establishment, weed control, and root decay. However, Iles and Dosmann, (1999) reported that tree height and stem diameter of red maple trees (*Acer rubrum* L.) were not affected after two years of mulching. Mulching materials can be successfully used as an alternative to chemical weed control. The mulching materials tested provided a similar weed control, while un-mulched pots had the highest number of weeds. Weed species diversity and abundance were the highest in the control pots that had no mulch. There were 7 broad leaves,1 grass species and 1 sedge encountered during the study. Also, there were less weed species in pots mulched up to 4 cm depth.

CONCLUSION

Sesbania pachycarpa mulch up to 4cm depth gave the best growth performance of the *Cleopatra mandarin* rootstock. Mulching up to 4 cm depth reduced the emergence of weeds.

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Table 1: Effect of mulch types and densities on growth parameters of *Cleopatra mandarin* in the nursery in Ibadan

	Plant Height (cm)			Stem Diameter (cm)			Number of Leaves		
Treatment	4	8	12	4	8	12	4	8	12 (WAT)
1	23	42.2	50.2	0.13	0.22	0.3	8	23.2	37.2
2	20.6	40.2	53.4	0.11	0.17	0.31	6.8	22	37.6
3	22.4	40.3	52.8	0.14	0.19	0.32	7	21.6	37.6
4	20	41.2	51.8	0.17	0.22	0.32	7.6	20.6	36.8
5	23.4	40.8	52	0.14	0.19	0.3	7.8	22.8	37.4
6	21.6	42	51.6	0.11	0.17	0.29	7.8	22.2	36.2
LSD (0.05)	2.3	2.9	2.8	0.12	0.5	0.4	1.1	2.7	1.8

(Where WAT is weeks after transplanting, PH is plant height, SD is stem diameter, NL is number of leaves).
1 = *Sesbania* at 2cm depth, 2 = *Sesbania* at 4cm depth, 3 = *Panicum* at 2cm depth, 4 = *Panicum* at 4cm depth, 5 = Saw dust at 2cm depth, 6 = Control

Table 2: Analysis of the soil used for the study

Soil Properties	Values
Ph (H_20)	7.03
Physical composition (%)	
Sand	76.6
Clay	13.8
Silt	9.60
Exchangeable bases (cmol/kg)	
Ca	2.19
Mg	1.58
Na	0.21
K	1.28
ECEC	5.32
% base sat	99.06
C (g/kg)	1.94
N (g/kg)	0.16
Av P (mg/kg)	29.28
Cu (mg/kg)	2.10
Zn (mg/kg)	1.06
Mn (mg/kg)	25.20

Table 3: Relative Importance Value of weeds encountered at the end of study

Control weed species	F	D	RF	RD	RIV
Aspilia africana	20	0.1	15.75	16.13	15.94
Asystasia gangetica	12	0.06	9.45	9.68	9.6
Boehavia diffusia	7	0.03	5.51	4.84	5.18
Tridax procumbens	9	0.04	7.09	6.45	6.77
Talinum fruticosum	28	0.14	22.05	22.58	22.32
Cyperus rotundus	20	0.1	15.75	16.13	15.94
Callopogonum spp.	5	0.02	3.94	3.23	3.59
Sida acuta	8	0.04	6.3	4.84	5.57
Panicum maximun	18	0.09	14.17	14.52	14.35
	127	0.62	100.01	98.4	99.26

Panicum maximum(2cm)					
Asystasia gangetica	3	0.01	20	25	22.5
Tridax procumbens	2	0.01	20	16.67	18.34
Talinum fruticosum	2	0.01	20	16.67	18.34
Callopogonum spp.	3	0.01	20	25	22.5
Sida acuta	2	0.01	20	16.67	18.34
	12	0.05	100	100	100
Panicum maximum (4cm)					
Asystasia gangetica	10	0.05	25.64	25	25.32
Boehavia diffusia	12	0.06	30.77	30	30.39
Cyperus rotundus	5	0.03	12.82	15	13.91
Panicum maximun	12	0.06	30.77	30	30.39
	39	0.2	100	100	100
Saw dust (2cm)					
Aspilia africana	10	0.05	27.8	26.32	27.06
Tridax procumbens	7	0.03	16.7	18.42	17.56
Callopogonum spp.	12	0.06	33.33	31.58	32.46
Sida acuta	9	0.04	22.22	23.68	22.95
	38	0.18	100.05	100	100.03
Sesbania (2 cm)					
Aspilia africana	11	18.64	69.23	0.54	42.94
Boehavia diffusia	10	17	6.41	0.05	19.71
Tridax procumbens	18	30.51	11.54	0.09	7.82
Cyperus rotundus	12	20.34	7.69	0.06	18.02
Callopogonum spp.	8	13.6	5.13	0.04	11.37
	59	100.09	100	0.78	100
Sesbania (4cm)					
Aspilia africana	3	0.01	32.26	37.5	34.88
Boehavia diffusia					
Callopogonum spp.	2	0.01	32.26	25	28.63
Panicum maximum	1	0.001	3.23	12.5	7.87
	2	0.01	32.26	25	28.63
	8	0.031	100.01	100	100.01

Where F is frequency, RF is relative frequency, D is density, RD is relative density and RIV is relative importance value. (RIV =RD+RF/2)

POULTRY MANURE RATES ON GROWTH AND PROXIMATE COMPOSITION OF GOLDEN MELON (*Cucumis Melo* l.)

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ABSTRACT
In order to obtain high yield in Golden melon production, there is need to augment the soil constantly with nutrients to meet the crops need and thus maintain soil fertility. This study was carried out at the Federal University of Agriculture, Abeokuta, Ogun State, Nigeria, to determine the rate of poultry manure that will enhances optimum growth and proximate composition of Golden melon. Poultry manure was applied at rates of 0, 5, 10, 15 or 20 t·ha^{-1} in 4 replicates and arranged in a randomized complete block design. Growth and proximate composition of the melon plants were assessed. Data collected were subjected to analysis of variance using GENSTAT Mean differences were separated using Least Significant Difference at 5% probability level. Results showed that vegetative growth increased as the rate of poultry manure increased. The number of leaves and stem girth of Golden melon cultivated with 10 t/ha poultry manure had higher number of leaves, larger girth and wider leaf area. Proximate composition increased as the rate of poultry manure increased from zero to 15 t/ha while the values declined with when the rate increased to 20 t/ha with respect to the fat, ash and protein composition. For optimum growth and better proximate composition of Golden melon, soil fertility enhancement with 10 t/ha poultry manure is efficient.

INTRODUCTION

Melon (*Cucumis melo*) originated from the Middle East to the Mediterranean and it belongs to the family Cucurbitaceae (Maynard *et al*., 2001). Melons are consumed as desserts, fresh-cut fruits and as juice (Saftner and Lester, 2009). The refreshing pulp, high nutritional, sweet pleasant aroma, bright color, firm flesh texture, high sugar content of above 10% and proper fruit shape are important traits which make melons unique and a relish for the imperial family in Japan (Gusmimi and Whener, 2005). According to FAOSTAT (2019), melon production in the world was 27,501,360 tons with a total area harvested of 1,039,691 ha. China is the leading country in the production of melon (13,541,452 ton), followed by Turkey (1,777,059 ton) and Iran (854,090 ton). It is an important commercial crop in many countries and mostly cultivated in the temperate regions of the world due to its good adaptation to temperate soils and climate (Zulkarami *et al*, 2010). In Nigeria, it is mostly grown in the Northern part of the country where it is popular because of its sweet pulp and the pleasant aroma (Villanueva *et al*., 2004). The edible portion of a matured melon fruit is 45–80%. Raw peeled fruits per 100 g edible portion contains: 90.2 g water, 142 kJ (34 kcal) energy, 0.8 g protein, 0.2 g fat, 8.2 g carbohydrate, 0.9 g fibre, 9 mg Ca, 12 mg Mg, 15 mg P, 0.2 mg Fe, 0.2 mg Zn, 3382 IU vitamin A, 0.04 mg thiamin, 0.02 mg riboflavin, 0.7 mg niacin, 21 µg folate and 37 mg ascorbic acid (USDA, 2002). Comparatively, the nutritional composition of snake melon per 100 g edible portion is: 94.5 g water, 75 kJ (18 kcal) energy, 0.6 g protein, 0.1 g fat, 4.4 g carbohydrate, 0.3 g fibre and 13 mg ascorbic acid (Polacchi *et al*., 1982). In order to obtain high yield in golden melon production, there is need to augment the nutrient status of the soil to meet the crop's need and thereby maintaining soil fertility and increasing production. Therefore, this study was conducted to determine the effects of poultry manure on the growth and proximate composition of golden melon in Abeokuta area of Ogun State, Nigeria

MATERIALS AND METHODS

The experiment was conducted at the Directorate of University Farms, DUFARMS site of the Federal University of Agriculture, Abeokuta, Ogun State in August, 2021. Golden melon seeds (Uranus F1) were purchased from East West Company at Abeokuta, Ogun state. Poultry manure was collected from the Directorate of University Farms (DUFARMS) at Federal University of Agriculture. The treatments consisted of five poultry manure rates 0, 5, 10, 15 and 20 t/ha and the experiment was laid out in a

Randomized Complete Block Design (RCBD) with four replicates. The experimental field 19 m × 15 m was marked out, ploughed, harrowed and carved into twenty raised beds of 3 m ×3 m with 1m spacing between the beds.

The poultry manure collected was air-dried and broadcast on the plot according to the treatment rates and was left to mineralize in the soil for two weeks before planting. Samples of the manure were subjected to routine analysis to determine its nutrient status. Soil samples were taken at random at a depth of 15 cm and composite samples were taken to the Laboratory for routine analysis to determine the soil physio-chemical properties. Golden melon seeds were planted by drilling at a spacing of 100 cm by 60 cm (16,666 plants/ha) according to Ayeni, *et al.*, (2021). Data were collected on the number of leaves, vine length, stem girth, flowering and proximate composition which includes the dry matter, fat, ash, crude protein, crude fibre and carbohydrate contents using standard procedures. Data collected were subjected to Analysis of Variance (ANOVA) using GENSTAT Significant mean differences were separated using the Least Significant Difference at 5 % probability level.

RESULTS

The manure used had a near neutral pH (7.3) and contained nitrogen (3.42%), organic carbon (20.86%), available phosphorus (1.73%), potassium (1.58%), calcium (6.16%), and magnesium (1.92%). The experimental site soils had a near neutral pH (6.8) with nitrogen (0.14%), organic carbon (0.54%), available phosphorus (14.11mg/kg), potassium (0.47cmol/kg), calcium (0.25 cmol/kg), and magnesium (0.37 cmol/kg) while the textural class of the soil was sandy loam (Table 1). Total rainfall during the experimental period (September to December) was 285.1mm. The peak of the rainfall was in October (139.0mm). Mean temperature range during the period of experiment was 26-28 ^{0}C. The relative humidity ranged between 75 and 90% (Table 2). There were no significant differences in the number of leaves produced at 3 and 4 weeks after planting but there was a significant difference in the mean number of leaves produced at 5 WAP as influenced by the poultry manure rates (Table 3). At 3 WAP, the unfertilized golden melon produced more leaves which were similar when compared with the fertilized stands. At 4 WAP, golden melon cultivated with 10 t/ha poultry manure produced more leaves which were similar compared with other rates. At 5 WAP, golden melon cultivated with 10 t/ha poultry manure produced more leaves which were significantly higher compared with other rates (Table 3).

There were no significant differences in the vine lengths produced at 3 and 4 weeks after planting but there was a significant difference in the vine lengths produced at 5 WAP as influenced by poultry manure rates (Table 4). At 3 WAP, golden melon cultivated with 20 t/ha poultry manure produced longer vines which were similar when compared with other rates. At 4 WAP, unfertilized golden melon produced longer vines which were similar when compared with the fertilized golden melon. At 5 WAP, golden melon cultivated with 10 t/ha poultry manure produced longer vines which were significantly higher when compared with those cultivated with 15 t/ha manure but similar when compared with those cultivated with unfertilized, 5 and 20 t/ha poultry manure (Table 4). There were no significant differences in the stem girth produced at 3 and 4 weeks after planting but there was a significant difference in the stem girth produced at 5 WAP as influenced by poultry manure rates (Table 5). At 3 WAP, golden melon cultivated with 5and 10 t/ha poultry manure produced wider girths which were similar when compared with other rates. At 4 WAP, fertilized golden melon produced wider girths which were similar when compared with the unfertilized golden melon. At 5 WAP, golden melon cultivated with 5 t/ha poultry manure produced wider girth which were significantly higher when compared with unfertilized those cultivated with 10 t/ha manure but similar when compared with those cultivated with unfertilized, 15 and 20 t/ha poultry manure (Table 5)

There were significant differences in the proximate contents of golden melon as influenced by poultry manure rates (Table 6). Unfertilized golden melon had significantly higher moisture content when compared with those cultivated with 10 and 20 t/ha poultry manure but similar when compared with those cropped with 5 and 15 t/ha manure. Golden melon cultivated with 10 t/ha manure had significantly higher dry matter content when compared with the unfertilized melon but similar when compared with those cultivated with 5, 15 and 20 t/ha manure. Golden melon cultivated with 10 t/ha manure had significantly higher fat content when compared with those cultivated with 15 and 20 t/ha manure but similar when compared with unfertilized melon and those cultivated with 5 t/ha manure. Golden melon cultivated with 10 t/ha manure had significantly higher ash content when compared with the unfertilized and those cultivated with 5, 15 and 20 t/ha manure. Unfertilized golden melon had significantly higher crude fibre content when compared with those cultivated with 5, 15 and 20 t/ha poultry manure but similar when compared with those cropped with 10 t/ha manure. Golden melon cultivated with 10 t/ha manure had significantly higher crude protein content when compared with the unfertilized and those cultivated with 5, 15 and 20 t/ha manure. Golden melon cultivated with 15 t/ha manure had significantly higher carbohydrate content when compared with the unfertilized but similar when compared with those cultivated with 5, 10 and 20 t/ha poultry manure (Table 6).

DISCUSSION

The soil pH of the experimental site was near neutral and was within the favourable range for crop cultivation. (Van der Vossen, *et al*., 2004). The organic carbon was low but the Total N was just adequate, with the critical level of 1.5 g/kg reported by Aduayi et al. (2002). Available P was high based on the 8-12 mg/kg critical level reported by Udo et al. (2009). The soil had a high content of sand, medium silt content and a low clay content making the soil adequate for the cultivation of golden melon. The observed rainfall pattern was irregular while the observed range of air temperature during the vegetative and reproductive phase was within a permissible range of 10 to 45ºC according to Baker and Reddy (2001). Poultry manure rates affected the growth and proximate composition of Golden melon in the tropical rainforest/savannah transition zone of southwestern Nigeria. Vegetative growth was observed to increase as the rate of poultry manure increased from zero to 10 t/ha while a decline was observed as the rate increased from 15 to 20 t/ha with respect to the number of leaves, vine length and leaf area of Golden melon. This may be due to toxicity of nutrients resulting to the deposition of excess nutrients on the soil surface made available to the plant.

Proximate composition of harvested fruits was observed to be greatly influenced by the weather condition, especially rainfall. Moisture content determination is an integral part of the proximate n analysis of food. The high moisture content in Golden melon is in agreement with the finding of Falodun and Ogedegbe (2019) in their study on performance and Quality of Golden melon. Lower poultry manure rates produced fruits with higher moisture content and reduced dry matter content while higher manure rates produced fruits with more dry matter content with reduced moisture content, which may be due to the low weed competition which allows the plant more space available for the plants to grow and access more manure thereby aiding the production of more assimilate. Proximate composition of golden melon as influenced by poultry manure rate was observed to increase with the rate of manure from zero to 10 t/ha with respect to the fat, ash, fibre and protein contents while a decline was observed as the manure rates increased from 15 to 20 t/ha poultry manure. It is therefore concluded that cultivating golden melon with 10 t/ha poultry manure was sufficient for its optimum growth and proximate composition.

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Table 1: Pre-cropping soil and manure physico-chemical properties.

Physiochemical properties	**Soil**	**Manure**
pH (H2O)	6.8	7.3
N (%)	0.143	3.42
Org C (%)	0.539	20.86
Org M (%)	0.929	35.96
Av. P (mg/kg)	14.11	1.73 %
Ex. A (meq/100g)	0.2	0.6
Na	0.359 cmol/kg	0.22 %
K	0.466 cmol/kg	1.58 %
Ca	0.245 cmol/kg	6.16 %
Mg	0.368 cmol/kg	1.92 %
Sand (%)	80.2	
Clay (%)	8.2	
Silt (%)	11.6	
Textural class	Sandy loam	

Table 2: Weather conditions for the experimental period.

	Total rainfall (mm)	Mean temperature (^{0}C)	Relative humidity (%)
September	93.5	26.3	75.0
October	139.0	27.2	78.1
November	52.6	27.8	78.3
December	0.0	26.9	78.9
January	0.0	27.4	88.9
February	0.0	27.8	75.3
Total	285.1		

Source: Meteorological Station, Department of Water Resources Management and Agro-meteorology, Federal University of Agriculture, Abeokuta, Nigeria

Table 3: Effect of poultry manure rates on number of leaves of golden melon (*Cucumis melo* L.)

Rates (t/ha)	3	4	5
	Weeks after planting		
0	7.27	13.25	17.52
5	7.08	14.83	19.00
10	7.00	15.25	25.25
15	6.05	13.35	17.93
20	7.08	13.80	17.73
LSD (0.05)	ns	ns	5.96

Table 4: Effect of poultry manure rates on vine length (cm) of golden melon (*Cucumis melo* L.)

Rates (t/ha)	3	4	5
	Weeks after planting		
0	6.42	7.32	7.78
5	5.83	6.65	6.90
10	6.30	6.65	8.88
15	6.34	5.67	6.33
20	6.71	6.70	6.83
LSD (0.05)	2.36	2.04	2.13

Table 5: Effect of poultry manure rates on stem girth (mm) of golden melon (*Cucumis melo* L.)

Rates (t/ha)	3	4	5
	Weeks after planting		
0	26	26	27
5	30	30	32
10	30	30	27
15	28	30	30
20	26	30	29
LSD (0.05)	5	6	4

Table 6: Effect of poultry manure rates on flowering attributes of golden melon (*Cucumis melo* L.)

Rates (t/ha)	Days to flowering	Days to 50% flower
0	25.25	26.25
5	24.50	26.25
10	23.75	25.00
15	24.75	26.26
20	24.25	26.00
LSD (0.05)	1.72	1.89

Table 7: Effect of poultry manure rates on proximate composition of golden melon (*Cucumis melo* L.)

	Moisture content	Dry matter content	Fat content	Ash content	Crude fibre content	Crude protein content	Carbohydrate content
				%			
0	93.31	6.69	2.23	4.87	10.14	7.45	75.45
5	91.92	7.89	2.01	4.71	8.18	6.96	76.71
10	90.21	9.79	2.27	5.38	9.30	8.41	75.72
15	91.81	8.06	1.89	4.85	8.42	6.92	77.99
20	91.21	8.79	1.92	4.91	8.65	7.28	77.23
LSD (0.05)	2.06	2.01	0.34	0.42	1.46	0.74	2.43

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EFFECT OF FERTILIZER TYPES ON QUALITY AND SAFETY OF POTTED *Ocimum gratissimum* IN IFITE OGWARI, ANAMBRA STATE

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ABSTRACT
Type of fertilizers used in vegetable production influences quality of the crop and safety of the consumers. Presence of heavy metals in vegetables above the FAO/WHO permissible value is detrimental to human health. Treatments consisted of fertilizer types (control, 5 t ha^{-1} of cow dung, 5 t ha^{-1} of compost, 400 kg ha^{-1} of NPK fertilizer 20-10-10 and 400 kg ha^{-1} of urea). Heavy metal contents of scent leaf harvested one month after treatment application and analyzed in the laboratory showed the following trend: Fe (Control > urea > Cow dung > compost > NPK), Zn (Control > urea > compost > NPK > Cow dung), Cu (Control > urea > compost > cow dung > NPK), Ni (control > urea, NPK > compost > cow dung), Pb (control > urea > cow dung > compost > NPK) and Cd (Compost > NPK > control > urea > cow dung). Heavy metals in scent leaf produced with compost, cow dung and NPK fertilizer were below FAO/WHO permissible values. Therefore, the use of cow dung, compost and NPK fertilizer produced quality and safe scent leaf and is recommended for potted scent leaf production in Ifite Ogwari, Anambra State.
Keywords: *Compost, cow dung, inorganic manure, heavy metals, food safety*

INTRODUCTION
Scent leaf (*Ocimum gratissimum*) belongs to the group of plants known as spices, which belongs to the family Labiatae and is the most abundant of the genus *Ocimum*. Scent leaf is an aromatic plant that grows as a wild plant and also cultivated for culinary, medicinal and ornamental purposes. The proximate composition of scent leaf as reported by Anjili *et al.* (2018) shows that scent leaf contains crude protein of 7.61%, 32.00% crude fibre, and crude fat content of 18.66% and ash content of 15.33%. Scent leaf is rich in alkaloids, tannins, phytates, flavonoids, oligosaccharides, terpenoids, thymol and saponin, with tolerable cyanogenic contents (Alexander 2016). Agricultural and food wastes can be harnessed by farmers as compost for soil amendment and thereby reduce environmental pollution. A lot of research work on the use of different agricultural and food wastes for compost and their effect on crops abound. Oyeyemi *et al*., (2017) reported that the application of compost to nutrient deficient soil promoted growth, fresh shoot and dry matter yield of *A. cruentus*. Kumngen *et al*., (2023) stated that the use of BA compost promoted growth, chlorophyll content, phytochemicals and chemical contents of lettuce.
The type of fertilizer used in soil amendment will influence the quality of nutrient elements and the phyto-availability of heavy metals and thus influence the safety of the vegetable for human consumption. Cow dung is known for containing heavy metals which come from feed additives and even when composted or used it is original form can still be a significant source of heavy metal (Vukobratovic *et al*., 2014). The range of heavy metals above the safe limit set by WHO is very harmful to the human health and heavy metal concentration in the soil can lead to soil pollution, negative effect on organisms and crops (Iyama *et al.,* 2021). The FAO/WHO (2017) maximum permissible values (mg/kg) in vegetables are Cd (1), Pb (2), Ni (0), Fe (48), Cu (30) and Zn (60) (Olayiwola *et al.,* 2017). Above the FAO/WHO permissible values, heavy metals such as Cd cause artery problems (Khan *et al*., 2013: Nordberg *et al*., 2022; Turkdogan *et al*., 2003), Ni causes cardiac arrest, fatigue, heart problems and respiratory diseases (Muhammad *et al*., 2011), Pb and Cd can cause heart, kidney and bone diseases (Iyama *et al*., 2021). Therefore, this experiment aimed at determining the effect of fertilizer types on heavy metal concentration on the leaves of scent leaf and the safety of scent leaf produced using each fertilizer type.

MATERIALS AND METHODS
Experimental site
Experiment was conducted in the Teaching and Research Farm of the Department of Crop Science and Horticulture, Nnamdi Azikiwe University, Ifite Ogwari Annex, Nigeria. The research farm lies at the

latitude of 06 °15 N and longitude 07 °08 E, with an average annual rainfall of 1810.3 mm and relative humidity of 72.3%. The average minimum and maximum temperatures of the field were 28.74 °C and 28.96 °C with average relative humidity of 63.48% during the experiment.

Experimental design

Treatments consisted of five fertilizer typees (control (zero application of fertilizer sources), cow dung, compost, urea and NPK 20-10-10). Compost and cow dung were applied at 5 t ha^{-1} while NPK fertilizer and urea were applied at 400 kg ha^{-1}. Mid stem cuttings with five nodes were used for planting and. The scent leaf cultivar used for this experiment has adapted to Ifite Ogwari environment and are commonly used by the farmers.

The experimental design was a completely randomized design and treatments were replicated four times in both field and laboratory analysis.

Composting process

Food wastes were gotten from Madonna Eatery at Nnamdi Azikiwe University, Awka Annex. Cowdung, wood ash and dried grasses were obtained from Nnamdi Azikiwe University, Ifite Ogwari Annex. Compost pile was produced by placing the food wastes, followed by grasses and cow dung till the bucket was filled in the ratio of 3:2:1, wood ash of 1 kg sprinkled on top of the each compost pile and 1 litre of water was sprinkled on the compost pile. Four buckets of compost pile were made for the experiment. The piles were turned every evening for four weeks and were dried to 10% moisture content under shade by spreading them a clean poly sheet.

Fig 1: Compost pile

Fig 2: Four weeks old compost

Agronomic operations

Top soils of 0 – 20 cm depth were excavated, mixed together and solarized using black polythene nylon. Bags of 20 x 30 cm contained 15 kg of sand. The bags were perforated at the bottom and used for the experiment. Stem cuttings of 20 cm length were planted by inserting 5cm portion of the stem cutting inside the soil. NPK 20-10-10 and urea were bought from fertilizer market. Soils were irrigated before and after planting of the stem cuttings. Four Stem cuttings of 20cm length were planted per bag and were thinned to two stands per bag after two weeks of planting. Cow dung and compost of 110 g each per plant and NPK fertilizers of 140 g per plant each were applied to scent leaf stem cuttings at two weeks after planting using ring method at 10 cm away from the stem cuttings. Stem cuttings were planted in late February and irrigated till rain became steady and harvested at 73 days after planting. The surrounding and in between the bags were weeded as the weeds come up.

Laboratory analysis of food waste, compost, grass, wood ash, top soil and cow dung

Five soil samples were collected randomly from the experimental site at 0 - 20 cm depth before bagging in the bags. Soil pH was analyzed by the use of pH meter (Hendershot *et al.,* 1993), organic carbon was determined by Nelson and Sommers, (1982), organic matter values were obtained by multiplying total carbon with 1.724 (Van Bemmelen's correlation factor) (Nelson and Sommers, 1982), available phosphorus was determined according to the procedure of Olsen and Sommers (1990), total nitrogen was done by microkjeldahl digestion technique (Bremner and Mulvaney, 1982), calcium and magnesium by

Versenate titration method and potassium by flame photometer method. Cowdung, wood ash and compost were analyzed for their nutrient status using the same procedures in the soil analysis.

Methods for the Heavy Metal Analysis

Heavy metal analysis was conducted using Varian AA240 Atomic Absorption Spectrophometer according to the method of APHA 1995 (American Public Health Association)

Working principle: Atomic absorption spectrometer's working principle is based on the sample being aspirated into the flame and atomized when the AAS's light beam is directed through the flame into the monochromator, and onto the detector that measures the amount of light absorbed by the atomized element in the flame. Since metals have their own characteristic absorption wavelength, a source lamp composed of that element is used, making the method relatively free from spectral or radiational interferences. The amount of energy of the characteristic wavelength absorbed in the flame is proportional to the concentration of the element in the sample.

Dry Digestion

2g of the sample was weighed into a crucible and put into a muffle furnance for ashing at a temperature of 450^0c for 2hours. The sample was removed from the furnance and allowed to cool. The dry ash was emptied into a 250ml beaker 20ml of 20% H_2SO_4 was added, heated in a water bath for 20mins, filtered and made up to 50ml with distilled water and stored in a sample bottle for AAS macro and micro nutrient analysis.

Preparation of Reference Solution:

A series of standard metal solutions in the optimum concentration range was prepared, the reference solutions were prepared daily by diluting the single stock element solutions with water containing 1.5ml concentrated nitric acid/litre. A calibration blank was prepared using all the reagents except for the metal stock solutions. Calibration curve for each metal was prepared by plotting the absorbance of standards versus their concentrations

Analysis of data

All data measured were subjected to analysis of variance using Genstat 2019 and means were separated using Least Significant Difference at 5% level of probability.

RESULTS

Table 1: Chemical properties of the soil, grass, food waste, cow dung and compost used in the experiment

Nutrient contents	Soil	Grass	Food waste	Cow dung	Wood ash	Compost	Testing method
Lead (mg/kg)	0.42	-	2.18	2.35	0.91	2.93	APHA (1995)
Mercury (mg/kg)	0.85	-	2.40	0.55	1.10	0.55	APHA (1995)
Copper (mg/kg)	2.3	-	5.38	4.85	10.30	18.10	APHA (1995)
pH (water)	7.40	7.17	6.45	7.40	9.63	7.09	Hendershot *et al.,* (1993)
Carbon (%)	16.98	28.58	26.89	24.93	18.72	19.98	Nelson and Sommers, (1982)
Nitrogen (%)	2.80	2.52	2.18	2.30	3.58	2.91	Bremner and Mulvaney, (1982)
C/N ratio	6.06	11.34	12.31	10.60	5.22	6.86	
Phosphorus (mg/kg)	15.88	13.83	12.58	16.33	18.10	21.56	Olsen and Sommers, (1990)
Potassium (cmol/kg)	0.42	0.72	0.59	0.78	0.47	1.01	Flame photometer method
Calcium (cmol/kg)	0.76	0.85	0.66	0.86	0.94	0.99	Flame photometer method
Magnesium (cmol/kg)	1.10	0.78	0.62	0.43	1.25	1.02	Flame photometer method
Organic matter (%)	3.46	7.37	5.28	5.98	4.16	3.84	Nelson and Sommers, (1982)

Source: Docchy Laboratories and Environmental Services Limited. Nigeria

Effect of fertilizer types on heavy metal contents of the scent leaves

Effect of fertilizer types on heavy metal contents of the scent leaves is shown on Table 2. Fertilizer types significantly ($p \leq 0.05$) affected iron (Fe) content of the scent leaf. Fe was highest in control scent leaf (63.73± 0.58 mg/kg) and was least in scent leaf produced with NPK fertilizer (32.86 ± 0.11 mg/kg). Scent leaf produced with compost and cow dung had 41.33 ± 0.14 and 46.84 ± 0.09 mg/kg of Fe respectively while soil amended with NPK and urea produced scent leaves with 32.86 ± 0.11 and 51.79 ± 0.16 mg/kg of Fe respectively. Organic amendment showed a decreased and less variable Fe content in scent leaf than the inorganic manures. Zinc (Zn) was highest in scent leaf produced without soil amendment (31.89 ± 0.123 mg/kg) and lowest in scent leaf produced with cow dung (22.33 ± 0.38

mg/kg). Soil amendment reduced Zn content in scent leaf, however, scent leaf produced with urea had highest Zn content (26.53 ± 0.14 mg/kg). Copper (Cu) was highest in control (9.62 ± 0.10 mg/kg) and lowest in scent leaf produced with NPK fertilizer (3.89 ± 0.08 mg/kg). Soil amendment reduced Cu content in scent leaf, however, scent leaf produced with urea had highest Cu content (6.63 ± 0.11 mg/kg). Nickel (Ni) was highest in scent leaf produced without soil amendment (2.07 ± 0.08 mg/kg) and lowest in scent leaf produced with urea (0.03 ± 0.04 mg/kg). Soil amendment reduced Ni content in scent leaf, however, scent leaf produced with urea had highest Ni content (0.97 ± 0.04 mg/kg). Lead (Pb) was highest in control (6.23 ± 8.03 mg/kg) and lowest in scent leaf produced with NPK fertilizer (0.11 ± 0.06 mg/kg). Soil amendment reduced Pb content in scent leaf; however, scent leaf produced with urea had highest Pb content (2.06 ± 0.04 mg/kg). Cadmium (Cd) was highest in scent leaf produced soil amended with compost (0.61 ± 0.04 mg/kg) and lowest in scent leaf produced with cow dung (0.26 ± 0.09 mg/kg). There was no significant difference in Cd contents of scent leaf produced without soil amendment (0.56 ± 0.09 mg/kg), compost (0.61 ± 0.04 mg/kg) and NPK fertilizer (0.58 ± 0.08 mg/kg).

Inorganic fertilizer and organic manures are used in reducing heavy metals in soil. The use of inorganic fertilizers reduce the bioavailability of metals, due to production of binding sites (Puschenreiter *et al*., 2005) and through the addition of nitrogen and phosphorus which affect the remediation of heavy metals through the promotion of metabolism of plants and changing the forms of metals (Sun *et al*., 2007). Organic manures such as cow dung and composts made from are also used to reduce heavy metal availability in soil because organic manures have high content of organic matter, phosphorus and iron and can form chelates in soil (Brown *et al*., 2003). Cow dung and compost made from cow dung are high in heavy metals because of feed additives used in rearing cows and this raises the heavy content of the manure and increases heavy metal content of the soil during soil amendment and increases the absorption of these heavy metals by the plants. However, organic matter contents and chelation of organic manures help to reduce phyto-availability of heavy metals in plant tissues.

Cultivation of scent leaf without soil amendment increased heavy metal contents in the leaves in comparison with scent leaf produced with organic and inorganic manure. Wang *et al.,* 2020 and Nkoh *et al.* 2022 independently reported the effectiveness of organic manure in reduction of heavy metals absorption by crops, promoting plant growth and producing safe crops. Soil amendment using urea did not reduce phyto-availability of heavy metals in comparison with NPK fertilizer. This could be attributed to the ability of urea to supply only nitrogen element to the soil and supports the report of Puschenreiter *et al*., (2005) which stated that complete inorganic fertilizers are used in heavy metal remediation through the actions of N and P which form binding sites in the soil.

Cow dung reduced the phyto-availability of Zn, Cu. Ni and Cd in comparison with compost. Compost had higher heavy metals than the cow dung and thus, contributed to higher heavy metals presence in scent leaf leaves (Table 1). Cd content of scent leaf was higher in NPK fertilizer than in control. This agrees with the reported of Singh *et al*., (2010) in Beta vulgaris L. which stated that phyto-availability of Cd, Cu, Pb, Zn, Mn, Ni and Cr was least in Beta vulgaris L. produced with farmyard manure and highest in soil treated with NPK fertilizer compared to control. Control had highest heavy metals above FAO/WHO (2017) permissible values in crops, while scent leaf produced in soils amended with cow dung, compost and NPK fertilizer had heavy metals values below the FAO/WHO permissible values than urea. This disagrees with the report of Alromian (2020) who stated that the use of different rates of compost made from residues of chicken, animal and mixed organic residues increased the heavy metal concentration in lettuce tissues and were above permissible values and thus, made the lettuce unsafe for human consumption.

Table 2: Effect of fertilizer types on heavy metal contents of the scent leaf

Fertilizer types	Iron (mg/kg)	Zinc (mg/kg)	Copper (mg/kg)	Nickel (mg/kg)	Lead (mg/kg)	Cadmium (mg/kg)
Control	63.73± 0.58a	31.89± 0.123a	9.62 ± 0.10a	2.07 ± 0.08a	6.23 ± 8.03a	0.56 ± 0.09a
Compost (t ha^{-1})	41.33 ± 0.14d	23.89 ± 0.07b	4.82 ± 0.06c	0.66 ± 0.01d	0.48 ± 0.09a	0.61 ± 0.04a
Cow dung (t ha^{-1})	46.84 ± 0.09c	22.33 ± 0.38e	4.16 ± 0.05d	0.03 ± 0.04e	0.85 ± 0.05a	0.26 ± 0.09c
NPK 20:10:10 (kg ha^{-1})	32.86 ± 0.11e	23.15 ± 0.07d	3.89 ± 0.08e	0.84 ± 0.10c	0.11 ± 0.06a	0.58 ± 0.08a
Urea (kg ha^{-1})	51.79 ± 0.16b	26.53 ± 0.14c	6.63 ± 0.11b	0.97 ± 0.04b	2.06 ± 0.04a	0.40 ± 0.05b
LSD $_{(0.05)}$	0.51	0.35	0.15	0.11	6.53	0.12
Significant level	**	**	**	**	NS	**

NS = Non significant, ** = Highly significant, * = Significant

CONCLUSION

Scent leaf produced with cow dung and compost had reduced heavy metal contents than scent leaf produced with urea and NPK fertilizer. Scent leaf produced with urea showed higher heavy metal accumulation than scent leaf produced with NPK fertilizer. Soil amended with urea produced scent leaf with higher contents of Fe and Pb. Control had highest Fe, Cd, Ni. Cu, Mn, Pb and Zn contents. Therefore, the use of cow dung, compost and NPK fertilizer produced quality and safe scent leaf with heavy metal presence below FAO/WHO permissible values and is recommended for potted scent leaf production in Ifite Ogwari, Anambra State.

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EVALUATION OF COCOA POD HUSK AND CASHEW DRY LEAVES AS ORGANIC SOIL AMENDMENT ON CASHEW (*Anacardium occidentale L.*) SEEDLING GROWTH IN THE NURSERY

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ABSTRACT
A nursery experiment was conducted at the Cocoa Research Institute of Nigeria to evaluate the impact of cocoa pod husk and dry cashew leaves on young cashew seedling growth. Medium cashew biotype was used. The treatments were applied at the rate of 0g (NF), 4g cashew leaf (CL4g), 6g of cashew leaf (CL6g), 4g of cocoa pod husk (CPH4g), 6g of cocoa pod husk (CPH6g), 2g each of cocoa pod husk +cashew leave (CPHCL4g) and 3g each of cocoa pod husk +cashew leave (CPHCL6g). The trial was laid out in a Completely Randomized Design (CRD). The physio-chemical properties of the soil were determined before the establishment of the experiment. Data on morphological parameters collected at two-week intervals for two months include plant height (cm), number of leaves, stem diameter (mm), and leaf area (cm^2). Data collected was subjected to Analysis of Variance (ANOVA) using GENSTAT (2012) statistical software. The result of the physio-chemical properties revealed that the soil was acidic and belongs to the sandy clay loam textural class. The application of CL4g gave a superior improvement of young cashew seedling growth while CPH4g gave considerable improvement. The application of CPH6g, CL6g, and CPHCL6g all gave a fair improvement in young cashew seedling growth.
***Keywords**: Cashew, Cocoa Pod Husk, Dry Cashew Leaf, Nursery, Seedling, Growth.*

INTRODUCTION
Cashew is a very important horticultural crop in Nigeria and other tropical countries, contributing significantly to their economies and ranked third globally in edible nut production (Akanni, 2011). Cashew trees are adapted to many different agro-ecosystems (Olubode *et al.*, 2018), but are grown economically in the savannah and tropical forest agro-ecological zones of Nigeria. Aliyu *et al.* (2014) highlighted some savannah areas such as Kwara State and north-central Nigeria such as Kogi State, where cashew nuts are commercially produced. Falade (1978) reported that cultivation had spread to other agroecological zones of Nigeria as well as Oyo, Enugu, Abia, Anambra, Ekiti, and Imo. The cashew tree, a resilient fruit tree, thrives in degraded lands, particularly on sandy soils (Ohler, 1979). Its modest soil requirements allow it to adapt without affecting productivity. However, it requires a continuous nutrient supply for fruit development and seed growth.

Plant growth is maintained by organic matter recycling, but chemical fertilizers introduce toxicity, nutrient leaching, and soil degradation (Nottidge *et al,* 2005). To maintain productivity levels, it is mandatory to adopt the use of organic nutrient sources such as wood ash, manure and compost (Northwood, 1996, Moyin - Jesu and Atoyosoye, 2002). Organic agricultural production in Nigeria is gaining interest due to the use of plant residues, animal manures, and compost (Hugo *et al.* 2001). These residues, including cocoa pods, cashew leaves, livestock manure, Oil palm waste, tea waste, rice bran, and other plant wastes are combined with controlled chemical fertilizers for growing cashew trees. Further research is needed (Moyin-Jesu, 1999 and Hugo *et al.* 2001).

Cashew and cocoa plantations have huge organic biomass potential for recycling. The amount of cashew leaf waste available from plantations in different age groups (10 to 40 years old) ranged from 1.38 to 5.20 tons/ha. About 5.5 tons of available cashew biomass waste per hectare can be converted into 3.5 tons of organic fertilizer or vermin-compost, thereby meeting 50% of the nutritional needs of cashew trees. It is estimated that 8,000,000 tons of cocoa pods are discarded during harvesting, providing between 64,000 and 94,000 tons of K, Ca, and P (Egunjobi, 1975). There are many suggestions for the use of CPH as a prerequisite for adding fertilizer to rice crops (Eegunjobi and Larinde, 1975; Adv Dappah *et al.,* 1994); Moyinjesu and Atoyosoye, 2002). Most of the fallen cashew nuts and cocoa leaves are wasted on plantations because they are not collected for fertilizer due to their difficulty in decomposing on-site in open conditions due to high lignin content and unfavorable decomposition conditions. Farmers often burn the land with leaves, which is not a healthy practice. During the dry season, fallen leaves can cause problems such as forest fires in cashew and cocoa plantations. Therefore, collecting fallen leaves not only keeps the plantation safe from fire hazards and allows adequate composting but also keeps the plantation clean for ease of harvesting of fallen nuts. This study was conducted to evaluate the use of cocoa pods and cashew leaves as organic soil amendments for the growth of cashew nuts in nurseries.

MATERIALS AND METHODS

The experiment was conducted at the screen house of the Cocoa Research Institute of Nigeria (CRIN), Ibadan, in the Southwestern belt of the Nigerian agro-ecological zone, from February to April 2023. Before the commencement of the experiment, surface soil samples were collected. (0-20 cm) taken from the Institute estate. Soil samples were air-dried, sieved through a 2-mm sieve, and analyzed for their physicochemical properties. Cocoa pods (CPH) were sourced from the CRIN area while dried cashew leaves were sourced from the Institute's plantations. The dried cashew leaves have been crushed for ease of use and to facilitate the mineralization process. The topsoil (0-20 cm) collected from the Institute campus was air-dried, sieved, thoroughly mixed, and poured into 25 cm x 12.5 cm perforated polyethylene bags. Each polyethylene bag is filled with 0.8 kg of topsoil. The polythene bags were watered to capacity in the field and placed on a raised platform in the greenhouse. Watering was carried out twice a week throughout the experimental period.

Treatment Application

The treatments involve cashew leaf (CL), cocoa pod husk (CPH), and their combinations (CL+CPH) at two rates, with six treatment combinations and a control, laid out in a Completely Randomized Design (CRD) replicated three times. Agronomic parameters measured include plant height (cm), number of leaves, stem diameter (mm), and leaf area (cm^2). They were measured fortnightly for two months and data collected therein were analysed using ANOVA and Duncan Multiple Range Test.

RESULT AND DISCUSSION

Table 1 shows the result of the chemical properties of soil before planting. The soil pH value 4.12 was acidic, suitable for cashew crops, hence cashew crops with a tolerant range of pH 4.5-8.5, as optimum values are within 5.2-7.5 (Dedoe *et al*., 2001). The organic carbon content of the soil (1.13g/kg) was below the critical value of >2% considered suitable for cashew cultivation (Aikpokpodion *et al*., 2010). The soil nitrogen is below 0.1% N required for cashew cultivation (Egbe *et al*., 1989). Possibly due to the low organic matter content of the soil. Hence it is expected that the application of cashew leaf and cocoa pod husk would enhance soil fertility and the performance of cashew crops. However, available P 2.49cmol/kg is low compared to the 3.7 cmol/kg recommended for optimal growth of cashews (Egbe *et al*., 1989). The soil K value of 0.12 cmol/kg on the other hand is higher than the critical value of 0.81 cmol/kg (Egbe *et al.,* 1989).

Table 2 shows the impact of cocoa pod husk and cashew leaves on cashew nuts' growth index after 8 weeks of sowing (WAS). No significant difference was observed between NF (24.77 cm), CPH4g (25.83 cm), CL4g (25.67 cm), CPHCL4g (19.9 cm), and CPHCL6g (25.07 cm). CL6g however, recorded the highest plant height value (29.60m). This result could be as a result of the higher nutrient supply in 6g of dry cashew leaves which were accessible for the cashew seedling root for utilization (Brady, 1990). This confirms the suggestion by Janick (1986) that higher availability of nutrients increases the succulent growth of plants. The result supports the findings of Nanjundappa *et, al* (2001) who reported improvement in the general performance of crops that received a combination of the different nutrient sources. The outstanding performance of 6g of cashew leaf over others could be due to higher levels of N, P, and K that are contained in the leave compared to others.

This assumption supports Abhijit (2015) who reported that considerable levels of macro-nutrients and secondary nutrients indicate the efficacy of the cashew leaves as the ingredients of organic fertilizer. The treatments did not significantly differ in leaf and stem diameter, but CPH4g (12), CL4g (11.67), and CPH6g (10.33) had more leaves and thinner stem diameters than NF (9.50). The control NF (40.73 cm2) treatment did not significantly affect leaf area, but CPHCL6g (48.56 cm^2) and CL4g (44.74 cm^2) improved the stem diameter of cashew seedlings. The leaf area differences between treatments were only observed between CPHCL6g (48.56 $cm^{2)}$ and CPH 4g (27.77 cm^2), with the latter having the smallest leaf area. The study confirms earlier research work of Akanbi, (2016) on the impact of cocoa pod husk and oil palm bunch ash on cocoa performance, revealing enhanced agronomic parameters.

CONCLUSION

To reduce the cost of purchasing inorganic fertilizers and maintain good soil quality, it becomes imperative to use plant materials as a source of organic manure. All organic materials used in this study, except CPHCL4g, showed various potentials to improve cashew growth when used. However, applying CL4g brought outstanding improvement in the growth rate of cashew trees, while CPH4g showed significant improvement. The application of CPH6g, CL6g and CPHCL6g all brought about a significant improvement in the growth rate of cashew trees.

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Table 1: Physicochemical properties of the topsoil and critical soil nutrient levels for cashew

Parameters	**Values**	**Critical levels for Cashew**
pH in (1:2$H_2$0)	4.12	5.2-7.5(Dedoe *et al*., 2001)
Organic Carbon (g/kg)	1.13	>2% (Aikpokpodion *et al*., 2010).
Organic Matter (g/kg)	1.95	
Total Nitrogen (g/kg)	0.22	0.1% Egbe *et al.,* 1989
Available P (mg/ kg)	2.49	3.37 - ,,
K (cmol /kg)	0.81	0.12 - ,,
Sand (g/kg)	608	
Silt (g/kg)	120	
Clay (g/kg)	272	
Textural Class	Sandy clay loam	

Table 2: Morphological parameters of cashew seedlings as influenced by cocoa pod husk and cashew leaf at 8 weeks after sowing.

Treatments	**Eight Weeks After Sowing**			
	Plant height (cm)	No of Leaves	Stem Diameter (mm)	Leaf Area (cm^2)
NF	24.77^{ab}	9.50^{a}	5.10^{a}	40.73^{ab}
CPH4g	25.83^{ab}	12.00^{a}	5.40^{a}	27.77^{b}
CPH6g	21.93^{b}	10.33^{a}	5.28^{a}	35.50^{ab}
CL4g	25.67^{ab}	11.67^{a}	5.17^{a}	44.77^{ab}
CL6g	29.60^{a}	8.67^{a}	5.47^{a}	34.90^{ab}
CPHCL4g	19.9^{b}	9.17a	4.83^{a}	36.25^{ab}
CPHCL6g	25.07^{ab}	9.17^{a}	4.60^{a}	48.56^{a}
SED	**2.84**	**1.81**	**0.74**	**6.24**

Keywords: NF = control, MCPH (4g) = medium cashew nut+4grams of cocoa pod husk, MCPH (6g) =medium cashew nut+6 grams of cocoa pod husk, MCL(4g) = medium cashew nut +4 grams of cashew leaf, MCL(6g) = medium cashew nut +6 grams of cashew leaf, MCPHCL (4g) =medium cashew nut+4grams of cocoa pod husk+4grams of cashew leaf, MCPHCL (6g) = medium cashew nut+6grams of cocoa pod husk+6grams of cashew leaf an = standard error of difference

ECONOMIC ANALYSIS OF DATE PALM FRUIT (*Phonix Dactylifera l,)* MARKETING IN KIYAWA LOCAL GOVERNMENT AREA FF JIGAWA STATE, NIGERIA

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ABSTRACT

The study analysed the economic analysis of date palm fruit marketing in Kiyawa local government area of Jigawa state Nigeria. The data were to describe the socioeconomic characteristics, profitability, efficiency and finally the major constraints. Primary data were used for the study through the distribution of a structured questionnaire. There were 800 date palm fruit marketers according to their association record. Ten percent (10%) were selected at random to give the sample size of 80 respondents. Descriptive statistics, marketing margin, net margin, and efficiency. The results indicated sex, 84.8% were male and 15.2% were female. age, the mean age was 37.9 years, which implies that marketing is profitable, 63.3% were married, non-formal education was the highest 39.3% and the mean household size was 8.10 people. The results of profitability marketing margin and net margin 0.10 and 362370 in 100kg per bags of total the respondents and had constraints, such as unstable price, irregular supply, poor road network, and pest. It was recommended that financial institutions such as microfinance banks and BOA should ensure provision of soft credit facilities for agriculture to date palm fruit marketers at very low interest rates, to block the constraint of inadequate capital, to expand their date palm fruit marketing.

Keywords: *date palm, economic analysis*

INTRODUCTION

Date Palm fruit (*phoenix dactylifera L,*) is considered a symbol of life in the desert because it tolerates high temperature, drought and salinity more than many other fruit crop plant species. It is a popular food in the Middle East, found in abundance in the desert and around oases. Hays J, (2009) stated that many parts of the Middle East would be uninhabitable were it not for date palms, one of the few crops that grow in the desert. It has been described as the "tree of life." Botes and Zaid (2001) opined that date palm fruit (dates) is marketed all over the world as a high-value confectionary and fruit crop, and remains an extremely important subsistence crop in most of the desert regions. Thus, the heavenly religions honoured the date palm fruit and showed concern for its cultivation and care (El-juhany, 2010).

Date palm fruit is grown extensively in the arid region of the northern parts of Nigeria from latitude 10^0N in the Sudan savannah to the Sahel regions. These parts include Jigawa, Katsina, Kaduna and Kano State etc. It is generally believed that the date palm fruit was introduced into Nigeria in the early 17^{th} century by traders and Muslim pilgrims on pilgrimage to the holy cities of Mecca and Madina through the Tran Saharan trade route from North Africa and Middle East (Omoti & Okolo, 2000)

The date palm fruit is a multipurpose tree, providing food, timber products, and shelter. The date palm fruit is a good source of food, provides carbohydrates, minerals vitamins and fibre.In Arab countries, the date palm fruit is considered one of the main fruit crops. The major producers of date in the world are situated in the Arabia Gulf and north. Kader and Hussein (2009) reported that in 2006, world production of date palm fruit was about 7 million tons; there are thousands of date palm cultivars, including those with soft, dry and semi-dry fruit depending on their water and types of sugar content at harvest when full-ripe, grown in these countries (Kader & Hussein,2009).

According to (folayan, 2005). Agricultural marketing can be defined as comprising all the activities or operations that are involved in the movement of goods and raw materials from farm production to the final consumer of consumption. Efficiency in marketing can only be achieved through services such as transportation, storage, packaging, financing, grading, risk bearing, price determination and distribution of market information. Dates palm fruit lend themselves to a wide variety of value-added food products, including date paste, date sugar, date syrup and date vinegar. The high nutritional composition, profitability as well as environmental advantages make date palm fruit an excellent choice for farmers

(Al-shahib& Mashall, 2003). Its cultivation and marketing is a good alternatives to improve the food and economic status of the people (Hassan et al, 2006) agricultural holdings and supplies are very small and scattered as a result of which the marketable surplus generated is very meagre which subsequently results in low supply of commodities in the market (Reddy and Devi, 2004). This study thereforedescribe the socio-economic characteristics of the date palm fruit marketers in the study, analyse the profitability of date palm fruit in the study area, determine the marketing efficiency in the study area, and describe the major constraints militating against effective date palm fruit marketing in the study area.

MATERIALS AND METHODOLOGY

Study Area

Kiyawa Local Government Area (LGA) is situated in the south-eastern part of Jigawa state, between latitude 11.42ºN and longitude 9.40ºE. Its landform is characterized by undulating land with sand dunes of variable sizes spanning across the northern part of the LGA. The south-eastern part consist of fine textured clay to sandy loam soil that is greyed and have some humus content that favoured arable agricultural practices in the area. It has an average annual rainfall of about 550mm. Mean annual temperature of 23.75ºC and average relative humidity of about 45% has been recorded. The area lies within the Sudan savannah type of vegetation, Kiyawa has an estimate population of 17,704 according to 2006 National Population Census, of which Hausa/Fulani dialect is predominant and their major occupation is farming. (J.SDSD, 2005).

Sampling Technique

Shuwarin market was purposively selected based on the concentration of date palm marketers. Then, a list of 800 date palm marketers was collected from their association found in the market out of which, 10% of them were selected at random to give the sample size of 80 respondents were interviewed.

Data Analysis

The analytical tools used for this research included descriptive statistics, marketing margin, net margin and Efficiency was used to achieve objectives.

Marketing Margin Analysis

Marketing margin is the difference in price of a commodity at different stages of time, place, and possession as it moves from producer to the ultimate consumer, (olukosi and isitor, 1999). Part of objective3 was analysed and achieved used this particular model. It is specified as follow, where MM= marketing margin wereMM $= \frac{SP-PP}{SP}$.SP= selling prices.

PP= purchasing price or Supply price.

Net Margin= SP-MC. SP= selling price. MC= marketing cost.

RESULTS AND DISCUSSION

The results obtained from the tests conducted on the data collected for the study based on the stated objectives. The result showed that 84.8% of the Date palm marketers were male while 12.2% were female.The age range from 18-60 with Mean of37.9, the result show that majority of the Date palm fruit Marketers were within age of 36-44. The result revealed majority of the date palm marketers were married 63.3%. Therefore, house hold size is the total number of individuals who live and feed in the particular pot, adekanye (1998) Minimum = 1, Maximum = 20, Mean = 8.10. Educational levels indicate that 29.1% have primary certificate and 25.3% have secondary school certificate while 39.3% have no formal education and 6.3% have Tertiary certificate. Were found that majority of the respondents have no formal education. Marketing experiences is an important variable to determining the quality of the commodity and experience as the major factor that increases the traders' profit

Income, the marketing experience were range from 1-20 with mean 7.8. This is in line with the finding of Ali et al, (2008).

Table 1: Socioeconomic Characteristics of the Respondent

Variable	Range	Frequency(f)	Percentage (%)
Sex	Male	67	84.8
	Female	12	15.2
Age	18-26	13	16.5
	27-35	19	24.1
	36-44	27	34.2
	45-53	13	16.5
	54-60	7	8.9
	Single	19	24.1
	Married	50	63.3
	Divorce	8	10.1
	Widow	2	2.5
	1-5	24	30.4
Marital status	6-10	32	40.5
	11-15	17	21.5
	16-20	6	7.6
	Primary	23	29.1
	Secondary	20	25.3
	Tertiary	5	6.3
	Non formal	31	39.3
Household size	1-5	23	29.1
	6-10	24	30.4
	11-15	22	27.8
	16-20	10	12.7
Educational level			
Years of experience			

Table 2: Marketing Margin, Net margin and Efficiency of Date palm fruit marketing

Variables Items	Total Cost of Respondents (₦)100kg	Average Cost (₦)/100kg 1bag	% average Total Cost
Date palm purchase	3608000	45670.89	99.13
Transport	17330	219.37	0.48
Loading	3400	43.04	0.09
Offloading	2950	37.34	0.08
Revenue	1600	20.25	0.04
Storage	4650	58.86	0.13
Other	1700	21.52	0.05
Total Marketing Cost	3639630	46071.27	100
Total Marketing Service	31630		
Selling Price	4002000		
Marketing Margin	0.10		
Net Margin	362370		
Marketing Efficiency	109.96%		

Source: Field Survey 2017

Profitability Analysis

The results in Table 2 were profitability analysis of 100kg/ bag of date palm fruits marketing in the study area was presented in Table 2. The purchase price of total respondents was ₦3608000. Total marketing service was ₦ 31630. The total cost incurred in date palm fruits marketing was obtained from the addition of the total marketing costs and the purchase price of date palm. This was found to be ₦

3639630. The total Selling price was found to be 4002000. The average purchase price was ₦ 45670.89, while the average total marketing cost was ₦ 46071.27. The result in table 2 also shows that the total cost of marketing in 100kg was ₦ 363930 of total Date palm fruit respondents, more so, the total return of ₦ 4002000 was realized which gives a net marketing margin of ₦ 362370. This implies that Date palm fruit marketing is profitable in the study area,

Marketing Margin, Net Margin and Efficiency Analysis

Marketing margin is the difference in prices of the commodity at different stages of time, place, form and possession as it moves from producer to the ultimate consumer. The lower the marketing margin the profitability becomes higher. The marketing margin from results of table 2 was found 0.10. The result indicated that the marketing efficiency was 109.96%.

Table 3: Constraints of Data palm fruit marketers in the Study Area

Purchasing Constraints	Frequency (f)	Percentage (%)
Poor road network	8	10.1
Unstable price	27	34.2
Activities of middle men	16	20.3
Lack of marketing information	8	10.1
Insecurity on the road	3	3.8
Irregular supply	9	11.4
Pest	8	10.1
Total	**79**	**100**

Source: Field Survey 2017

The results in table 3 showed that 10.1% were facing constraints of poor road network and 34.2% are facing the constraints of unstable price and 20.3% were facing the problem of activities of middlemen while 10.1% were facing the constraints of lack of marketing information and 3.8% are facing the constraints of insecurity on the road and 11.4% are facing the problem of irregular supply and 10.1% are facing pest constraints. The finding here shows that majority of the date palm fruit marketers are facing the constraint of unstable price

CONCLUSION AND RECOMMENDATIONS

It is clear that, Date palm fruit marketing is dominated by middle aged of marketers, with middle number of household size. The date palm fruit marketing is a profitable, the marketing margin, net margin indicated that the cost of providing those market functions is reflected in the profit. It was recommended that financial institution such as microfinance bank and BOA should ensure provision of soft credit facilities for agriculture to date palm fruit marketers at very low interest rate, so as to block the constraint of in adequate capital, in order to expand their date palm fruit marketing. Government should take appropriate policy measures to guard against price fluctuation / uncertainties of agricultural commodities so as to aid both the producer (farmer) and the marketers.

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INSECT SPECTRUM ON *ROSA* SPP AND THEIR ASSOCIATED DAMAGE IN IBADAN, SOUTH-WEST NIGERIA

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ABSTRACT

Roses are ornamental plants of economic value with high demand for domestic and exports markets. They are known for their beauty, fragrance and bright colours. Rose plants are susceptible to insect pests which affect flower yield, flower quality and reduce aesthetic value of the plant. Grasshopper (Zonocerus variegatus), mealybug (Maconellicoccus hirsutus), aphids (Macrosiphum rosae), cotton stainer (Dysdercus spp) and stink bug (Nezera viridula) were major insect observed on the rose field in this study. Grasshoppers were the most abundant (42.80%) on the field and its occurrence was observed throughout the vegetative, flowering and post flowering stages of the plant while cotton stainer recorded the lowest (5.20%) population density. Damage to rose plants included defoliation, sap sucking, petals and flower buds deformation. Adequate knowledge of pests and associated damage on the host is essential for the development of efficient and sustainable management package for the pest.

Keywords: *Rosa spp, insect spectrum, damage, aesthetic value, ornamental plant*

INTRODUCTION

Rose (*Rosa* spp) is one of the most important and cherished plant in the ornamental industry (Horibe and Yamada, 2017). It ranked first among the top cut flowers in the international flower market (Hegde, 2010). Rose is native to Asia and belongs to the family Rosaceae (Chaudhari and Kumar, 2020). The plant is known as "Queen of Flowers" due to its beauty, fragrance, varied colours and size of its flowers (Hegde, *et al*., 2020). Rose flower is a symbol of love and adoration, it attracts both pollinators and human admirers (Horibe and Yamada, 2017; Hegde *et al*., 2020). Its uses range from cut flowers and landscape beautification to being used as raw material in agro and floriculture industries especially in the production of cosmetics, soaps and perfumes (Chaudhari and Kumar, 2020).

Roses also play important roles in medicine and nutrition. It is used as a medicinal herb against nephritis and hemorrhoids (Bitis *et al*., 2017). The essential oil from rose petals is incorporated in ayurvedic medicines, flavoring soft drinks, and alcoholic beverages (Hegde *et al*., 2020). Among the various factors affecting rose cultivation and quality of flowers produced, insect pests are paramount. Insects attack on rose plants may stunt or kill plant parts, affect flowering, reduce yield and flower quality or cause aesthetic damage (Hegde *et al*., 2020). Rose plants are vulnerable to the attack by many insect pests among which are; aphids, *Macrosiphum rosae* (Linnaeus) (Hemiptera: Aphididae); thrips, *Frankliniella schultzei* (Pergande) (Thysanoptera: Thripidae), whitefly, *Trialeurodes vaporariorum* (Westwood) (Hemiptera: Aleyrodidae); mealybug, *Planococcus citri* (Risso) (Hemiptera: Pseudococcidae); foliage feeders and bud borers, *Helicoverpa armigera* (Hubner); *Spodoptera litura* (Fabricius) (Lepidoptera: Noctuidae) (Dreistadt, 2001; Rajkumar *et al*., 2004). The aim of this study however, is to identify the spectrum of insect pests on rose plants and their associated damage in the floriculture garden of the National Horticulture Research Institute (NIHORT), Ibadan, Nigeria.

MATERIALS AND METHOD

The study was conducted in the Floriculture garden of the National Horticultural Research Institute Ibadan, (Latitude 7° 54′ N and Longitude 3° 54′ E, 213 m above the sea level). Rose seedlings were transplanted on the field 644m^2 and spaced 2m x 2m apart. A total of 103 rose stands were established and maintained. At full establishment and stability (4 weeks after transplanting), 30 rose plants were selected at random and tagged for the study. Insect population was assessed and counted visually on the randomly selected plants on a weekly basis in the early hours of the morning between 07:30 and 09:00 am (when the insects were usually inactive) till flower maturity. The plants were categorized into damage and undamaged. Damaged (when leaves and flowers show signs of insect feeding or as undamaged when signs are absent). Collected data were subjected to analysis of variance. Data on insect counts were transformed using square root model $\sqrt{(X + 0.5)}$ prior analysis.

RESULTS

Table 1 shows insect species associated with rose plant on the field during the study. Five major insect pests belonging to two orders and five families were observed on the rose. The insect pests included: Grasshopper (*Zonocerus variegatus*), Mealybug (*Maconellicoccus hirsutus*), Rose Aphids (*Macrosiphum rosae*), Cotton stainer (*Dysdercus* spp) and Stink bug (*Nezera viridula*). Grasshopper observed on the field during the study were variegated with brown, greenish -yellow colours. *Zonocerus variegatus* (42.8%) were the most abundant on the field, followed by mealybugs (33.0%), while *Dysdercus* spp (5.2%) recorded the low pest population density (Fig.1). The occurrence of *Z. variegatus* and *M. hirsutus* were observed throughout the vegetative, flowering and post flowering stages of the plant, while *M. rosae*, *Dysdercus* spp and *N. viridula* were observed at flowering stage. Damage caused by grasshopper to the rose plant was defoliation of the leaves leaving behind ragged holes on them. *Maconellicoccus hirsutus* suck sap from the plant, they excrete sticky honeydew and wax, which reduces plant vigour and flower quality (Perring, 2018). *Macrosiphum rosae* cluster underneath the leaves where they pierce and suck cell sap from the plant. They produce honeydew which cause black fungal growth (sooty mold) on the leaves. This sooty mold interferes with plant photosynthetic activity resulting into stunting and poor development of the plant. *Dysdercus* spp caused damage to flower buds by sucking the sap and destroys the buds while stink bugs damage rose petals on blooming, they feed and disfigure blooms of buds and flowers making them unmarketable (Table 3).

DISCUSSION

Results of this study indicated that grasshopper (*Z. variegatus*), mealybug (*M. hirsutus*), aphids (*M. rosae*), cotton stainer (*Dysdercus* spp) and stink bug (*N. viridula*) were major insect pests that induced damage to rose plants causing plant tissue consumption and distortion in the physiological processes of the plant. This corroborates earlier reports by Rajkumar *et al*. (2004) and Chaudhari and Kumar, (2020 indicating similar trend of insects attack on rose plants regardless of location. Grasshoppers are polyphagous insects. They feed on many plant hosts including rose plants. High population of grasshopper on rose in the study may be as a result of palatability and suitability of the plant for consumption. Wisotsky *et al*. (2011) reported that insects have well developed taste receptor which they used in sampling food for suitability and consumption. The abundance of species on a host can also be due to choice made by female insects (Fitt, 1986). Akol *et al*., (2013) reported that female insects prefer to lay their eggs on hosts in which their offspring fare best. In this study, eggs of grasshoppers were found on the leaves of roses which most likely support the growth and development of the insect.

Insect-host relationship resulted into damage to the host as observed in this study. Damage to rose plants range from defoliation (grasshoppers), sap sucking (mealybugs), production of honeydew and sooty mold on leaves which affect photosynthesis (aphids) and damage to petals and flower buds (cotton stainers and stinkbugs).

CONCLUSION

Roses are important and highly demanding landscape plants grown for their beauty and as raw materials in agro and floriculture industry. Five major insect pests; grasshopper, mealybug, aphids, cotton stainers and stinkbug have been identified in the study. These insect pests reduced plant growth, flower growth, flower quality and aesthetic damage to the plant. The development and introduction of an effective management package is essential to keep the population of the insects low and remain under economic threshold.

Table 1: Profile of insect pests and their status on rose plants on the field

Common name	Scientific name	Order	Family	Status
Grasshopper	*Zonocerus variegatus*	Orthoptera	Pyrgomorphidae	Pest
Mealybug	*Maconellicoccus hirsutus*	Hemiptera	Pseudococcidae	Pest
Rose Aphids	*Macrosiphum rosae*	Hemiptera	Aphididae	Pest
Cotton stainer	*Dysdercus spp*	Hemiptera	Pyrrhocoridae	Pest
Stink bug	*Nezera viridula*	Hemiptera	Pentatomidae	Pest

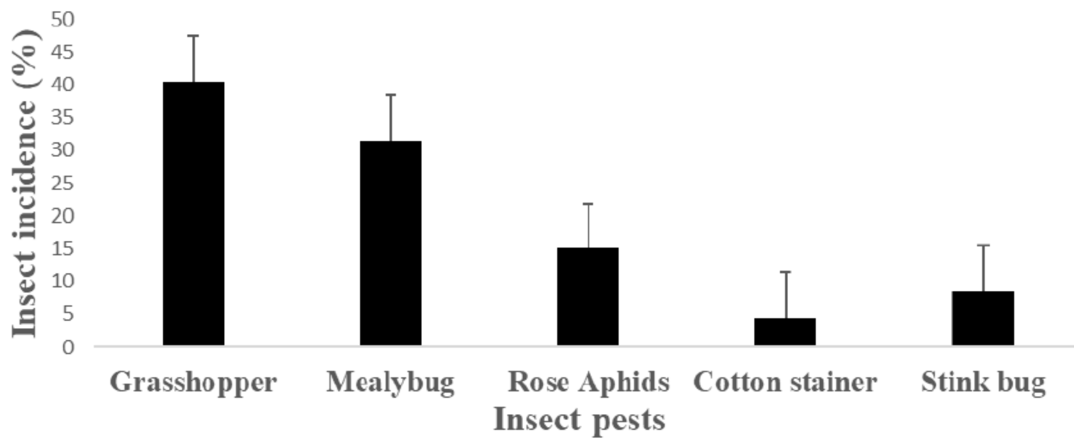

Fig. 1: Insect pests and incidence on rose plants in the field

Table 3: Rose insect pests, plant part damaged and nature of damage

Common name	Part damage	Nature of damage
Grasshopper	Leaf	Defoliation
Mealybug	Leaf, buds, flowers	Sap sucking
Rose Aphids	Leaf, buds, flowers	Sap sucking
Cotton stainer	flower buds	Sap sucking
Stink bug	flowers	chewing of petals

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ASSESSMENT OF THE AVAILABILITY AND AFFORDABILITY OF MUSHROOM RAW-MATERIALS IN IBADAN METROPOLIS

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ABSTRACT
Mushroom is regarded as mother of all vegetables because of its roles in human nutritional supply with abundant number of essential vitamins, minerals and protein. However, there is dearth of information on what goes into its domestication, therefore this study assessed the availability and affordability of raw-materials for mushroom production in Ibadan metropolis with a view to encourage sustainable production for economic growth. Ibadan metropolis was purposively chosen based on the abundance of various institutions who are actively involved in the production of mushroom and presence of some trained farmers who are into the production. Information was elicited from 36 mushroom producers with the aid of structured questionnaire. Data were analysed using descriptive statistics such as frequencies and percentages. Findings revealed that 58.3% respondents rarely had materials for mushroom production whenever they intend to produce, 50% respondents cannot afford relevant materials needed for the production, while 30.5% respondents revealed that spawn production cost between 500-1,000 naira. Also, lack of capital and favourable environment are key factors contribution to no increase in mushroom production. It is therefore recommended that basic and necessary production materials be made available and accessible to producers at subsidized rates. In order to enhance production, credit support should be made available to producers at affordable interest rates.

***Keywords**: Mushroom production, availability of mushroom, production materials, affordability of mushroom production materials*

INTRODUCTION

Mushroom, a very nutritious horticultural crop that double as non-timber forest product is generated from lignocelluloses waste materials rich in crude fibre and protein. (Adedokun and Okomadu, 2017) The amount of protein in mushroom is double than any other vegetables. Hence, it is called vegetable protein. In fact, mushroom contains low fat, low calories and good vitamins (Jiao-Jiao *et al*., 2016) Mushroom is a source of extra ordinary power, virility and is used in the preparation of many continental dishes. It is a good source of protein, vitamins and minerals and contain about 85-95% water, 3% protein, 4% carbohydrates, 0.1% fats and 1% minerals and vitamin, this made mushroom to be regarded as game changer (Osuafor and Edeh, 2020).

Mushroom possesses multifunctional and medicinal properties; therefore, a culture of mushroom could be a source of additional income for the families on small scale farms with active participation of members (Osemwegie and Okhuoya, 2014). According to (Osuafor *et al.,* 2021), mushroom production is a useful way of earning income when climate change makes farming less reliable. In order to increase revenue, ensure food security and improve living conditions in the face of poor crop yields brought on by the effects of climate change, farmers can make an effort to grow protein-rich mushrooms. Mushroom is congenial for their flavour, economic and ecological values, and medicinal attributes for many years (Gupta *et al.,* 2018)

Mushroom can be cultivated easily in home yards because it requires a small space to grow thereby serve as means of creating employment, particularly for rural women and youths in order to improve their social status (Osemwegie and Okhuoya, 2014). The natural habitat of mushroom ranges from farm land, forest and newly cleared lands, pieces of wood found in several place. Naturally, the availability of mushroom is seasonal, depending on the species some may be available just at the onset of rains, others during the rains, some when the rains are winding up. By practicing mushroom production, farmers can contribute successfully and significantly to the economic development of the country (Stamets, 2020) It also provides additional work for the farmers during winter months when the farming schedule is light.

So, mushroom production plays a vital role on socio-economic development of those who are involved in the production (Zhang *et al*., 2014).

According to National Farmers Information Service (NAFIS, 2021), Nigeria produces 300 tonnes of mushrooms per year and has a market demand of 1200 tonnes, this means that many consumers of mushroom which include homes, hotels, and kitchens import from elsewhere, this implies that the supply within Nigeria does not meet up with the demand. In this case, there is market demand but insufficient supply within the country, hence the need to research on the availability and cost of raw-materials for the production of mushroom in the study areas.

MATERIALS AND METHOD

Study area

This study was carried out in Ibadan metropolis. Ibadan is the state capital of Oyo state Nigeria, It has a population of 3,720,643 people according to the ~~(~~2006~~)~~ census and it is the most populous city in Nigeria after Lagos and Kano.~~,~~ It is the largest city by geographical area with 128 km inland northeast of Lagos and 530 km southwest of Abuja, the federal capital, and is a prominent transit point between the coastal region and the areas in the hinterland of the country. The city covers a total area of 3,080 square kilometers (1,190 sq mi), the largest in Nigeria~~.~~ (Olanrewaju *et al.,* 2018). There are eleven local governments in Ibadan; the metropolitan area comprises five (5) urban local governments' areas in the city and six (6) semi urban local governments in the lesser city. The five urban local governments include; Ibadan-north, Ibadan North-east, Ibadan North-west, Ibadan South-east and Ibadan South-west while six semi-urban consists of Akinyele, Egbeda, Ido, Lagelu, Ona-ara and Oluyole (Olanrewaju *et al.,* 2018).

Sources and types of data

The study made use of primary data which were obtained through the use of structured questionnaire designed for generating data for the study area. The data collected from mushroom producers includes the following: demographic characteristics such as age, sex, household size, marital status and religion, availability and affordability of raw materials, types of mushroom cultivated and factors responsible for increase in production among others.

Sampling technique

The study made use of multistage sampling technique. The first stage was the purposive selection of Ibadan metropolis because of the high demand for fresh mushroom and mushroom products. The second stage involves the purposive selection of some organizations in Ibadan who are known to be the areas where mushrooms were been produced, these sites were also known for training and capacity building on mushroom production such as Forestry Research Institute of Nigeria (FRIN), National Horticultural Research Institute (NIHORT), ZARTECH, the Department of Crop Protection & Environmental Biology, and Department of Botany at University of Ibadan, Ibadan, Nigeria as well as the random selection of individual mushroom producers based on reference by the above named organizations. In all a total of thirty-six (36) respondents were sampled for the study.

Analytical technique

In order to achieve the set objectives for this study, data were analysed using descriptive statistics such as frequency and percentages.

RESULT AND DISCUSION

Socio-demographic characteristics of respondents

As observed from the results on Table 1, majority (61.1%) of the respondents were male, married (91.7%), within the age bracket 45-54 years (52.8%), are of the Christian religion (61.1%) and have between 1-10 years of experience in mushroom production. The implication of these results is that married people are more involved in mushroom production, this can be connected to the more responsibility attached to married people, they need extra income to cater for the wellbeing of their immediate family and other social responsibility. Also, young people were not showing interest in the production of mushroom in the study area, which may be as result of unavailability of social amenity to encourage young people into the farming system. Studies have shown that rural-urban migration by young people had leads to a shift in the roles of farming and collection of non-timber forest product such as mushroom to the hands of older people taking the lead in the collection of non-timber forest product (Hechat *et al.,* 2015*)*. On the years of experience, the result indicates that the low years of experience might have contributed to low production of mushroom in Ibadan metropolis.

Availability and affordability of mushroom raw materials

Results also revealed that, more than 50 percent of the respondents claim that they rarely had materials available for mushroom production (Table 2). This may be connected to lack of loans, incentives and credit facility to people engaging in farming activities couple with inflation ravaging most communities in the country According to the research work of Neelam *et. al,* (2013), important things to note before going into mushroom production include availability of materials needed for production including finance and ability to identify strategic area where mushrooms are been sold.

Results on Table 2 also revealed that 50.0% of the respondents believe that the necessary materials needed for production are affordable while the remaining half believe they are not. Additionally, oyster mushroom was the most cultivated in the study area thus affirming the result of Tolera and Abera (2017) that oyster mushroom are cultivated in different parts of the world. It also revealed in Table 2 that oyster mushroom was the most patronized (97.2%) mushroom by consumers.

Factors responsible for increased production

As shown in Table 3, more than 50 percent of the respondents affirmed that mushroom production increased within the last 2 years prior to the study and that market patronage was responsible for the increase. On the other hand, 63.9% arrogated the lack of increase in production to lack of capital and unfavourable environment (19.4%). Also majority do not make use of unskilled labour probably due to the technicality of mushroom production. Cost of producing spawn which is one of the key materials for mushroom production is between ₦500-1000 (30.5%) followed by ₦1501-2000.

Production method

Majority of the respondents affirmed that necessary materials needed to train people on mushroom production are not available and that such training cannot be done free of charge (Table 4). Also, a larger proportion of the sampled were satisfied with the reliability of the sterilization methods used in production and do not employ any special method during harvest. More than 80 percent cultivate mushroom on land especially in the garden (control environment), while only 11.1% picked their own from the forest.

CONCLUSION

Mushroom is an important horticultural and non-timber forest product which plays very important roles in improving the food and nutrition security of most developing countries such as Nigeria. Nigeria's sources of exchange and economic stability can be improved and achieved if proper attention is given to mushroom production. Findings from the study indicate that necessary materials needed for mushroom production are not readily available and affordable. Also lack of capital and favourable environment are key factors contribution to no increase in mushroom production. It is therefore recommended that basic and necessary production materials be made available and accessible to producers at subsidized rates. In order to enhance production, credit support should be made available to producers at affordable interest rates.

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Table 1: Distribution of respondents by demographic characteristics

Variables	Frequency (n=36)	Percentage (%)
Sex		
Male	22	61.1
Female	14	38.9
Age		
25-34	6	16.7
35-44	11	30.5
45-54	19	52.8
Marital status		
Single	3	8.3
Married	33	91.7
Religion		
Christian	22	61.1
Islam	14	38.9
Years of experience (Years)		
1-10	34	94.4
11-20	-	-
21-30	1	2.8
31-40	1	2.8

Source: Field survey (2023)

Table 2: Availability and affordability of mushroom raw materials

Variable	Frequency (n=36)	Percentage (%)
Availability of production materials		
Readily available	15	41.7
Rarely available	21	58.3
Materials affordability		
Yes	18	50.0
No	18	50.0
Type of mushroom cultivated		
Chanterelles	2	5.6
Oyster	34	94.4
Type of mushroom mostly purchased by consumers		
+Oyster	35	97.2
Chanterelles	1	2.8

Source: Field survey (2023)

Table 3: Factors responsible for increased production

Variable	Frequency (n=36)	Percentage (%)
Production increase in the last 2 years		
Yes	21	58.3
No	15	41.7
Factors responsible for production increase		
Customers' demand	11	30.5
Market	24	66.7
Increase in staff number	1	2.8
Factors responsible for no increase in production		
Lack of capital	23	63.9
Low demand	2	5.6
Unfavourable environment	7	19.4
Unavailability of spawns	1	2.8
Lack of awareness	3	8.3
Use of unskilled labour		
Yes	7	19.4
No	29	80.6
Cost of spawn production (Naira)		
Less than 500	5	13.9
500-1000	11	30.5
1001-1500	6	16.7
1501-2000	9	25.0
>2000	5	13.9

Source: Field survey (2023)

Table 4: Production method

Variable	Frequency (n=36)	Percentage (%)
Availability of necessary training materials		
Yes	11	30.6
No	25	69.4
Mushroom training can be done for free		
Yes	1	2.8
No	35	97.2
Satisfied with the reliability of sterilization method		
Yes	29	80.6
No	7	19.4
Use special method for harvesting mushroom		
Yes	5	13.9
No	31	86.1
Use land for production		
Yes	31	86.1
No	5	13.9
Hectares of land used for production		
Less than 1ha	30	83.3
1-2 ha	6	16.7
Cultivation method		
Scattered in the field	5	13.9
Garden	29	80.6
Pick in the forest	2	5.5

Source: Field survey (2023)

IMPACT OF Arbuschular mycorrhizal INOCULATED SOIL AND WATER REGIMES ON ROOT GROWTH AND DRY MATTER BIOMASS OF THREE CASHEW BIOTYPES IN IBADAN, NIGERIA

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ABSTRACT
A study was conducted at the Headquarters of Cocoa Research Institute of Nigeria (CRIN) during the 2020/2021 dry season, with the aim of evaluating the effects of Arbuscular mycorrhizal inoculated soil and water regimes on root growth and dry matter biomass of three cashew biotypes in Ibadan, Nigeria. The study was designed as a Screen house experiment, consisting of a 3 x 3 x 2 factorial with 18 treatment combinations replicated three times, for a total of 54 experimental units, laid out in a completely randomized design (CRD). The factors included three cashew biotypes - Jumbo (C1), Medium (C2), and Madras (M3); 3 water regimes – 40% Field capacity (F1), 60% Field capacity (F2), and 80% Field capacity (F3) and 2 levels of Mycorrhiza - with Mycorrhiza (M1) and without Mycorrhiza (M0). Growth parameters such as plant height (cm), stem girth (cm), root length (cm), and dry matter biomass were collected and analyzed using ANOVA. The results indicated that Cashew biotypes responded differently to AMF inoculation, with Jumbo cashew inoculated with AMF showing a higher level of root colonization. Both negative and positive responses of the cashew biotypes were observed. The AMF inoculation significantly ($p > 0.05$) improved all the growth parameters considered, irrespective of the levels of water treatment. Jumbo cashew biotype (C1) inoculated with mycorrhizal (M1) at 80% field capacity produced the longest root (23cm) compared to others, followed closely by Jumbo biotype (C1) partially drought (F1) cashew seedlings with a root length of 22.00cm. Similarly, AMF inoculation, irrespective of rates of water applied, positively improved both fresh and dry matter accumulation of cashew biotypes throughout the periods of the experiment, with Jumbo biotypes inoculated with AMF inoculum at 80% field capacity. However, there was no significant difference between C1F1M1 and C1F3M1. C1F1M0 recorded the least dry matter yield. It is recommended that further research be directed towards exploring the potential of Arbuscular mycorrhizal in sustainable cashew production and other agricultural crops to enhance productivity. Such efforts would significantly contribute to the overall development of agriculture in the country. Notably, the pots that received AMF inoculation in conjunction with 80% field capacity (water treatment) exhibited the most significant response to the applied treatments ($p > 0.05$).
Keywords: Accumulation, Arbuscular, Biotypes, Cashew, Field capacity, Inoculation, parameters

INTRODUCTION

Over 80% of the world's plant species have the ability to establish symbiotic relationships with Arbuscular Mycorrhizal Fungi (AMF) in their native habitats, as reported by Eom *et al.* (2000) and Parniske (2008). The association between AMF and plant roots has been linked to enhanced plant productivity, as demonstrated by Kaya *et al*. (2003). The colonization of plant roots by mycorrhizal organisms significantly increases the area available for nutrient uptake and drainage, leading to improved plant absorption. Previous studies on various crops have shown that mycorrhizal colonization results in a prolonged period of growth, as reported by Augé (2001). The presence of AMF can be observed in the early stages of plant development, as vesicles and spores resembling those of the Glomus species, as reported by Fulekar (2010). The first evidence of the superior growth of mycorrhizal plants compared to non-mycorrhizal plants was reported in Japan in the 1940s by Koide et al. (2014). In Europe, Mosse's study in 1957 demonstrated the beneficial interaction between Arbuscular mycorrhizal sporocarps of Endogone (Glomus) mosseae and apple seedlings and clonal leaf cuttings in autoclaved soil, as reported by Koide *et al*. (2004). The discovery and expression of AMF growth dates to the late nineteenth century, as reported by Brundrett (2004). AMF organisms obtain starch from plants, while plants benefit from mycorrhizal growth through nutrient supplementation, disease resistance, improved water relations, and reduced nutrient uptake.

These benefits have been demonstrated by numerous studies, including those by Augé (2001), Birhane *et al*. (2012), Bolandnazar *et al.* (2007), Kaya *et al.* (2003), and Rutto *et al.* (2002). Peterson *et al.* (2004) classified Arbuscular mycorrhizal organisms into six categories based on morphological characteristics and chemical investigations. Various species have been used for AMF identification, including hyphal traits, hyphae helper cells, spores, or spore carp intogeny, morphology, germination, spore separator protection, biochemical, sub-atomic, and physiological characteristics, as reported by Mukerji *et al*. (2002). When combined with mycorrhizal chemicals, almost all types of trapped roots show a yellow color indicative of disease (Bengum, 2019). Mycorrhizal fungi are present in any soil that support plant growth and help plants absorb water and nutrients. As a food source, plants provide sugars from their leaves to fungi. In addition, mycorrhizae can increase root surface area, allowing plants to absorb more water and nutrients from a larger volume of soil (Nadeem *et al.*, 2014). Furthermore, different mycorrhizal species respond differently depending on the plant species they are associated with (Ortas and Ostner, 2014). This is due to the wide variety of mycorrhizal fungal species that can alter the strength of plant-to-plant interactions and change the rate of plant growth. It is widely accepted that plants inoculated with mycorrhizal fungi have higher growth rates than control plants due to increased photosynthetic activity. The objective of this study therefore was to evaluate the effects of Arbuscular mycorrhizal inoculated soil and water regimes on root growth and dry matter biomass of three cashew biotypes in Ibadan, Nigeria.

MATERIALS AND METHODS

The study was conducted at the Headquarters of Cocoa Research Institute of Nigeria (CRIN), Kilometer 14, Ijebu – Ode Road, Onigambari, Adebayo, Idi Ayunre, Ibadan in Oluyole Local Government Area, Oyo state, Nigeria during the 2020/2021 dry season, with the aim of evaluating the effects of arbuscular mycorrhizal inoculated soil and water regimes on root growth and dry matter biomass of three cashew biotypes in Ibadan, Nigeria. The study was designed as a Screen house experiment, consisting of a 3 x 3 x 2 factorial with 18 treatment combinations replicated three times, for a total of 54 experimental units, laid out in a completely randomized design (CRD). The factors included three cashew biotypes - Jumbo (C1), Medium (C2) and Madras (M3); 3 water regimes – 40% Field capacity (F1), 60% Field capacity (F2) and 80% Field capacity (F3) and 2 levels of Mycorrhiza - with Mycorrhiza (M1) and without Mycorrhizal (M0). Ibadan is located at latitude 70 10’ N and longitude 030 52’ E. It is situated at an elevation of approximately 122 meters above sea level and is situated within the tropical rainforest region of Nigeria.

Planting of cashew seedlings

The topsoil utilized in this study was obtained from a Cashew plantation. It was air-dried and passed through a 10mm mesh sieve. Ten kilograms of the sieved soil were then filled into ten-liter plastic pots, watered to field capacity, and allowed to drain for 24 hours prior to planting Cashew seeds. The plastic pots were arranged on a raised concrete platform in a Screen house. The current season's Cashew seeds of Large, Medium, and Madras biotypes were planted individually in the pots. Two seeds were initially planted in each soil-filled punctured plastic pot, and later thinned to one seedling per pot. Prior to sowing the Cashew seeds, 50g of Arbuscular mycorrhizal was weighed and introduced halfway into the plastic container, mixed with soil, and watered immediately after sowing. Water treatments were applied at 40%, 60%, and 80% field capacity (F). Destructive sampling was carried out two months after treatment application to evaluate the effect of the mycorrhizal on fresh and dry shoot weight (g), leaf root weights (g), and root length (cm). This necessitated a doubling of 54 experimental units, thereby increasing the total experimental units from 54 to 108. The Cashew seedlings were monitored for four months at fortnight intervals for their growth parameters, which included plant height, girth, number of leaves, and branches. The growth parameters were measured using the following techniques: plant height was measured in centimetres using a meter rule from the plant base to the plant's terminal bud tip; visual inspection was used for the number of leaves and branches. Stem size was measured in centimetres using an advanced Vernier-Caliper 10cm above the ground level.

Agronomic practices carried out.

During the study period in the Screen house, watering was conducted biweekly with a three-day interval. Additionally, hand weeding and insecticide application were diligently executed in a timely manner.

Project termination and post-treatment soil sample collection

Upon completion of the experiment, the plants were harvested and subjected to a meticulous washing process with sterile water to eliminate any adherent soil particles. The various components of the plant, namely the roots, stem, and leaves, were segregated and packaged individually. The fresh weight of each component was measured and subsequently, the samples were subjected to oven drying at a temperature of 70 OC for a duration of 72 hours, following which their weight was determined. The oven-dried plant materials were then processed using a Glen Creston Mill equipped with a stainless-steel grinding chamber. The resulting materials were preserved for the determination of their nutrient contents in accordance with the procedures outlined by IITA (1979). Additionally, representative soil samples were collected from each experimental unit after thorough mixing of the soil in each pot. The soil samples were processed and analysed using the procedures prescribed by IITA (1979).

RESULTS AND DISCUSSION

Root length (cm) and growth biomass of cashew biotypes as influenced by Arbuscular mycorrhizal and water regimes. Despite the discernible treatment effects observed on the various cashew biotypes (C1F2M0; C1F3M0; C2F1M0 and C2F2M0) two months after treatment imposition with regards to the root length of the seedlings, the disparities were comparable and did not exhibit statistical significance ($p<0.05$) amongst themselves (Table 2). The Jumbo cashew biotype (C1) that was inoculated with mycorrhizal (M1) at 80% field capacity (F3) exhibited the longest root length (23cm) in comparison to the other biotypes. This was closely followed by the Jumbo biotype (C1) that was partially drought (F1) treated, with a root length of 22.00cm (Table 1). This result confirms the earlier observation of Kaya *et al.,* (2003) who reported that the association between AMF and plant roots is linked to increased plant productivity as Kaya et al., (2003). Similarly, the result of the present study agrees with the observations of Ying – *et al.,* (2014) and Campo *et al.,* (2020) who opined that inoculation with arbuscular mycorrhizal fungi significantly increased root projected area, surface area, volume, and total length, mainly in the range of 0 – 1 cm. However, the increase in length experienced by cashew seedlings may have been as a result of the colonization of the rhisozphere of the cashew seedlings by the AMF. However, the mean root difference was not statistically significant ($p < 0.05$). Cashew seedlings that were not inoculated with AMF, regardless of biotype, produced the least root length (8.00 cm). These trends persisted until the end of the experiment, which was 4 months after treatment imposition (4MAA).
Similar results were observed 4 months after treatment (4MAA), with the control producing the shortest roots and Jumbo cashew seedlings treated with mycorrhizal at 80% field capacity producing the longest roots (40.33cm) (Table 2). There were no significant differences observed in the root length values (15.00 and 15.17cm) of the medium cashew biotypes that were inoculated with Arbuscular mycorrhizal fungus at 40 and 80% field capacities (C2F1M1 and C2F2M1) respectively. However, these values were found to be significantly different ($p < 0.05$) when compared to the cashew biotypes that were not inoculated with mycorrhizal fungi and subjected to different water regimes at 2MAA as presented in Table 1. Moreover, the utilization of Arbuscular Mycorrhizal Fungi (AMF) inoculation exhibited a favorable impact on the fresh weight of roots and shoots, irrespective of the water application rate, as evidenced by Tables 1 and 2. Notably, the jumbo cashew (C1F3M1) that was subjected to AMF inoculum at the highest water regime (80% field capacity) demonstrated a significant improvement in both underground and above-ground fresh matter accumulation, in comparison to the other treatments applied. The control group exhibited the lowest fresh root and shoot weight (g/plant), respectively. The increase in weights (root and shoot) further confirms the work of Xue – Guang and Ming (2013) that, mycorrhizal plants exhibited significantly greater plant heights, stem diameters, leaf counts, and shoot masses (including leaf blades) in comparison to non - mycorrhizal plants. Additionally, the total masses of mycorrhizal plants were found to be considerably higher than those of non-mycorrhizal plants, they concluded.
Influence of Arbuscular mycorrhizal and water regimes on the dry root and shoot biomass of cashew biotypes. Throughout the experiment, the application of Arbuscular mychorrhizal in combination with three different field capacities and various water regimes had a significant impact on the accumulation of dry matter both underground and above ground in cashew biotypes (Tables 1 and 2). This result confirms the findings of Bengum *et al.,* (2022) who reported that introduction of Arbuscular mycorrhizal fungi (AMF) enhances the accumulation of dry matter and improves water moisture uptake, thereby resulting

in an overall improvement in crop performance. The Jumbo biotypes that received AMF inoculum at 80% field capacity demonstrated the most notable enhancement. Nonetheless, there was no discernible variation between C1F3M1 and C3F3M1 during the entire duration of the experiment ($p > 0.05$). At 2MAA and upon conclusion of the experiment, C1F1M0 exhibited the lowest dry matter yield (Tables 1 and 2). The Jumbo biotypes that were subjected to AMF inoculum at 80% field capacity manifested the most significant improvement. However, there was no statistically significant difference ($p < 0.05$) between C1F3M1 and C3F3M1 throughout the experimental periods. C1F1M0 recorded the least dry matter yield at 2MAA and at the conclusion of the experiment (Tables 1 and 2).

Table 1: Root length (cm) and dry matter accumulation (DMA) of cashew Biotypes at 2MAA months after treatment application

	2 Months after treatment application (2MAA)				
Treatments	**RL**	**FRW**	**DRW**	**FSW**	**DSW**
$C_1F_1M_0$	8.00^{h}	0.01^{d}	0.01^{c}	0.04^{ef}	0.02^{n}
$C_1F_2M_0$	10.50^{gh}	0.05^{d}	0.03^{bc}	0.15^{e}	0.09^{i}
$C_1F_3M_0$	12.00^{g}	0.05^{d}	0.03^{bc}	0.10^{e}	0.06^{k}
$C_2F_1M_0$	11.33^{g}	0.08^{c}	0.05^{b}	0.08^{e}	0.05^{l}
$C_2F_2M_0$	12.20^{g}	0.05^{d}	0.03^{bc}	0.15^{e}	0.09^{i}
$C_2F_3M_0$	14.00^{e}	0.10^{b}	0.06^{b}	0.47^{c}	0.03^{m}
$C_3F_1M_0$	8.33^{h}	0.05^{d}	0.03^{bc}	0.13^{e}	0.08^{j}
$C_3F_2M_0$	12.00^{g}	0.05^{d}	0.03^{bc}	0.30^{d}	0.18^{h}
$C_3F_3M_0$	10.00^{gh}	0.08^{c}	0.05^{b}	0.49^{c}	0.39^{c}
$C_1F_1M_1$	13.00^{f}	0.17^{a}	0.10^{a}	0.89^{a}	0.53^{a}
$C_1F_2M_1$	22.00^{a}	0.02^{d}	0.07^{b}	0.40^{cd}	0.24^{g}
$C_1F_3M_1$	**23.00^{a}**	**0.18^{a}**	**0.11^{a}**	**0.96^{a}**	**0.58^{a}**
$C_2F_1M_1$	15.00^{d}	0.05^{d}	0.03^{bc}	0.75^{b}	0.45^{b}
$C_2F_2M_1$	15.17^{d}	0.07^{c}	0.04^{bc}	0.47^{c}	0.28^{e}
$C_2F_3M_1$	18.00^{c}	0.10^{b}	0.06^{b}	0.53^{c}	0.32^{d}
$C_3F_1M_1$	19.33^{b}	0.05^{d}	0.03^{bc}	0.47^{c}	0.26^{f}
$C_3F_2M_1$	15.87^{d}	0.05^{d}	0.03^{bc}	0.30^{d}	0.18^{h}
$C_3F_3M_1$	20.00^{ab}	0.02^{d}	0.13^{a}	0.57^{a}	0.58^{a}

Means that carried the same letter within a column are not significantly different from one another. C1= Jumbo; C2= Medium Cashew; C3= Madras Cashew; F1= 40% Field capacity; F2 = 60% Field capacity; F3 = 80% Field capacity; Mo = Without Mycorrhizal; M1=With Mycorrhizal

Table 2: Root length (cm) and dry matter accumulation (DMA) of cashew Biotypes at 4 months after treatment (4MAA) application

	4 Months after treatment application (4MAA)				
Treatments	**RL**	**FRW**	**DRW**	**FSW**	**DSW**
$C_1F_1M_0$	10.00^{h}	4.00^{cde}	2.16^{de}	11.87^{i}	7.80^{g}
$C_1F_2M_0$	13.33^{g}	14.00^{b}	7.74^{cd}	35.00^{d}	16.80^{c}
$C_1F_3M_0$	18.00^{e}	15.00^{b}	7.05^{cd}	37.00^{d}	20.65^{d}
$C_2F_1M_0$	19.00^{e}	6.00^{cd}	3.60^{d}	27.00^{ef}	12.00^{fg}
$C_2F_2M_0$	12.50^{g}	10.00^{bcd}	6.00^{cd}	30.00^{e}	16.20^{ef}
$C_2F_3M_0$	15.17^{g}	14.00^{b}	8.40^{c}	29.00^{ef}	18.20^{e}
$C_3F_1M_0$	22.00^{d}	4.00^{cde}	2.40^{de}	22.17^{g}	13.20^{f}
$C_3F_2M_0$	15.50^{f}	7.00^{cd}	4.20^{d}	26.67^{f}	13.30^{f}
$C_3F_3M_0$	20.33^{de}	12.00^{bc}	7.20^{cd}	30.00^{e}	29.40^{b}
$C_1F_1M_1$	27.00^{b}	18.00^{b}	8.40^{c}	42.00^{a}	30.00^{b}
$C_1F_2M_1$	39.00^{a}	4.17^{cd}	2.50^{de}	30.37^{e}	18.24^{e}
$C_1F_3M_1$	**40.33^{a}**	**25.00^{a}**	**13.60^{a}**	**57.20^{a}**	**33.92^{a}**
$C_2F_1M_1$	25.00^{c}	5.37^{cd}	3.22^{d}	42.37^{c}	25.22^{c}
$C_2F_2M_1$	22.27^{d}	6.00^{cd}	3.60^{d}	26.50^{f}	15.90^{ef}
$C_2F_3M_1$	21.17^{d}	12.90^{bc}	10.80^{b}	49.40^{b}	29.64^{b}
$C_3F_1M_1$	20.97^{de}	4.17^{cd}	3.16^{d}	23.00^{g}	13.80^{f}
$C_3F_2M_1$	20.67^{de}	5.17^{cd}	2.50^{de}	19.50^{h}	11.70^{g}
$C_3F_3M_1$	21.33^{d}	**20.00^{a}**	**15.20^{a}**	**51.70^{a}**	**32.62^{a}**

Means that carried the same letter within a column are not significantly different from one another

CONCLUSION

According to the findings of the current study, Arbuscular mycorrhizal fungi exhibit promising potential for enhancing seedling root development and promoting both below-ground and above-ground growth and dry matter accumulation. If utilized effectively, this could result in an overall increase in cashew production in the cashew-growing regions of Nigeria. Consequently, it is recommended that further research be conducted by scientists, particularly Agronomists in partnership with soil scientists and other stakeholders, to explore the prospects of this fungus in agricultural productivity.

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MICROBIOLOGICAL AND ORGANOLEPTIC QUALITIES OF STORED SCOTCH BONNET (*Capsicum chinense*) PRESERVED WITH GUM ARABIC–CINNAMON OIL COATINGS

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ABSTRACT

In 16-days storage, this study assessed preservative effects of gum Arabic coating discretely and with cinnamon oil on fresh hot-pepper fruits, wherein microbial and colorimetric enumerations were monitored at 4 days intervals. Coatings significantly (p<0.05) achieved 30–70 % bacteria reductions from initial 7.3 x 10^4CFU/g, restraining rapid produce deterioration for ≥8<12 days; antifungal efficacies were exhibited through storage duration as yeasts and molds ranged 2.5 x 10^2 – 7.0 x 10^3CFU/g, within recommended 10^3–10^5 microbial limit for related food category. Brightness L (27–33) of preserved peppers gradually increased with ripening unto 8 days. Based on produce' variety, a (-3.14 – 9.11) and b (6.12 – 12.38) values were yellow on the colorimetric chart, without significant difference within treatments until two weeks storage. Gum Arabic without cinnamon oil ranked best across assessed visual and textural qualities, significantly different to other treatments. Applied coatings are effective in postharvest management of Capsicum fruits.

Keywords: *Peppers, Postharvest, Gum-Arabic, Cinnamon, Preservation*

INTRODUCTION

After tomatoes, the highly perishable Scotch Bonnet (*Capsicum chinense*) – a variety of chilli pepper ranks amongst important crops with about 18 t/ha yield in open fields (Barth *et al.,* 2009; Obayelu *et al.,* 2021; Ogungbemi, 2020). In the tropics of Sub-Saharan Africa, incurred losses in the postharvest value-chain of fresh produce, especially fruits and vegetables are in high (40–60 %) estimates (Obayelu *et al*., 2021) due to contributing pathological, physiological, ecological and mechanical factors such as microbial contaminants, prevailing environmental conditions (temperature and relative humidity), continued respiration of produce, and related gaseous interactions contribute to incidences of rapid quality deteriorations, safety and storability of these produce (FAO and CIRAD, 2021; Suchánková et al., 2015). In Nigeria and other developing nations, identified effective technologies with reduced temperature and increased relative humidity effectiveness for maintenance of quality during downstream value-chain are relatively unaffordable to smallholder farmers who are major producers of these fruits and vegetables (Obayelu et al., 2021; Oluwatobi, E. A., 2022). The adoption and utilization of Generally Regarded As Safe (GRAS) bio-polymeric materials (including Gum Arabic and essential oils) as edible coatings are recent interventions considered in the agricultural sector (Duguma, 2022). Thus, this study aims at preservation of scotch bonnet fruits with Gum Arabic–Cinnamon Oil edible coatings in related postharvest management.

MATERIALS AND METHODS

All materials were reliably sourced within Ilorin metropolis. Cinnamon bark was procured from Mandate market, while fresh Scotch Bonnet fruits were obtained at farmgate and transported early morning to NSPRI laboratory in surface-sterilized reusable plastic crates. The Scotch Bonnet fruits were sorted washed, surface sterilized by immersing in 0.01% hypochlorite solution for one minute, and air-dried.

Preparation and Application of Coatings: Cinnamon oil was extracted as described by Abubakar *et al.* (2014), while Gum Arabic coating was prepared according to Utami *et al*., (2014) with modifications. Ten grams (10 g) Gum Arabic was dissolved in 100 mL distilled water at 50 °C under continuous homogenization on a magnetic-stirrer hotplate for 60 minutes. Impurities were filtered off using muslin cloth, 2 mL glycerol was added as plasticizer to sustain potency and elasticity of coating mix, followed by addition of 3 mL cinnamon oil; this was tagged Coating A. Coating B with similar preparation lacked cinnamon essential oil. In three experimental lots: Treatment A (control) – fruits dipped in distilled water for 1-2 minutes; Treatment B – fruits dipped in Coating A; and Treatment C – fruits dipped in Coating B. Upon being air dried, all lots were assessed under same ambient storage conditions closely monitored with a data logger for 16 days, analytical monitoring was spaced 4 days.

Microbial Enumerations: Discrete samples initially diluted (1 mL aliquot) unto 10^{-6} dilutions were pour-plate inoculated for Bacteria and Fungi (yeast and mold) contaminants, enumerated using sterilized (121˚C, 15 psi, for 15 minutes in the autoclave) nutrient agar (FLUMEDIA, UK) and potato dextrose ager (HIMEDIA, India) appropriately; cultures were incubated at 35±2 ºC and 30±5 ºC for overnight 20±4 hrs. and 48±12 hrs. respectively. Colonies recorded were used for appropriated computation of microbial populace associated with the fruits and expressed as Colony Forming Unit per gram CFU/g (Fawole and Oso, 2007; FAO, 1997).

Color Measurements: Measurements on the epicarps were taken with a non-invasive colorimeter (FRU Color Reader, WR-10) of ShenZhen Wave Optoelectronics Technology Co. Ltd., China; and values presented as L (brightness), a (green to red) and b (yellow).

Organoleptic Assessment: Twenty panelists evaluated sensory attributes to infer consumer acceptance of the treated fruits as described by Fashanu *et al*. (2019).

Statistical analyses: Replicate data were subjected to Analysis of Variance (ANOVA) and tested for significant difference among treatments by New Duncan's Multiple Range F-Test (DMRT) at ($p<0.05$) using IBM SPSS software package version 26.0.0.

RESULTS AND DISCUSSIONS

The microbial populace enumerated from the three experimental lots of this study are presented in Figure 1. The recorded microbial loads of pepper fruits bulk (Day 0) distributed in lots exhibited an undulating pattern across treatments for the 16-days storage, this reflects microbial succession under supportive and unconducive environmental conditions for associated microbial diversity on the fruits. For Bacteria, similar to (Parveen et al., 2014), the proliferation of initial 7.3 x 10^4 CFU/g were 30–70 % reduced unto Day 8 evaluations, this infers influences of clean water dips (Treatment A), protective antimicrobial membranes of Gum Arabic and Cinnamon (Treatments B and C) to restrain rapid microbial deteriorations of produce and sustain marketable qualities for 72±12 hrs., which were best achieved in Treatment B (Day 4) and Treatment C (Day 8). Inclinations of bacteria loads by Day 12 unto Day 16 highlight the proliferation of less susceptible species to the coats and potency decline of in-place antimicrobial barriers, such that the extended shelf-life and quality retention against bacteria deteriorations of preserved scotch bonnet with Gum-Arabic and Cinnamon oil are optimally considered for 8 days. Recorded fungal contaminants relatively ranged 2.5 x 10^2 – 7.0 x 10^3 CFU/g with similar yeast and mold count of (Garuba et al., 2022; Ogungbemi, 2020), the antifungal efficacy of Treatments B and C were relatively inferred through the storage duration. The predominating yeasts by the 12th day of evaluations were significantly succeeded by associated molds.

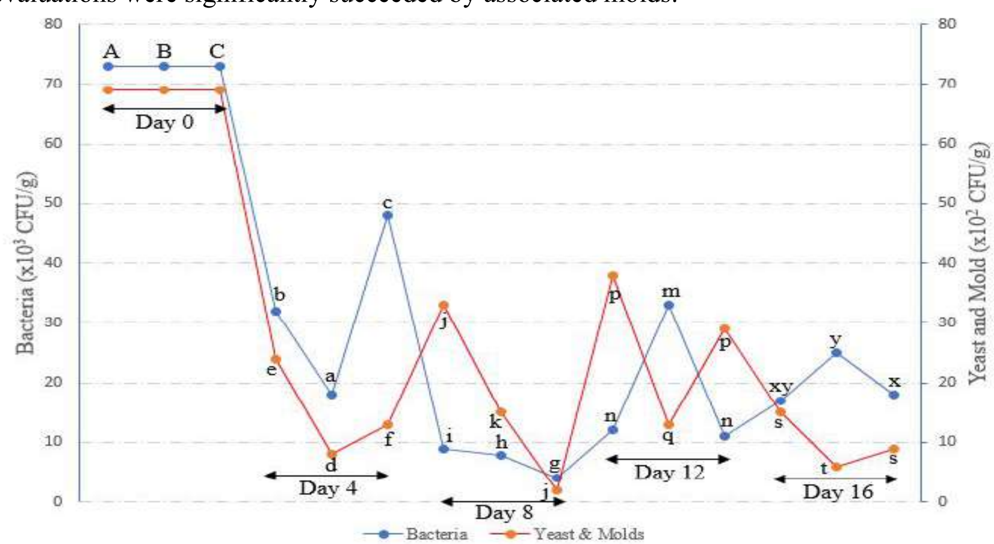

Figure 1: Microbial Enumeration of Pepper Fruits under Storage. A = Control; B = 10% Gum Arabic + 3 mL cinnamon oil; C=10% Gum Arabic; Lower-case alphabets (a – y) at markers are statistical comparison within A, B, C at each day of evaluation.

The color readings of evaluated *Capsicum* fruits are presented in Table 1 below. The brightness (27 – 33) of measured colors were observed to gradually increase unto the 8th day in storage, this considerably relate to the fruits' ripening characters within this duration. Recorded brightness were similar to (Díaz-Pérez et al., 2020). The fruits occupied the yellow region between green-red transition on the colorimetric charts, which relates to the varietal coloration of the *Capsicum* fruits used (-a to +a hemisphere), other varieties might highly tend towards red region (+a values) as reported by (Rahman et al., 2014). Despite non-significant difference ($p<0.05$) in recorded values, intensities of uncoated pepper fruits (Treatment A) were higher than the coated (Treatments B and C) till the 16th day; at which coloration (a, b) values of the coated peppers were significantly similar but different to the control; an effect of coating on the fruits' color is deduced.

Table 1: Color Measurements (L, a, b values) for Treated Scotch Bonnet under Storage

Sample	Day 0	Day 4	Day 8	Day 12	Day 16
L–values (brightness / intensity)					
A		$29.69^a±0.87$	$33.48^a±5.98$	$29.74^a±1.97$	$28.75^a±0.37$
B	$28.37^a±0.24$	$30.35^a±2.18$	$30.43^a±0.64$	$28.81^a±0.35$	$28.64^a±1.89$
C		$30.72^a±0.08$	$31.22^a±0.18$	$28.50^a±0.82$	$28.23^a±0.63$
a-values (green-red)					
A		$4.30^a±1.56$	$9.11^a±7.86$	$4.92^a±5.88$	$4.46^b±1.23$
B	$-3.14^a±0.26$	$5.30^a±1.80$	$5.90^a±2.89$	$-2.37^a±0.30$	$-1.17^a±0.11$
C		$6.48^a±0.59$	$8.15^a±1.05$	$2.31^a±2.93$	$0.94^a±0.35$
b–values (yellow)					
A		$9.03^a±0.76$	$12.38^a±6.38$	$8.23^a±1.95$	$7.69^b±0.40$
B	$6.12^a±0.67$	$10.05^a±2.30$	$10.36^a±0.10$	$7.17^a±0.68$	$6.50^a±0.16$
C		$10.70^a±0.07$	$9.66^a±1.03$	$6.92^a±0.39$	$6.19^a±0.07$

A = Control; B = 10% Gum Arabic + 3 mL cinnamon oil; C=10% Gum Arabic

The sensory qualities of the fruits evaluated are presented in Table 2 below. Appreciably, fruits coated with Gum Arabic without cinnamon oil constituents ranked best across assessed visual and texture qualities, significantly different to Treatments A and B. The panelists' preferences highlight significant shelf-life extension and retention of market qualities by applied coatings.

Table 2: Organoleptic attributes of Treated and Stored Scotch Bonnet

Sample	Aroma	Appearance	Colour	Firmness	Overall Acceptability
A	$2.10^a±0.10$	$1.90^a±0.18$	$2.20^a±0.20$	$2.40^a±0.16$	$2.30^a±0.15$
B	$2.10^a±0.23$	$2.00^a±0.21$	$2.50^a±0.17$	$2.30^a±0.26$	$2.90^b±0.10$
C	$3.50^b±0.17$	$3.50^b±0.17$	$4.00^b±0.21$	$3.30^b±0.15$	$3.80^c±0.13$

A = Control; B = 10% Gum Arabic + 3 mL cinnamon oil; C=10% Gum Arabic

CONCLUSION

The application of Gum Arabic and Cinnamon based edible coatings appreciably extended shelf-life and relatively retains qualities of preserved scotch bonnet peppers.

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CORRELATION COEFFICIENT ON SUNFLOWER YIELD AS AFFECTED BY WEED CONTROL METHODS AT BAGAUDA KANO STATE

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ABSTRACT

Field studies were conducted during 2018 and 2019 rainy seasons at Faculty of Agriculture Bayero University Kano (BUK) (Latitude 11° 58.861' N and Longitude 008° 25.155' E, Altitude 449 m above sea level) and at National Horticultural Research Institute (NIHORT) (Latitude 11^0 33^1 N and Longitude 8^0 23^1 E with Altitude of 481m above sea level) in the Sudan Savannah of Nigeria, to determine effects of spacing and weed control methods on the matrix correlation coefficient of sunflower production in Kano State. The experiment consisted of spacing (with three levels 30 x 75 cm, 60 x 75 cm and 75 x 75 cm) and eight weed control methods (as weedy check (T1), manual hoe weeding at 3 and 6 WAS (T2), pre emergence application of Tithonia plant extract followed by post emergence application of extract at 6 WAS (T3), pre emergence application of Tithonia followed by manual hoe weeding (T4), pre emergence application of Tithonia followed by post emergence application of post emergence Fluazipop (T5), pre emergence application of herbicide metolachlor followed by manual hoe weeding (T6) , pre emergence herbicides at planting (PEH) followed by post emergence application of herbicides Fluazipop (T7) and manual hoe weeding (MHW) followed by post emergence application of herbicides at 6 weeks (T8)). These were factorially combined in split plot design and replicated three times. Data were recorded on weed attributes, growth and yields character of sunflower. Results showed that the correlation coefficient between plant height, leaf area, weed dry weight and weed density were negative and non-significant. While the weed control efficiency and relative growth rate were highly significant and negatively correlated. The correlation coefficient between some selected weeds, growth characters and yield components of sunflower indicated negative and highly significant ($p \leq 0.01$) correlation between sunflower kernel yields and weed density. However, there was high negative and significant correlation between sunflower kernel yield and weed control efficiency.

Keywords: *Coefficient, correlation, herbicides, kernel, matrix, sunflower, weed, yield*

INTRODUCTION

Sunflower (*Helianthus annuus* L.) is the most successful cultivated species of the family *Asteraceae* (order *Asterales*), that includes over 70 species of shrubs (Anonymous, 2016). It is an important oilseed crop which ranks third after soybean and groundnut as source of edible oil in the world (Oyinlola *et al.*, 2010). The crop originated from North America (anonymous, 2016). It was likely to be the most "camp follower" Sunflower crop that is cultivated widely throughout the world (Groove *et al,* 2005). FAO (2010) reported that the current world area under sunflower cultivation was 22.3 million hectares, while seed production and average yield stood at 27.7 million tons and 1.2 ton per hectare respectively (Sani *et al.,* 2014). The major goal of growing sunflower is for its seed (achene) that contains oil (36- 52%) and protein (28– 32%) as reported by Rosa *et al.* (2009). It's a vegetable crop of economic importance that has a high oil content. It can be used as edible oil in form of margarine, salad dressing oil and cooking oil, it can also be used as snacks (Qahar *et al.,* 2010). The non-dehulled or partly dehulled sunflower meal can be used for ruminant animals, pigs and poultry feeds. Weeds significantly affect sunflower yield and reduce the quality and quantity of kernel during harvest. According to report loss due to weeds may reached up to 96 percent at the global level

MATERIAL AND METHODS

The experiments were conducted during the 2017/2018 and 2018/2019 rainy season at the Teaching and Research Farm of Bayero University, Kano, ($11^0$58N and $8^0$25E) and the Teaching and Research Farm of National Horticultural Research Institute NIHORT ((Latitude 11^0 33^1 N and Longitude 8^0 23^1 E with altitude of 481m above sea level) in the Sudan Savannah agroecology zone of Nigeria. The average rainy days of about 110 and annual rainfall of about 1033.3 maximum and minimum of 981.2.) At Bagauda in 2018 rainy season. The average rainfall of 500mm to 1000mm per annum was adequate for growing sunflower. The rainy days of 100 to 120 days can support sunflower production (Badu-Apraku *et al*., 2011), the area has an average temperature of $28^0 – 32^0$C and dry season of 6 to 9 months (Sowunmi and Akintola, 2010). Data were collected on growth parameters of sunflower, weeds and yield attributes. The data collected were subjected to the analysis of variance

RESULTS

Table 1 showed the matrix of the correlation coefficient between some selected weed characters, growth characters and yield components of sunflower in 2018 rainy season at Bagauda. The results indicated a negative and highly significant ($p \leq 0.01$) correlation between sunflower kernel yields, weed density. The correlation between sunflower kernel yield and weed control efficiency was negative but not significant. The correlation coefficient between sunflower kernel yields and weed dry weight was negative and highly significant. The correlation coefficient between sunflower kernel yields and weed cover score was negative and highly significant ($p \leq 0.01$). The correlation coefficient between weed density and number of leaf was negative and significant. The association between leaf area and weed density was negative and significant. The correlation coefficient between weed density and crop growth rate was negative and significant. There was positive significant correlation between weed density and relative growth rate of sunflower plants. The weed density was highly significant ($p \leq 0.01$) and negatively correlated with plant height. Relative growth rate was significant at ($p \leq 0.05$) and positively correlated with plant height. The association between number of leaves and lead area were highly significant at ($p \leq 0.01$) in relation with the plant height.

Table 2 showed the matrix of the correlation coefficient between some selected weeds, growth characters and yield components of sunflower in 2019 rainy season at Bagauda. There was negative correlation between sunflower kernel yield and weed density. The weed dry weight was negatively correlated with sunflower kernel yield and significant while weed control efficiency was highly significantly ($p \leq 0.01$) correlated with sunflower kernel yields. The association between sunflower kernel yield and weed cover score was negative and significantly correlated. The correlation coefficient between plant height and weed density was negative and non-significant. The correlation between leaf area and weed dry weight was negative but not significant, while the weed control efficiency and relative growth rate were highly significant and negatively correlated. The correlation coefficient between plant height and number of leaf were highly significant and positively correlated.

Table 3 showed the matrix of the correlation coefficient between some selected weeds, growth characters and yield components of sunflower in 2019 rainy season at BUK. The results indicated negative and highly significant ($p \leq 0.01$) correlation between sunflower kernel yields and weed density. There was highly negative and significant correlation between sunflower kernel yield and weed control efficiency. However weed dry weight was highly significant ($p \leq 0.01$) but negatively correlated with kernel yield per hectare. The number of leaf was not significantly correlated with sunflower kernel yield per hectare. Similarly plant height was negatively correlated with kernel yield per hectare and not significant. The correlation coefficient between plant height and weed cover score was highly significant ($p \leq 0.01$) and negatively correlated while number of leaf, was not significant and negatively correlated. The correlation coefficient between leaf area and crop growth rate was highly significant ($p \leq 0.01$) and negatively correlated.

Table 4 showed the matrix of the correlation coefficient between some selected weeds, growth characters and yield components of sunflower in 2019 rainy season at BUK. The results indicated positive and highly significant ($p \leq 0.01$) correlation between sunflower kernel yields sunflower and number of leaf. There was highly significant association between leaf area and crop growth rate. There was positive correlation between sunflower kernel yield and leaf area index highly and significantly ($p \leq 0.01$) correlated. The correlation coefficient between plant height and sunflower kernel yield was negative and not significant. The correlation coefficient between sunflower kernel yield and weed cover score was negative and highly correlated. The correlation coefficient between sunflower kernel yield and weed control efficiency was highly significant ($p \leq 0.01$) and negatively correlated. Also weed dry weight and sunflower kernel yield were highly significant and negatively correlated. The correlation coefficient between weed density and weed control efficiency were highly significant ($p \leq 0.01$) and positively correlated. The correlation between weed density and weed dry weight were significant and positively correlated. Weed cover score and weed control efficiency were significant ($p \leq 0.01$).

DISCUSSION

Matrix of Correlation Coefficients Analysis of Growth and Yield Characters of Sunflower

The results of correlation analysis of the experimental trial carried out showed that the negatives correlation between the sunflower kernels yield per hectare and weed attributes like weed density, weed dry weight, weed cover score and weed control efficiency during the periods of the experiments and combined this could be attributed to the fact that weed competes with sunflower for the environment resources required for the growth of the plant. This is in line with the findings of Nojavan, 2001 and Yaghobi and Yousefi, 2008 in which they reported that weed competes with sunflower for water, light and plant nutrient thereby reducing yield. Similar findings was reported by Gani and Shingu (2016) which indicated that, the grain yield of millet was negatively and highly significantly correlated with cumulative weed dry weight and weed density. The correlation coefficient analysis showed positive and significant correlation between sunflower kernel yield per hectare and growth parameters like plant height, leaf area, leaf area index, and crop growth rate this indicated the value and importance of these growth characters in determining the yield of sunflower. This agreed with reports by Gubta *et al*. (2007) who reported positive significant correlation of panicle weight and other yield attributes.

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Table 1: Simple Correlation Matrix between Kernel Yield, Growth and Weed Components of Sunflower at Bagauda in 2018 Rainy Season

	1	2	3	4	5	6	7	8	9	10	11	12
1	1.00											
2	0.04	1.00										
3	0.08*	0.09*	1.00									
4	-0.13	0.94*	0.15**	1.00								
5	-0.21*	0.15**	0.12**	0.16**	1.00							
6	-0.13*	0.05	0.23**	0.05	0.39**	1.00						
7	0.04	-0.11	-0.18	-0.09	-0.55**	0.47*	1.00					
8	0.31*	0.35**	0.38*	0.10*	0.40**	0.44*	0.39*	1.00				
9	-0.15*	-0.23*	-0.13	-0.12*	-0.21*	-0.11	-0.22*	0.35*	1.00			
10	-0.27**	-0.31*	-0.30	-0.51*	-0.10*	-0.20*	-0.30*	0.98**	0.52*	1.00		
11	-0.14	-0.36*	-0.23*	0.25**	-0.09*	-0.55*	0.34*	-0.64**	-0.22*	0.45*	1.00	
12	-0.37**	0.88**	-0.66*	-0.60*	-0.19*	0.95*	-0.51*	0.76**	0.75**	-0.67**	-0.67**	1.00

*Significant at P < 0.05 ** Significant at P < 0.01

Table 2: Simple Correlation Matrix between Kernel Yield, Growth and Weed Components of Sunflower at BUK in 2018 Rainy Season

	1	2	3	4	5	6	7	8	9	10	11	12
1	1.00											
2	-0.06	1.00										
3	0.10**	0.11*	1.00									
4	0.15**	-0.96*	0.17**	1.00								
5	-0.23*	0.15	0.25**	0.07	1.00							
6	-0.15	0.07*	-0.27**	-0.09**	-0.41**	1.00						
7	-0.06	-0.18**	-0.21*	-0.10*	-0.45**	0.47**	1.00					
8	0.31**	-0.35**	0.40*	0.21*	0.10*	0.44*	0.39*	1.00				
9	-0.05*	-0.23**	-0.36**	-0.15**	-0.23**	-0.11	-0.29*	0.38*	1.00			
10	-0.07*	-0.35**	-0.34**	-0.53**	-0.12**	-0.25**	-0.32*	-0.84**	-0.42**	1.00		
11	-0.05**	-0.38**	-0.27**	-0.34**	-0.11	-0.52**	0.37**	-0.44**	-0.28**	-0.46**	1.00	
12	-0.39*	-0.75**	-0.68**	-0.64**	0.13	-0.59**	0.55**	0.68**	0.50**	0.41**	0.48**	1.00

*Significant at P < 0.05 ** Significant at P < 0.01

Table 3: Simple Correlation Matrix between Kernel Yield, Growth and Weed Components of Sunflower at Bagauda in 2019 Rainy Season

	1	2	3	4	5	6	7	8	9	10	11	12
1	1.00											
2	0.08	1.00										
3	0.13	-0.15	1.00									
4	0.25**	-0.69	0.27**	1.00								
5	0.32**	0.23*	0.30**	0.34**	1.00							
6	0.26^	0.10**	0.29**	0.15**	0.45	1.00						
7	0.08**	0.20**	0.25**	0.14**	0.47**	0.40	1.00					
8	0.31**	0.31*	0.41*	0.15**	0.45**	0.51**	0.36*	1.00				
9	-0.19**	0.35**	0.33**	0.18**	0.23*	0.16**	0.30**	0.40**	1.00			
10	-0.21**	0.33**	-0.39**	-0.51**	-0.07	-0.20*	-0.30*	0.98**	0.52*	1.00		
11	-0.26**	0.20**	-0.21**	0.20**	-0.05*	-0.55*	0.34**	0.22**	-0.32*	-0.22**	1.00	
12	-0.28**	0.39**	-0.36**	-0.30**	-0.15	0.52**	0.33**	0.30**	0.40**	-0.58**	-0.61**	1.00

*Significant at P < 0.05 ** Significant at P < 0.01

Table 4: Simple Correlation Matrix between Kernel Yield, Growth and Weed Components of Sunflower at BUK in 2019 Rainy Season

	1	2	3	4	5	6	7	8	9	10	11	12
1	1.00											
2	-0.11	1.00										
3	0.35**	0.18**	1.00									
4	0.30**	0.14**	0.67**	1.00								
5	0.33**	0.07	0.18**	0.18**	1.00							
6	0.18**	0.35**	0.22**	0.22**	0.19**	1.00						
7	0.30*	0.19**	0.32**	0.20**	0.17**	0.32**	1.00					
8	0.08**	0.14	0.35**	-0.19*	-0.23*	0.19**	0.34**	1.00				
9	-0.62**	-0.23**	-0.15	-0.24**	0.25**	-0.11	0.29**	0.08	1.00			
10	-0.20**	-0.06**	-0.08**	-0.06**	0.20*	0.22*	-0.39**	-0.33**	0.25*	1.00		
11	-0.40**	-0.25**	-0.27**	0.14**	-0.36**	-0.55	-0.42**	-0.22**	-0.12	-0.37*	1.00	
12	-0.17**	0.05**	0.18**	-0.20*	0.02**	0.25**	-0.19	0.34**	0.18**	0.37**	-0.27**	1.00

*Significant at P < 0.05 ** Significant at P < 0.01

1. Kernel yield
2. Plant height
3. Number of leaf
4. Leaf area
5. Leaf area index
6. Crop growth rate
7. Crop growth rate
8. Relative growth rate
9. Weed density
10. Weed dry weight
11. Weed control efficiency
12. Weed cover score

ANALYSIS OF USE OF AGRO-CHEMICALS AMONG FADAMA VEGETABLE FARMERS IN IBADAN NORTHWEST LOCAL GOVERNMENT AREA, IBADAN, OYO STATE.

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ABSTRACT
Most farmers use agro-chemicals in different ways to improve agricultural productivity however, it is essential to track the use of such agro-chemical. The study analyzes the use of agro-chemicals among vegetable farmers in Ibadan North west Local Government Area (IBNW LGA), Oyo State, Nigeria. Multi-stage sampling techniques was used. It involves purposive selection of one farmers' association in IBNW LGA, Oyo state followed by random selection of 40 farmers that came for the monthly meeting. Primary data was collected through questionnaire and analyzed using descriptive statistics. Majority (70.0%) of the respondents were male, 85.0% were married, 45.0% had tertiary education. Major vegetables planted by the respondents are Amarathus, Corchorus, Celocia, 67.5%, 65.0%, 42.5% respectively, tomato, okra, pepper with 22.5%, 20.0%, 12.5% respectively are the least of the fruity vegetables planted. The major agrochemicals used by the farmers are herbicides, fertilizer, insecticides, pesticides and fungicide, 67.5%, 57.5%, 50.0% and 12.5 respectively during farming operations. The study revealed that (77.5%) of the respondents got information on the use of agrochemicals from Agricultural Development Programmes, and research institute (57.5%) followed by other farmers and agrochemicals dealers with 50% and 7.5% respectively. The major constraints considered as severe on the use of agro-chemicals were high cost of agro-chemicals (87.5%), inadequate fund to purchase agrochemicals (85.0%), adulteration of agro-chemicals (67.5%) each were scored 1st, 2nd and 3rd respectively. Relevant agricultural stakeholders should link farmers with input agency and provide farmers with comprehensive training in safe use of agrochemicals.
Keywords: *Analysis, Utilization, Agro-chemicals, Vegetable farmers, Environment*

INTRODUCTION

Vegetables are the most important ingredients of human diets for the maintenance of good health and prevention of diseases (Funmilayo et al., 2016). Cultivation of vegetables is an excellent source of employment for both rural and urban dwellers as it takes place in many rural areas, towns and cities in the form of market and backyard gardening to supply fresh produce to urban markets. It thus, plays an important socio-economic role as well as in diversifying diets for improved nutrition (Ntow et al., 2006; Matthews, 2008). As vegetables are generally susceptible to a wide range of pests and diseases, production requires intensive effort in their management. The increased demand for food, particularly to feed the growing urban population in Nigeria has necessitated an expansion of agriculture and horticulture and consequently increase in use of synthetic agro-chemicals for production of high-value cash crops and vegetables (Jamala et al., 2013). However, these agro-chemicals are often applied indiscriminately and inappropriately, resulting in adverse environmental and health effects.

Agro-chemicals refers to the broad range of pesticides and insecticides including fertilizers, hormones, herbicides, fungicides, and other growth chemicals and concentrated stores of raw animal manure (cow dung and poultry droppings) (Ngowi1 et al., 2007). Globally, agro-chemicals are used as soil conditioners, acidifiers, nutrients and are also used to control diseases caused by bacteria, fungi, pests and viruses, enhancing agricultural productivity. These agro-chemicals to some extent proved harmful not only for humans but also pose a great danger to the environment. Fleisher (2006), reported that the use of synthetic fertilizers and pesticides in the developing countries has grown substantially during the past four decades. Government promotes the use of agro-chemicals in order to achieve national food security and improve the production of export crops.

The total exposure to chemicals is the sum of exposure during agro-chemicals storing, mixing, applying and disposing (Bhandari et al., 2020). These agro-chemicals are inhaled through different routes via; oral (through the mouth and digestive system), dermal (through the skin), occularly (through eyes) or by inhalation (through the nose and respiratory system. Scientific information on the agrochemical use and possible constraints to the use of agro-chemicals by vegetable farmers would provide insight for decision making on best ways of enhancing its use among vegetable farmers in the study area.

The specific objectives of this study were to: -

I. Identify the personal and entrepreneur characteristics of vegetable farmers in the study area;
II. Ascertain the farmers' knowledge of agro-chemicals application
III. Investigate constraints to use of agro-chemicals on vegetable productions.

METHODOLOGY

The study area was Ibadan Northwest local government area, Oyo State Nigeria, which belongs to the Yoruba ethnic group. The study was carried among Fadama Vegetable Farmers in Ibadan Northwest Local Government Area, Oyo State. A multistage sampling technique was used. The first stage was the selection of local government area which is Ibadan Northwest Local Government Area. The second stage was random selection of 40 Fadama Vegetable farmers from the selected local government. A total of forty (40) structured questionnaires were administered. The data collected were analyzed using descriptive statistics such as frequencies, percentages and mean scores were used to achieve objectives of the study.

RESULTS AND DISCUSSION

Personal and entrepreneur Characteristics of Respondents:

Table 1 shows that the respondents were within the mean age of 54.37 ± 9.42 meaning that farmers are still in their middle age and have the capabilities for the utilization of improved agricultural technologies such as agro-chemicals. This is in line with (Benedicta, 2010) who said younger people are relatively more open to risk taking and have longer planning horizon. Majority (70.0%) of the farmers were male, this could be that male farmers have more access to production resources and had the time to attend the monthly meeting of the farmer's organization because women are often time engaged in household chores and other activities. According to Onu (2006), activities of women farmers are faced with socio-cultural restrictions and sex plays significant role in having access to production resources such as agro-chemicals. Also, 85.0% of the respondent were married showing high sense of responsibilities and willingness to improve their standard of living. Most (45.0%) respondents had tertiary education while 37.5% had secondary education which means that an average number of the farmers could communicate well, 47.5% of the respondents had family size of (1-4), this could be as result of their high level education so that they can be able to provide for the family while (45.0%) of the respondents had 10-20 years of farming experience on vegetable production. The farm size of the respondents were within mean ratio 1.52 ± 1.04. Vegetable farmers operating on smaller farm holdings are placed at a disadvantaged position because of fragmentation (Idrisa et al., 2007). 60.0% of the respondents had contact with extension agents, the major vegetables planted by the respondents are *Amarathus, Corchorus, Celocia*, 67.5%. 65.0%, 42.5% respectively, tomato, okra, pepper with 22.5%, 20.0%, 12.5% respectively are the least of the fruity vegetables planted.

Knowledge on agro-chemical application

The result in table 2 revealed the major agrochemicals used by the respondent and their source of knowledge on agrochemical application. majority of the respondents identify pests attack on their vegetable before applying agro-chemicals. 82.5% were able to diagnose vegetable problem before applying agrochemicals, 95.0% of the farmers were able to read instructions on the use of agrochemicals. 67.5%, 57.5%, 50.0% and 12.5% of the respondents used herbicides, fertilizer, insecticides, pesticides and fungicide respectively during vegetable production. Hence, the use of herbicides, insecticides and pesticides among respondents is in accordance with the findings of Ngowi1 et al. (2007) who reported increased crop yield due to application of fertilizer. Fungicides was the least of agrochemicals used by the respondents, this could be as a result of farmers' inability and lack of technical know-how in identifying fungal infected plant in the locality or low incidence of fungal infection on the vegetable farms in the study area. The major pesticides used by the farmers are D.D Force (47.5%), Neem extract (37.5%) and Parac force (17.5%). 65.0% make use of inorganic fertilizer while 17.5% basically used organic (compost) fertilizers, and 42.5% of the famers apply their fertilizer weekly while 35.0% apply monthly. 72.5% of the respondents apply agrochemicals before pest infestation, Majority of the respondents got their recommendation on agrochemicals usage from ADPs and other farmers and friends 77.5% and 45.0% respectively, majority (85.0%) of the respondents use knapsack sprayer Also, 90.0% apply their agrochemical early morning using raincoat/safety clothes, nose mask and gloves, 77.5%,45.0%, 32.5% respectively while 57.5% leave their vegetable for 1-2 weeks after agrochemical application before harvest. (80.0%) of the farmers complain to expert when agrochemical is not effective, 97.5% have the knowledge/aware of the dangerous effect of agrochemical to people and the environment while 77.5% buried/burned their agrochemicals containers after use. Education has the capability of enhancing knowledge of the respondents. Majority of the respondents were literate with a good number of them having more than primary education. The high literacy level among the respondents could be responsible for the farmers' knowledge and awareness. Most (90.0%) respondents are aware and agreed that chemical residue can be identified in vegetable due to inappropriate use of chemical. Majority (57.5%) got information on use of agrochemicals from Agricultural Development Programmes (ADPs) and research institute (20.0%). This indicate that respondents got information on agro-chemicals usage mainly from ADPs and research institute due to the fact that the ADPs and research institute are mostly in touch directly with rural and grass root farmers in Nigeria.

Constraints to Utilization of Agro-chemicals among Respondents:

Table 3 shows the major constraints considered as severe on the use of agro-chemicals among the respondents as high cost of agro-chemicals (87.5%), inadequate fund to purchase agrochemicals (85.0%), adulteration of agro-chemicals (67.5%), high cost of personal protective materials (57.5%), ineffectiveness of agro-chemicals (52.5%), attracting a rank of 1st, 2nd, 3rd, 4th and 5th respectively

CONCLUSION AND RECOMMENDATION

The present study examined the analysis of the use of agrochemicals among Fadama Vegetable Farmers in Ibadan Northwest LGA, Nigeria. Pesticides such as insecticides and fertilizers are used by most farmers in the study area majorly to maximize productivity and pest attack reduction. Majority of the respondents were relatively young which result to their active participation on vegetable farming activities, and had 7 and above years of formal education, indicating that the respondents were literate and were able to read instructions for agrochemical use. Major challenges are high cost of agro-chemicals, inadequate funds and lack of training on the safe use of agro-chemicals. Based on the major findings of the study and the conclusions reached, the following recommendations were made

1. Creating awareness on safe use of agro-chemical should be promoted by both government and non-governmental organization.
2. Relevant agricultural stakeholders should link farmers with input agency and provide farmers with comprehensive training in agrochemical use.

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Table 1: Distribution of Personal and entrepreneur Characteristics of Respondents (N= 40)

Variables	Frequency N	Percentage %
Age in years		
32 – 39	17	42.5
40 – 49	7	17.5
50 – 59	16	40.0
60 – 70	14	35.0
Sex		
Male	28	70.0
Female	12	30.0
Marital status		
Single	3	7.5
Married	34	85.0
Divorced	2	5.0
Widowed	1	2.5
Educational qualification		
Primary school	2	5.0
Secondary school	15	37.5
Tertiary	18	45.0
Koranic education	1	2.5
Others	4	10.0
Family size		
1 – 4	19	47.5
5 – 9	16	40.0
10 – 20	5	12.5
Farming experience		
1 – 4	6	15.0
5 – 9	16	40.0
10 – 50	18	45.0
Farm size		
1-2	35	87.5
3-5	5	12.5
Contact with extension agent		
No	16	40.0
Yes	24	60.0
Vegetable planted		
Corchorus	26	65.0
Amarathus	27	67.5
Soko	17	42.5
Fluted pumpkin	6	15.0
Tete	4	10.0
Gbagba	2	5.0
Abalaye	2	5.0
Jute mallow	1	2.5
Tomato	9	22.5
Cucumber	4	10.0
Water mellon	1	2.5
Okra	8	20.0
Pepper	5	12.5
Total farm size for vegetable		
1-3	36	90.0
4-5	4	10.0

Source: Field Survey, 2023

Table 2: Frequency Distribution of Respondents According to knowledge on Agro-Chemical application

Variables	Frequency (N)	Percentage (%)
do you diagnose vegetable problem before applying agro chemical		
No	7	17.5
Yes	33	82.5
Able to read instructions on agrochemical before use		
No	2	5.0
Yes	38	95.0
Agrochemical used		
Insecticides		
No	17	42.5
Yes	23	57.5
Herbicides		
No	13	32.5
Yes	27	67.5
Fungicides		
No	35	87.5
Yes	5	12.5
Fertilizer		
No	13	32.5
Yes	27	67.5
Pesticides		
No	20	50.0
Yes	20	50.0
Pesticides used		
Neem extract	15	37.5
D.D. force	19	47.5
Caterpillar force	3	7.5
Cyper green	5	12.5
Parac force	7	17.5
how often do you apply pesticides		
Very often	19	47.5
Occasional	9	17.5
Rarely often	12	30.0
list of fertilizer used		
NPK		
No	14	35.0
Yes	26	65.0
Organic fertilizer		
No	33	82.5
Yes	7	17.5
Urea		
No	27	67.5
Yes	13	32.5
How often do you apply fertilizer		
Daily	9	22.5
Weekly	17	42.5
Monthly	14	35.0
when do you take decision on the use of agrochemicals		
Before pest infestation	29	72.5
During pest infestation	11	27.5
Who recommend agro used		
Farmers and friends		

No	22	55.0
Yes	18	45.0
Agro dealers		
No	37	92.5
Yes	3	7.5
Research institute		
No	36	90.0
Yes	4	10.0
ADPs		
No	9	22.5
Yes	31	77.5
Type of agro chemical applicator		
Knapsack sprayer	34	85.0
Sprayer nose	3	7.5
Motorized sprayer	2	5.0
Others	1	2.5
Agrochemical application timing		
Early morning	36	90.0
Afternoon	3	7.5
Evening	1	2.5
Protective measures used		
Raincoat/safety clothes		
No	9	22.5
Yes	31	77.5
Nasal mask		
No	21	52.5
Yes	19	45.0
Sunglass		
No	34	85.0
Yes	6	12.5
Gloves		
No	26	65.0
Yes	14	32.5
Boots		
No	28	70.0
Yes	12	30.0
I don't use any protective measures		
No	38	95.0
Yes	2	5.0
Number of days vegetable is left after chemical application before harvesting		
1-2weeks	23	57.5
3 weeks -1month	9	22.5
2 months and above	8	20.0
Which of the following do you observe while applying agrochemical		
Spray against the wind	9	22.5
Spray by walking forward	31	77.5
Agro chemical storage		
In a separated and safe area	34	85.0
In barn or toilet	4	10.0
No storage	2	5.0
What do you do when agrochemical is ineffective		
Complain to agricultural expert/professional		
No	8	20.0

Yes	32	80.0
Change to power one		
No	37	92.5
Yes	3	7.5
Combine with other agro-chemicals		
No	32	80.0
Yes	8	20.0
Increase application time and dosage		
No	36	90.0
Yes	4	10.0
Awareness about the danger to human about agrochemical use		
No	1	2.5
Yes	39	97.5
Disposal of agrochemical containers		
Left in the field	3	7.5
Collected and save in the safe place	6	15.0
Buried/burned	31	77.5
Awareness about chemical residue can be identified in vegetable due to inappropriate use of chemical		
No	4	10.0
Yes	36	90.0
Source of information on agro chemical use		
Other farmers and friends	4	10.0
Authorized dealers	5	12.5
Research institute	8	20.0
ADP	23	57.5

Source: Field Survey, 2023

Table 3: Constraints faced by vegetable farmers in the study areas

Constraints	No	Yes	Very Severe (3)	Severe (2)	Not severe (1)	Rank
High cost of agro-chemicals items	5(12.5)	35(87.5)	9(22.5)	27(67.5)	4(10.0)	(1st)
Inadequate fund to buy agro chemical	6(15.0)	34(85.0)	9(22.5)	26(65.0)	5(12.5)	(2nd)
Adulteration of agro-chemicals	13s(32.5)	27(67.5)	9(22.5)	24(60.0)	7(17.5)	(3rd)
Ineffectiveness of agro chemicals	19(47.5)	21(52.5)	7(17.5)	20(50.0)	13(32.5)	(4th)
Personal protective materials are expensive	17(42.5)	23(57.5)	7(20.0)	18(45.0)	15(37.5)	(5th)
No training on the safe use of agro-chemicals	26(65.0)	14(35.0)	5(12.5)	20(50.0)	15(37.5)	(6th)
No recommendation and guidance by expect	21(52.5)	19(47.5)	5(12.5)	20(50.0)	15(37.5)	(7th)
Not readily available	13(32.5)	27(67.5)	4(10.0)	22(55.0)	13(32.5)	(8th)
Spraying of agrochemical without nose-mask	16(40.0)	24(60.0)	8(20.0)	12(30.0)	20(50.0)	(9th)
Inability to recognize adulterated chemicals	15(37.5)	25(62.5)	7(17.5)	11(27.5)	22(55.0)	(10th)
Damage of hands through agro-chemicals	12.(30.0)	28(70.0)	4(10.0)	15(37.5)	21(52.5)	(11th)
Inability to read and decode instruction on agro-chemicals	22(55.0)	18(42.5)	5(12.5)	11(27.5)	24(60.0)	(12th)

Source: Field Survey, 2023

A SURVEY ON COMMON ORNAMENTAL PLANT SPECIES AT SOME SELECTED HIGHER INSTITUTIONS IN EKITI STATE

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ABSTRACT
Humans are much more drawn to ornamental plants due to the aura of beauty and environmental enhancement they produce. It promotes learning, especially in educational institutions, by appealing to human comfort in a serene setting. In 2021, a survey was conducted on the grounds of some selected higher education institutions in Ekiti State, Nigeria by collecting, identifying, and describing some common ornamental plant species discovered on campus grounds. The various plant species were presented as original colour photographs and evaluated by determining their family, scientific, and English names which were classified according to their characteristics, propagation method, and uses (hedges, shading and indoor plants). This study identified and described twenty-seven (27) ornamental plant species from eighteen (18) families, including twelve (12) species of hedge plants, nine (9) species of shading plants, and six (6) species of indoor plants. Aside from aesthetic, ornamental plants serve as landscaping, windbreak, and shade provider.
Keywords: *Hedge plants, indoor plants, ornamental plants, plant species, shading plants.*

INTRODUCTION
Plants are the foundation of life and the ecosystem's primary producers; consequently, all other organisms depend on them for survival. However, some plants are aesthetically pleasing and are grown solely for aesthetic purposes; these plants are known as Ornamental Plants. These plants have aesthetic qualities that improve life quality (Akintoye, 2004). Historically, humans have utilized ornamentals as a class of plants. From the perspective of ethnobotany, the use of ornamental plants is a response to local botanical knowledge that guides diverse cultivation and consumption strategies in various cultural contexts (Hurrel, 2014). These plants include trees, shrubs, ground covers, turf grass or sod, bulbs and plant stock, and environmental horticulture, which provides crops typically grown outdoors and used primarily for landscaping purposes (Kolavalli and Whittaker, 2004). In addition to providing shelter and food for smaller organisms, they serve as the ecosystem's primary producers and tourist attraction (Onuegbu, 2005). In recent years, ornamental plant growth has increased across the nation as a common strategy to control unused and marginal land, which serves as a dumping ground for waste and other undesirable materials. An unplanned setting is unsightly, unhealthy, and undesirable (Oloyede, 2012).
Moreover, the use of woody plants in university campus planting arrangements plays a crucial role because these plants have both an educational value and an ecological function. Since the importance of growing ornamental plant species is becoming increasingly apparent, no special care is given to appropriately selecting and identifying plant species used as ornamentals for different purposes. Consequently, this survey was conducted to document and characterize the common ornamental plant species in Ekiti State institutions.

MATERIALS AND METHODS
Study Sites
The areas for this study are the Ekiti State University, Ado-Ekiti (7°44' N, 5°16' E), Federal Polytechnic, Ado-Ekiti **(**7°37' N, 5°24' E), both located at the central, the Federal University, Oye-Ekiti **(**7°49' N, 5°23' E) located at the north and Bamidele Olumilua University of Education, Science and Technology, Ikere-Ekiti (7°30' N and 5°03' E) located at the southern senatorial district area. These areas are within the tropical rainforest belt covering most of southwestern Nigeria with a West African monsoonal climate with a dry and wet season (Olujobi, 2013; Ogundele and Jegede, 2013).

Sampling techniques and Methods of identification used
The survey was conducted around these study sites in March 2021, involving collecting, identifying and describing various ornamental plant species commonly found around the study areas. The ornamental plants were identified, captured and snapped using a digital camera. A vial of this work was presented as

an original-coloured photograph described through consultation with gardeners' books, encyclopedias, and the internet. Pictures and illustrations, identification keys in botanical books and floras, i.e. dichotomous keys, matching in the herbarium, asking experts (inquiring about such species from experts in the field/ horticulturists), sourced from books, encyclopedias, and the internet were used to identify the plants in this study.

RESULTS AND DISCUSSION

This survey work was carried out by visually assessing some common ornamental plants species at some selected higher institutions in Ekiti State, Nigeria, which resulted in the collection, description and identification of 27 ornamental plant species belonging to 18 families distributed around the campuses (Figure 1). The results and observations made during the survey, along with each species' importance, were grouped into hedge plants (Table 1), shading plants (Table 2) and indoor plants (Table 3).

The survey showed that plants species of the family Euphorbiaceae were the most predominant, having four species, followed by the family Rubiaceae, Palmeae, Fabaceae, Commelinaceae and Combretaceae, with each family having two species, while the last family are Annonaceae, Nyctaginaceae, Malvaceae, Cupressaceae, Rutaceae, Strelitziaceae, Palmeae, Araucariaceae and Agavaceae around these campuses. Ornamental plants were authentically attractive to humans as a beauty to behold (Onuegbu, 2005) in agreement with landscape design technology (Kolavalli and Whittaker, 2004). The ornamental plants on the campuses were found to perform other purposes, such as landscaping, sites for visibility studies and research works, and relaxation point apart from their primary goal of beautification.

CONCLUSION

Ornamental plants are essential to human life, providing shade, indicating the walkways, serve as windbreaks and beauty around the higher institution campuses. Therefore, schools, offices, markets, and the religious centre should be sensitised on the importance of growing ornamental plants and encourage them to cultivate the habit of raising them.

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Fig. 1: Some ornamental plants in some selected institutions in Ekiti State, Nigeria

Table 1: Most common hedge plant species identified at some established institutions in Ekiti State, Nigeria.

Family Name	Scientific Name	English Name	Common Name	Mode of propagation	Uses
Nyctaginaceae	*Bougainvillea spectabilis*	Bougainvillaea	Bougainvillaea	Stem cutting	Hedge plant and flowering climbers for covering trellises and spot plants.
Annonaceae	*Polyalthia longifolia*	Masquerade tree	Police tree	It is propagated by seed	Hedge plant also serves as a multipurpose plant
Malvaceae	*Rosa sinensis*	Hibiscus	Rose of china	Stem cutting	Hedge plant
Cupressaceae	*Thuja orientalis*	Orienta arborvitae	Thuja	Stem cutting	It is used as an avenue, spot and hedge plant
Rubiaceae	*Ixora duffi hybrid (Red)*	Jungle flame, dwarf Ixora	Double Ixora	Stem cutting	Hedge plant
Euphorbiaceae	*Cordiaeum variegatum (Gold dust)*	Gold dust croton	Croton	Stem cutting	It is used as a spot and hedge plant
Verbanaceae	*Duranta goldiana Linn.*	Duranta goldiana	Yellow bush	Stem cutting	Flowering/hedge plant
Rubiaceae	*Ixora javanica*	Jungle flame	Ixora nora (single ixora)	Stem cutting	Hegde plant
Rutaceae	*Murraya paniculata*	Orange jessamine	Murraya paniculata	Stem cutting	Hedge plant
Strelitziaceae	*Ravenala madagascariensis*	Traveller's palm			Hedge plant
Euphorbiaceae	*Cordiaum variegatum(Bravo)*	Codiaeum	Croton	Stem cutting	Hedge plant
Euphorbiaceae	Acalypha wilkesiana	copperleaf	Red acalypha	Stem cutting	Hedge plant

Table 2: Most common shading plant species identified at some selected higher institutions in Ekiti State, Nigeria.

Family Name	Scientific Name	English Name	Common Name	Mode of propagation	Uses
Combretaceae	*Terminalia catappa*	Umbrella tree	India Almond	Seed	It serves as a shade tree in landscaping
Combretaceae	*Terminalia mantaly*	Almond tree	French mantaly	It is propagated by seed	Shading or flowering tree
Palmae	*Roystonia regia*	Royal palm	Cuba royal palm	Seed	Avenue plant
Apocynaceae	*Plumeria rubra*	Temple tree	Frangipani	It is propagated by seed	Shade plant
Fabaceae	*Erythrina indica L.*	Variegated leave erythrina	India coral tree	Propagated by Seed	Shade plant
Cupressaceae	*Callitris rhomboidea*	Frenela or port Jackson pine	Oyster bay pine	Propagated by Seed	Shade
Pinaceae	*Pinus caribeae*	Honduras pine	Caribean pitch pine	Seed	Shade
Araucariaceae	*Araucaria* columnaris	Araucaria	Christmas tree	Propagated by seed	Shade
Fabaceae	*Delonix regia*	Flame of the jungle	Poiciana	Seed	Shading or flowering tree

Table 3: Most common indoor plant species identified at some selected institution campuses in Ekiti State, Nigeria.

Family	Scientific Name	Common Name	English Name	Mode of Propagation	Uses
Euphorbiaceae	*Euphorbia milli*	Euphorbia	Crown of thorns	Stem cutting	Potted plant
Moraceae	*Ficus benjamina*	Ficus (Variegated)	Weeping fig	Stem cutting	Potted plant
Commelinaceae	*Tradescantia spathacea*	Dwarf rheodiscolor	Moses-in-the-cradle	Plantlets	Potted plant
Cycadaceae	*Cycas revoluta*	Cycad palm	king's sago palm	It is propagated by seed	Indoor spot plant
Commelinaceae	*Tradescantia pallida*	Spiderwort	Purpleheart	Stem cutting	Potted plant
Agavaceae	*Cordyline terminalis*	T-1 plant	T-1 plant	Stem cutting	Potted plant

ASSESSING THE TRAINING NEEDS OF WOMEN FARMERS IN OYO STATE, NIGERIA: A CASE STUDY OF WOMEN FARMERS EMPOWERMENT INITIATIVE AND NATIONAL HORTICULTURAL RESEARCH INSTITUTE COLLABORATION

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ABSTRACT
A collaborative assessment was conducted to identify the training needs of women farmers in Oyo State, Nigeria. The study was carried out through a partnership between the Women Farmers Empowerment Initiative (WOFEI) and the National Horticultural Research Institute (NIHORT). The study aimed to identify the socio-economic profile of the respondents, evaluate the major crops cultivated by the farmers, and assess their areas of interest in horticultural production. A standardized closed-ended questionnaire was administered to 122 respondents, utilizing a descriptive research methodology. The study found that a significant proportion of the respondents (36%) were between the ages of 50-59 years, married (76.5%), reported having a family size of 6-8 (42.5%), and actively involved in agricultural activities as their main source of livelihood (93.3%). The horticultural crops of interest to the women farmers were found to be tomato (61.8%), jute mallow (58.4%), pepper (53.9%), okra (49.4%), amaranth (46.1%), and celosia (33.7%). Based on the findings, the study recommends developing targeted training programs that address the specific needs of women farmers, with a particular emphasis on improving their access to resources and enhancing their skills in horticultural production. This study represents a significant stride towards promoting gender parity and enhancing opportunities for women farmers in Nigeria
Keywords: *Women farmers, Collaboration, Horticultural crops, NIHORT, and WOFEI*

INTRODUCTION

Osabohien *et al.,* (2019) argue that the agriculture industry in Nigeria plays a significant role in terms of employment, engaging over 60% of the country's workforce. Additionally, it contributes 32.5% to the nation's gross domestic product (GDP) and serves as a source of cash through exports. The significance of skills development in rural areas is of paramount relevance, particularly because a substantial proportion, around 70%, of the global impoverished population is concentrated in these regions (Cicero *et al.,* 2021). According to Hassoun *et al.,* (2022), the enhancement of the agricultural sector through the cultivation of skills has the potential to contribute significantly to the attainment of the Sustainable Development Goals (SDGs). The acquisition of training and skills is crucial for both the agricultural and non-agricultural sectors, as it enables individuals to effectively address their livelihood requirements.

The inclusion of women in the agricultural industry is of utmost importance, as they make significant contributions to both global food security and economic development. Based on data provided by the Food and Agriculture Organisation (FAO), it is evident that women comprise approximately 43% of the agricultural workforce in developing nations (Olorunfemi *et al.,* 2016). According to Giroud & Huaman (2019), women agricultural practitioners encounter a multitude of constraints, encompassing restricted financial capital, availability of land, and educational prospects. Numerous studies have demonstrated that the empowerment of women in the agricultural sector can yield substantial enhancements in food security, productivity, and economic advancement. These goals can be attained through implementing interventions that encompass facilitating women farmers' access to loans, land, and various resources, with the provision of training and education programmes tailored to satisfy their individual requirements (Osabohien *et al.,* 2019). The promotion of gender equality in the agricultural sector is of utmost importance to effectively attain sustainable development goals and guarantee a more promising future for rural communities across the globe.

However, it is worth noting that there is a conspicuous lack of educational and training options accessible to this demographic, which has the potential to augment their skills and overall productivity Giroud & Huaman (2019). As a result, they rely on traditional agricultural practices that may demonstrate reduced levels of effectiveness and financial viability. Notwithstanding these constraints, Olorunfemi *et al.,*

(2016) posit that the government has implemented policies to promote gender parity and improve women's opportunities to get resources and services. Non-governmental organizations (NGOs) have also undertaken programmes to provide educational and training opportunities to women farmers, augmenting their agency, and addressing the challenges they face.

The aforementioned led to collaboration between the Women Farmers Empowerment Initiative (WOFEI) and the National Horticultural Research Institute (NIHORT) which took place intending to enhance the socio-economic conditions of women farmers in Oyo State, particularly in the Oke Ogun region. Collectively, their primary aim was to evaluate the training requirements of women farmers in the area and equip them with the essential competencies to augment their productivity and effectiveness. This collaborative effort represents a noteworthy stride in advancing gender equality and enhancing the prospects for female farmers in Nigeria.

Objectives of the Study

The overarching goal of this study was to ascertain the needs assessment of the women farmers in Oyo State. The specific objectives are to:

i. Identify the socio-economic components of the respondents
ii. Evaluate the major crops that are grown by the respondents
iii. Assess the respondents' horticultural crops of interest

MATERIALS AND METHOD

This study was conducted in Oke Ogun, a geographical area in the northern region of Oyo State, Nigeria, consisting of ten Local Government Areas (LGAs), including Saki West, Saki East, Atisbo, Iwajowa, Kajola, Irepo, Oorelope, Surulere, Itesiwaju, and Olorunsogo. Agriculture is the primary economic activity in the region, with community members engaged in the cultivation of crops such as yam, cassava, maize, groundnut, and vegetables, as well as livestock husbandry. Women's participation in small-scale enterprises and commercial activities has increased notably in the area. The study was conducted in three farm villages of Kajola Local Government Area: Ilero, Sepeteri, and Isemi-Ile. These locations were selected because they have a high concentration of WOFEI's women farmers who expressed a willingness to participate in the study. The research used a purposive sample method and a descriptive research methodology, administering a well-structured closed-ended questionnaire to 122 respondents in the farm villages of Kajola Local Government Area.

PRESENTATION OF FINDINGS

Socio-economic Characteristics of the Respondents

Table 1 indicates that the entirety (100.0%) of the participants in the study are residents of Oyo State. A significant proportion (36%) were the ages of 50-59 years, married (76.5%), and reported having a family size of 6-8 (42.5%). Most (41.6%) respondents possessed primary education while 23.6% had secondary education. A significant proportion (93.3%) of respondents reported being actively involved in agricultural activities as their main source of livelihood. Most (51.7%) respondents possessed farm sizes ranging from 1 to 4 acres. It is worth mentioning that a greater proportion (95.3%) of the respondents obtained their seed/seedlings from the open market, while 68.6% of them were affiliated with the Farmers Association

Table 1: Socio-economic characteristics of the respondents (n=89)

Variables	*Frequency*	*Percentage*
State		
Oyo	89	100
Age		
20-29	5	5.6
30-39	10	11.2
40-49	19	21.3
50-59	32	36.0
60-69	21	23.6
>69	2	2.2
Marital Status		
Married	65	76.5
Single	5	5.9

Divorced	5	5.9
Widowed	14	17.6
Family size		
0-2	16	18.4
3-5	28	32.2
6-8	37	42.5
9-11	8	8.9
Tribe		
Yoruba	89	100
Sex		
Male	7	7.9
Female	82	92.1
Education Qualification		
No formal Education	9	10.1
Primary	37	41.6
Secondary	21	23.6
OND/NCE	16	18.0
HND/BSc	6	6.7
Primary occupation (farming)		
Yes	83	93.3
No	6	6.7
Years of experience in Farming		
1-9	20	22.5
10-19	25	28.1
20-29	24	27.0
30-39	9	10.1
>39	11	12.4
Farm size (in Acre)		
134-9	46	51.7
10-19	31	34.8
20-29	10	11.2
30-39	0	0.0
>39	2	2.2
Source of Seed/Seedlings		
Open market	82	95.3
Others	7	24.7
Farmers' Association belongs to		
Real farmers association	3	3.4
Cassava and Maize Farmers Association	4	4.5
Agbeloba Farmers association	6	6.7
All Farmers Association of Nigeria (AFAN)	70	78.7
Liberators farmers	1	1.1
Poultry Association	1	1.1
Ifesowapo	4	4.5

Source: NIHORT/WOFEING Fieldwork, 2022

The Major Crops Cultivated by the Respondents

The findings presented in Table 2 reveal that the cultivation of cassava had the largest prevalence among the respondents, accounting for 75.3% of the respondents. Maize cultivation followed closely with 52.8%, while vegetable cultivation was reported by 22.5% of the respondents. In contrast, it was found that cashews, soybeans, fruit vegetables, watermelon, rice, okra, and cocoa had the lowest rates of cultivation among the respondents. The substantial proportion of respondents engaged in the cultivation of cassava can be ascribed to its significance as a fundamental agricultural commodity in Nigeria. The study by Ovharhe *et al.,* (2020) reveals that cassava holds a prominent position as a staple crop in Nigeria, mostly owing to its capacity to thrive in diverse soil conditions and its resistance to pests and diseases, while the substantial proportion of respondents engaged in maize cultivation can be credited to its significance as a vital means of sustenance and economic support for small-scale farmers in Nigeria. In the majority of instances, vegetable cultivation is commonly practised as an intercrop. This may be attributed to farmers' lack of trust in the profitability of vegetable production as a viable venture, coupled with a limited awareness of its potential for high profitability.

Table 2: The major crop(s) grown by the respondents (n=89)

	Yes/ (%)	No/ (%)
Cassava	67 (75.3)	22 (24.7)
Vegetable	20 (22.5)	69 (77.5)
Cashew	2 (2.2)	87 (97.8)
Maize	47 (52.8)	42 (47.2)
Soybeans	2 (2.2)	87 (97.8)
Yam	20 (22.5)	69 (77.5)
Fruit vegetable	1 (1.1)	88 (98.9)
Watermelon	1 (1.1)	88 (98.9)
Rice	1(1.1)	88 (98.9)
Tomatoes	4 (4.5)	85 (95.5)
Pepper	2 (2.2)	87 (97.8)
Beans	3 (3.4)	86 (96.6)
Okra	1 (1.1)	88 (98.9)
Cocoa	1 (1.1)	88 (98.9)

Source: NIHORT/WOFEING Fieldwork, 2022 **The percentages are represented in parentheses

The Respondents' Horticultural Crops of Interest

Table 3 found that the horticultural crops with the largest percentage of interest to the respondents were tomato (61.8%), jute mallow (58.4%), pepper (53.9%), okra (49.4%), amaranth (46.1%), and celosia (33.7%). The cultivation of these crops in Nigeria is characterized by strong market demand and their significant nutritional value, which may account for the substantial proportion of respondents expressing interest in their cultivation. Additional crops that were reported to have high-interest rates include *Telfairia* ('Ugu') and garden egg, with 24.7% of respondents reporting favourable responses for each crop. However, respondents' lack of knowledge, training, and facilities likely prevented them from responding to questions bothering on interest in value addition.

Table 3: Respondents' horticultural crops area of interest (n=89)

Horticultural crops	*Area of Importance/Interest*		
	Production		Value Addition
	Yes/ (%)	No/ (%)	
Leafy Vegetables			
Amaranthus	41 (46.1)	48 (53.9)	
Jute Mallow (Ewedu)	52 (58.4)	37 (41.6)	
Ugu	22 (24.7)	67 (41.6)	
Celosia (Soko)	30 (33.7)	59 (66.3)	
Fruit Vegetables			
Tomato	55 (61.8)	33 (37.1)	
Pepper	48 (53.9)	41 (46.1)	
Garden Egg	22 (24.7)	67 (75.3)	
Okra	44 (49.4)	45 (50.6)	
Exotic vegetables			
Watermelon	10 (11.2)	79 (88.8)	
Cucumber	4 (4.5)	85 (95.5)	
Lettuce	2 (2.2)	87 (97.8)	
Fruits			
Plantain/Banana	11 (12.4)	78 (87.8)	
Pawpaw	9 (10.1)	80 (89.9)	

Pineapple	3 (3.4)	86 (96.6)
Citrus	1(1.1)	88 (98.9)
Spices		
Basil (Basil)	12(13.5)	77(86.5)
Onions	7(7.9)	82 (92.1)
Ginger	5 (5.6)	84 (94.4)
Turmeric	2 (2.2)	87 (97.8)

Source: NIHORT/WOFEING Fieldwork, 2022 **The percentages are represented in pare

CONCLUSION AND RECOMMENDATION

The results of the study indicate that women farmers have notable constraints in obtaining educational and training resources to build their capacity, resulting in a hindrance to their productivity and economic advantages. The partnership between WOFEI and NIHORT signifies a significant step towards promoting gender equality and improving the opportunities available to women engaged in farming activities in Nigeria.

To enhance the productivity and efficiency of women farmers:

1. It is recommended that training should be conducted in their horticultural crops of interest along the value chain to encourage involvement in horticultural crop production.
2. The partnership between WOFEI and NIHORT signifies a significant step towards enhancing vegetable production, gender parity, empowerment, and improving the opportunities available to women farmers in Nigeria, thus it should be embraced with passion and commitment by the collaborators for sustainable development.

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INCIDENCE AND DISTRIBUTION OF CASSAVA (*Manihot esculentum* Crantz) VIRUS DISEASES IN EDO AND DELTA STATES, NIGERIA

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ABSTRACT
A survey was carried out in Edo and Delta States of Nigeria, to determine the incidence and distribution of cassava viral diseases. A total of 810 cassava leaf samples from visited fields were collected using quadrants and examined using Enzymes-linked immunosorbent assay (ELISA) tests for the detection of African cassava mosaic virus (ACMV), East African cassava mosaic virus (EACMV) and Cassava Brown Streak Virus (CBSV). Laboratory experiments were laid out in a complete randomized design replicated three times. Data obtained were analyzed using descriptive analysis and analysis of variance (ANOVA) while significantly different means were separated using Duncan's Multiple Range Test (DMRT) at 5 % level of probability. Symptoms of viral diseases were higher in Delta State. Edo South had the least percentage incidence of 2.45%. ELISA test revealed incidence of EACMV (78.89 %), ACMV (72.96 %) and CBSV (66.92 %).
Keywords: *Brown streak virus, Cassava mosaic virus, Incidence, Symptoms, Viral diseases*

INTRODUCTION

Cassava (*Manihot esculentum* Crantz) is a perennial shrub of the dicot family Euphorbiaceae (Leon, 1977). The genus *Manihot* is reported to have about 100 species but only *Manihot esculentum* Crantz is commercially cultivated (Benesi, 2005). Cassava is a drought tolerant shrub that is commercial propagated on a wide range of edaphic and climate conditions mostly by stem cuttings, although propagation by true seed occurs under natural condition and in breeding programmes, the root is the main storage organ, which result from secondary growth of the fibrous roots. All cassava organs except seeds contain cynogenic glycoside (CG) at varying quantity depending on the cultivar. Among food crops, cassava is ranked 12th in the world with Nigeria, Brazil, Thailand, Indonesia and Congo Democratic Republic producing over 70% of global cassava output (IITA, 2004). Nigeria is the largest Cassava producing country in the world with cassava being cultivated in all regions of the country however, with Benue and Kogi States in the North Central being the largest producers (IITA, 2004), It is used as a famine reservoir crop mainly for staple food and animal feed and also as a source of industrial raw material for local and refined starch, ethanol production for foreign exchange (IITA, 2003). Despite the immense importance of cassava, pests and diseases are the major constraints of cassava cultivation (Nweke *et al.,* 2002). The major diseases of cassava in Nigeria include Cassava Mosaic Disease (CMD), Cassava Bacterial Blight (CBB), Cassava Anthracnose Disease (CAD) and Cassava Root Rot (CRR) (Herren and Bennet, 1984).

MATERIALS AND METHODS

Experimental location

Samples used for the study were collected from three Senatorial districts each from Edo and Delta States of Nigeria. Laboratory analysis was carried out in the Virology laboratory of the Department of Crop Protection, Ahmadu Bello University (ABU) Zaria.

Surveyed Areas

Edo State Lies between Longitude 06^0 04^1 E 06^0 43^1 E, Latitude 05^0 44^1 N and 07^0 34^1 N. The climatic conditions are characterized by two distinct conditions of wet and dry seasons. The State experiences high rainfall and humidity (Ikhile and Aifesehi, 2011). Delta State lies roughly between longitudes 5Aº00 and 6Aº45E and latitude 5Aº 00 and 6Aº30 N it has total land area of 16, 842sq.km. Average rainfall is about 266.5 mm in the coastal areas and 1905 mm in the extreme north with the rainfall heaviest in July. Temperature increases from the south to the north (Osagie, 2002).

Survey and Sample Collections

Samples were collected from cassava farms in Edo and Delta States. For each senatorial district three cassava farms were selected within minimum distance of 1.55km and maximum distance of 10.55km consistence, two commercial farms five hectare and above and (2 – 5 ha) for subsistence farm. In each farm 5m x 5m dimension drowned 5 times, in 5 strategic locations in the farm. Total number of cassava plants and number of plants with symptoms in each quadrant were recorded. Nine symptomic and asymptomic leaf samples were collected randomly from each quadrant and three samples out of the nine were selected randomly for the laboratory analysis. Incidence of symptoms calculated using the formula below. The co-ordinates of farm locations and size of each farm were documented.

Disease incidence % $= \frac{Number\ of\ disease\ plants}{Total\ number\ of\ plant\ examine} \times 100$

Laboratory Analysis

Preparation of buffers: The buffers that were used in ELISA are (1) coating buffer (CB), (2) phosphate buffered saline (PBS) (3) PBS-Tween 20 (PBST) (4) sample extraction buffer (SEB), (5) conjugate buffer (6) substrate buffer (SB).

Serological procedures: The triple antibody sandwich formed of the enzyme-linked immunosorbent assay (TAS-ELISA). Polyclonal for serological diagnosis of (ACMV and EACV) while for the diagnosis of Cassava brown streak virus (CBSV) the Double antibody sandwich (DAS) Enzyme-linked immunosorbent assay (DAS-ELISA) was used. Results were assessed by (a) visual observation and (b) spectrophotometric measurement of absorbance at 405nanometer. Observance values twice those of the negative control were rated positive (Clark, and Adams 1977).

Data Analysis: The data collected were subjected to analysis of variance (ANOVA) using GenStart 2005 software. Mean separation was carried out using Duncan's Multiple Range Test (DMRT) of the same software.

RESULTS

Table 1 shows the farm location, characteristics and general observation for symptoms of viral diseases in Edo and Delta states. Farmers complied with the recommended plant population density of 10,000 plant/ha in Edo State. Plant population density was lower than the recommended rate Delta State7626 plants/ha. General observations for symptoms of viral diseases were higher in Delta State, severe in Delta North (57.45%), compared to Edo State, Edo South has the least percent incidence of 2.45%.

Table 2 show the disease incidence for ACMV, EACMV and CBSV were observed to occur at different levels in all farm locations in the study area (Table 2). In Edo State, ACMV had a highest incidence value of 90.4 followed by CBSV and EACMV (73.4 and 72.6) respectively. EACMV however had the highest disease incidence in Delta State (85.2) follow by CBSV and ACMV with incidence values of 60.4 and 55.5.

Table 1: Location, Characteristics and General Observation for Viral Disease Symptoms in Cassava Farms in Edo and Delta State

States	Senatorial Districts		Farm Location	Farm Size	Coordinate of Location	Plant density/ha	General observation for plant disease symptoms (%)	
							Total No. observed	No. of infected
EDO STATE	EDO CENTRAL	EC 1	Illeh	2 Hactre	N 060 45' 13.0" 006o 12 2.4"383m,	10480	131	51
		EC 2	Illeh	8 Hactre	N 060 45' 16.9" E 006o 12 57.0" 387m	11520	144	63
		EC 3	Agua-Irrua	10 Hactre	N 060 40' 45.0" E 006o 14 31.8" 373m	8480	106	15
		MEAN		**20 ha**		**10160**	**33.85**	
	EDO SOUTH	ES 1	Iguomokhia	2 Hactre	N 06° 07' 02.7" E 006° 48 41.7" 49m	6080	76	03
		ES 2	Iguomokhia	60 Hactre	N 06° 07 02.0" E 006° 48 47.8" 50m	7680	95	03
		ES 3	Iguomokhia	40 Hactre	N 06° 07' 00.2" E 005° 48 36.5" 58m	9120	114	01
		MEAN		**102 ha**		**7626**	**2.45**	
	EDO NORTH	EN 1	Ighara Road	40 Hactre	N 07° 05' 02.2" E 006° 15 4.6"	8880	111	05
		EN 2	Prison Road	2 Hactre	N 07° 04' 37.3" E 006° 16 21.7" 246m,	10480	131	03
		EN 3	Otaro palace Road	9 Hactre	N 07° 04' 36.4" E 006° 15 52.3" 240m	10880	136	45
		MEAN		**51 ha**		**10080**	**14.15**	
DELTA STATE	DELTA CENTRAL	DC 1	Orhomuro	10 Hactre	N 05° 42' 10.3 E 006° 04' 11.9, 16m	8400	105	59
		DC 2	Eboh	7 Hactre	N 05° 41' 59.0" E 006° 07 "28.5, 15m	19520	244	71
		DC 3	Otoro Orogun	2 Hactre	N 05° 39 01.7, E 006° 10" 17.5, 20m	13920	174	111
		MEAN		**19 ha**		**13946**	**46.1**	
	DELTA SOUTH	DS 1	Ifei	2 Hactre	N 05° 33' 49.2" E 005° 41' 02.3" 3m,	10240	128	86
		DS 2	Ifei	5 Hactre	N 05° 33' 68.5" E 005° 41 00.0" 10m	9520	119	15
		DS 3	Omadino	10 Hactre	N 05° 38' 25.1" E 005° 38' 55.2" 1m,	4880	61	19
		MEAN		**17 ha**		**8213**	**38.96**	
	DELTA NORTH	DN 1	Idumu Oliko	7 Hactre	N 06° 20' 44.3" E 006° 35 06.2" 198m	11280	141	100
		DN 2	Oliko	10 Hactre	N 06° 20" 40.2 E 006° 35 8.2" 194m	9120	114	83
		DN 3	Atuma-Iga	2 Hactre	N 06° 19' 27.5" E 006° 35' 09.5" 197m	9680	121	33
		TOTAL		**19 ha**		**10026**	**57.45**	
GRAND TOTAL								

Table 2: Percentage Disease Incidence from Laboratory Analysis of Cassava Samples in Edo and Delta States for ACMV, EACMV and CBSV.

States	Senatorial Districts		Farm Location	Tested plants/Location	Infected Samples	Incidence (%)		
						ACMV	EACMV	CBSV
EDO STATE	EDO CENTRAL	EC 1	Illeh	45	30	11 (73.33)	13 (86.67)	6 (39.99)
		EC 2	Illeh	45	36	15 (100.0)	13 (86.67)	8 (53.33)
		EC 3	Agua-Irrua	45	33	13 (86.67)	11 (73.33)	9 (60.02)
		TOTAL		**135**	**099**	**86.7ᵃ**	**82.2ᵃ**	**51.1ᶜ**
	EDO SOUTH	ES 1	Iguomokhia	45	44	15 (100.0)	14 (93.33)	15 (100.0)
		ES 2	Iguomokhia	45	43	15 (100.0)	13 (86.67)	15 (100.0)
		ES 3	Iguomokhia	45	44	15 (100.0)	14 (93.33)	15 (100.0)
		TOTAL		**135**	**131**	**100ᵃ**	**91.1ᵃ**	**100ᵃ**
	EDO NORTH	EN 1	Ighara Road	45	20	11 (73.33)	02 (13.33)	07 (46.67)
		EN 2	Prison Road	45	30	13 (86.67)	07 (64.67)	10 (66.67)
		EN 3	Otaro palace Road	45	31	14 (93.33)	09 (60.00)	08 (53.33)
		TOTAL		**135**	**081**	**84.4ᵃ**	**42.2ᵇ**	**55.5ᶜ**
DELTA STATE	DELTA CENTRAL	DC 1	Orhomuro	45	30	11 (73.33)	11 (73.33)	08 (53.33)
		DC 2	Eboh	45	30	07 (46.66)	14 (93.33)	09 (66.67)
		DC 3	Otoro Orogun	45	31	05 (33.33)	15 (100.0)	10 (73.33)
		TOTAL		**135**	**091**	**51.1ᵇ**	**88.9ᵃ**	**62.2ᶜᵇ**
	DELTA SOUTH	DS 1	Ifei	45	28	02 (13.33)	15 (100.0)	11 (73.33)
		DS 2	Ifei	45	30	06 (40.00)	12 (80.00)	12 (80.02)
		DS 3	Omadino	45	23	04 (26.67)	12 (80.00)	07 (46.67)
		TOTAL		**135**	**081**	**33.3ᶜ**	**86.7ᵃ**	**68.0ᵇ**
	DELTA NORTH	DN 1	Idumu Oliko	45	35	13 (86.67)	12 (80.02)	10 (66.67)
		DN 2	Oliko	45	33	11 (73.33)	14 (93.33)	08 (53.33)
		DN 3	Atuma-Iga	45	28	13 (86.67)	10 (66.67)	05 (33.33)
		TOTAL		**135**	**096**	**82.2ᵃ**	**80.0ᵃ**	**51.1ᶜ**
	GRAND TOTAL			**810**	**579**			

DISCUSSION

Enzyme-Linked Immunosorbent Assay (ELISA) was used to test the incidence of three important cassava viruses- ACMV EACMV CBSV in the senatorial districts of Edo and Delta States. In total, 810 samples from were analyzed. 78.89% were positive for EACMV, 72.96% for ACMV and 66.92% for CBSV. This is in agreement with IITA, (2000) which states that ACMV and EACMV occurs virtually throughout the cassava growing areas of Africa and that production losses due to CMD in Nigeria where estimated at 6.78-9.69 million metric tonne in 1998 when the total harvest for the country was 35.56 million tonne (Echendu *et al*, 2003). It implies that relying only on expression of CMD symptoms may often result in underestimating the CMD disease. While from this survey ELISA test of samples showed that EACMV and ACMV were widely distributed in the study area with 78.89, 72.96 mean, similar results were obtained in previous research study in 16 southern state of Nigeria including where ACMV and EACMV were widely distributed (Ogbe, *et al.,* 2006). The symptoms observed in the field include mosaic, chlorosis, yellow blotches, stunting, streak, stripe and reddening of leaves which is consistent with plant viral infections as described by (Calvert and Thresh, 2002a,b). The results of serological of samples from Edo and Delta States showed that ACMV, EACMV, CBSV, were detected in asymptomatic plant leaf samples. This finding was similar to the report of Ogbe, *et al.* (2006) that most samples from asymptomatic plants in Abia, Ebonyi, Enugu and Imo States were infected with either ACMV or EACMV and that the detection of (ACMV) and (EACMV) in asymptomatic plants is important information in the determination of (CMD) incidence. Survey farms were chosen within a minimum distance of 1.55km and maximum distance of 10.55km eighteen farms. Otim-Nape *et al*., (1997), Legg and Ogwal, (1998) estimated that a pandemic of CMD may exceed 20-30 km/annum. In all surveyed farm, cassava plant population per hectare were at range of 8000 -14000. This agree with the findings of Hahn *et al.,* (1979) who recommended that a plant population of 10,000-15,000 plants per hectares in general is economical and give a good yield of cassava.

CONCLUSION

Based on this survey work, all 18 cassava farms visited within the minimum distance of 1.55km and maximum distance of 10.55km in all the senatorial districts of Edo and Delta States of Nigeria has the three most important virus infecting cassava, out of 810 samples tested 78.89% were positive for EACMV, 72.96% for ACMV and CBSV 66.92%. High cassava plant density/ hectare could be one of the factors for the virus disease spread in these area. An epidemic of CMD and CBSD could occur in wide area of cassava production in Edo and Delta States of Nigeria.

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ASSESSMENT OF FACTORS LIMITING PRODUCTION OF CITRUS AMONG SMALL HOLDER FARMERS IN BENUE STATE (USHONGO LOCAL GOVERNMENT AREA OF BENUE STATE, NIGERIA)

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ABSTRACT

The study assesses the factors limiting the production of citrus among small holder farmers in Benue State of Nigeria. Primary data was sought from 120 respondents using structured questionnaire. Data were analyzed using frequency and percentage. Result revealed that 67% male and 33% female were involved in citrus production in the study area, 75% were married with 42% having 7 and above years of farming experience and 42% of them having a farm size of 2 – 5 acres of land. 63% of the respondents make an annual income of around ₦ 51,000.00 - ₦ 100,000.00 and irrigation, pest and disease control, variety selection, fertilizer application and site selection were the farm management system being practiced by the respondents. Citrus plant was used for medical purpose using the leave majorly, prepared by boiling and administered orally. Lack of access to quality inputs such as fertilizers, pesticides and irrigation systems, poor soil fertility due to over-cultivation or inadequate use of fertilizer, low level of technical knowledge on best practices for citrus cultivation, lack of credit facilities and Inadequate infrastructure like roads linking the farms to the market were the challenges faced by the respondents in citrus production. The study concludes that males and female in their productive age are into citrus farming. The study recommends that government should provide quality inputs including fertilizers, pesticides, herbicides, credit facilities etc for farmers to utilize for their citrus cultivation. Also, training should be carried out on the farmers by extension service providers for a better knowledge and best practice of citrus cultivation.

Keywords: *variety, irrigation, inputs, credit and horticulture*

INTRODUCTION

Citrus was introduced in Nigeria by the Federal Department of Agriculture and Missionaries in the 1930s (Mbah *et. al.,* 2018). Nigeria is the 9th major Citrus producing country globally after Italy and the largest region in Africa (Food and Agriculture Organization, 2012). Citrus is one of the most important fruit crops grown all over the world. It is rich in Vitamin C (Ascorbic Acid) and Folic Acid as well as a good source of fiber. Citrus contain Potassium, Calcium, Thiamin, Niacin, Vitamin B6 (Pyrodoxine), Copper, Phosphorus and Magnesium (Chase, 2017). They are fat free, sodium free and cholesterol. About 930,000 tons of citrus fruits are produced annually in Nigeria from an average of estimated 3 million hectares of Land. Citrus is grown in the rainforest and Guinea Savannah; most of these farmlands are in the remote part of the country with poor roads and about 30-50% of these fruits getting spoilt before reaching to the final consumers in Urban Centers (Taiwo, 2015).

Citrus is one of the most important fruit crops grown all over the world. Citrus fruits are rich in vitamin C (ascorbic acid) and folic acid, as well as a good source of fiber. They are fact free, sodium free and cholesterol free. In addition, they contain potassium, calcium, foliate, thiamin, niacin, vitamin B6 (pyridoxine), phosphorus, magnesium and copper. In Nigeria, about 930,000 tons of citrus fruits are produced annually from an estimated hectrage of 3 million hectares of land. Citrus is grown in the rainforest and guinea savannah, most of these farmlands is in the remote part of the country with poor road networks. About 30-50% of these citrus fruits get spoilt on the way before getting to the final consumers in the urban centre (cities).

Commonly grown Citrus species belong to the family Rutaceae. Important species grown in Nigeria are Sweet Orange, Lemon, Lime, Grape fruit and Tangerine. Although there has been an improvement in Citrus fruit production in Nigeria over time, there are challenges that still persist in the industry in areas of production; harvesting, post harvesting activities; processing, marketing and storage are still preventing full exploitation of the best of Citrus production (Chase, 2017). Citrus is one of the most important fruit crops widely cultivated in Nigeria especially in North Central with Benue State in particular. Fortunately, the area of land under production is increasing, it is unfortunately at a low pace due to a number of constraints face by farmers on use of resources and production (Phat *et al.,* 2015).

Citrus contribute greatly to agricultural development in the country economy however faced with a lot of challenges in its development and maximization of potential by small holder's farmers (Attah *et al.,* 2018). Some of the limiting factors to citrus production are lack of capital, pest, diseases, soil fertility problems, scarcity of large quantities of high yielding varieties, scarcity of early maturing true –to-type planting materials, high cost of labour for farm operations, lack of information on the use of agro-chemicals, land tenure system, lack of farmers training and lack of market information (Owoeye, 2010).

Bhat*et al.* (2015) observed that most Citrus farmers are constrained by finance and credit facilities. It is a perennial that require constant management for continuous productivity and inadequate finance may hamper its production. Losses due to pests and diseases remain a major constraint (NIHORT, 2010). It is in line with this that this study seeks to assess the factors limiting the production of citrus among small holder farmers in Benue State of Nigeria.

The specific objectives of the study will be:

i. Describe the demographic characteristic of the citrus farmers in Benue State
ii. Determine information on farm management system in Benue State.
iii. Ascertain ethnobotany of citrus production in Benue State
iv. Identify challenges of Citrus production in Benue State

METHODOLOGY

The research will be conducted in Benue State, Nigeria. Benue State is delineated into three agricultural zones namely, Northern Zone (A), Eastern Zone (B) and Central Zone (C). The State has 23 Local Government Areas with Makurdi as the State Capital. It is located between Longitude 7^o 45' and 10^o 0' East and Latitude 6^o 25' and 8^o 8' North. It is bounded by five other states namely, Nasarawa State to the North, Taraba State to the East, Cross River State to the South, Kogi State to the West and Enugu State to the South-West. It occupies a landmass of 34,059 square kilometers and has a population of approximately 4,253,641 (NPC, 2016). Benue State is inhabited predominately by the Tiv, Idoma and Igede people with their major occupation been farming. It is the major source of food production in the nation with major crops grown as rice, Groundnut, Cassava, Sweet potato, Maize etc. and also raises livestock like, Sheep, Goat, Pig, Rabbit etc. (Mbah *et al.,* 2018).

The population of the study will consist of Citrus farmers in Ushongo Local Government of Benue State. Ushongo is located in Zone A area of the State. Ten (10) Council wards will purposively be selected because of their contribution to Citrus production. In each of the council wards selected, simple random sampling will be used to select twelve (12) respondents, making a total of 120 respondents. Primary data will be collected through the use of a well-structured Questionnaire. Descriptive statistics such as frequency and percentage will be used for data analysis.

RESULTS AND DISCUSSION

A total of 150 questionnaires were distributed to the respondents, however 120 were retrieved and since this number represent a good percentage of the total questionnaires distributed, the researcher decides to use it for the analysis of the study. From the Table 1, it was observed that majority of the respondents fall within the age limit of 20 – 30 years (42%) followed by those within 31 – 40 years (33%). This is closely followed by those within 41 – 50 years (21%) and lastly 4% for those within 51 years and above. It can therefore be concluded that young and more vibrant youths are into the farming of Citrus in Benue State. Majority of the farmers are male (67%) while 33% are female. This shows that there are more male farmers than females in Benue State. Also, majority of the respondents are married (75%), followed by single with 17% and lastly 8% separated. This can be attributed to the married ones having more responsibility to carter for their family than the others. Furthermore, majority of the respondents have secondary school certificate (50%) followed by those with primary certificate (29%). This is closely followed by those without any formal education with 13% and only 8% had tertiary certificate. It can be seen from hear that farmers in Benue State had a good educational background to practice agriculture effectively. On the household size, majority of the respondents had 7 and above number of households (46%), 37% for those with 6-7 numbers, 10% for those with 3-4 numbers and 7% for those with 1-2 numbers. Finally, on the years of farming experience, majority of the farmers (42%) had 7 years and above farming experience, 25% had between 5 – 6 years of farming experience, followed by those with

3-4 years of experience with 23% and lastly with 10% for those with 1-2years of experience. It can therefore be concluded that more farmers have more years of farming experience in Benue State.

From the Table 2, majority of the respondents (42%) have 2 – 5 acres small land size, 25% of them has 6-10acres of land, 18% has <1acre while 15% has >10acres of land. The majority of them having a small land size can be attributed to the fact that they are smallholders farmers. Majority of their sources of labour is family members with (50%) followed by Hired with 33%. Majority of the respondents (75%) said they have access to extension services while majority (67%) does not have access to credit facility. Also, majority does not have access to physical infrastructure however majority of them (83%_ have access to market. Majority of the respondents (63%) annual income ranges from ₦ 51,000.00 - ₦ 100,000.00 followed by those within ₦ 101,000.00 - ₦ 150,000.00 with 25%. The least of them 10% earned above or equal to ₦ 150,000.00. This can also be attributed to their small scale nature (smallholders). Also, from the table, it can be noticed that the farm management systembeing practiced in the area include irrigation, pest and disease control, variety selection, fertilizer application and site selection. This implies that farmers in the area adopted different management practices of citrus production to impact their productivity and profitability. This is in accordance with the finding of Dorji, Lakey, Chopel, Dorgi and Tamang, (2016) who opined that efforts should be made to select varieties needed and desired in the region,

Table 3 shows the ethnobotany of citrus fruit. This has to do with the scientific study of the traditional knowledge an customs of the people concerning plants and their medical, religious and other uses. In respect to this, it was observed from the table that majority of the respondents (92%) affirmed that orange has symbolic beliefs while only 8% said otherwise. All the respondents (100%) said orange plant is used for medical purposes. Majority of the respondents (46%) said orange is used for animal forage, beverages and medicine and the major part used for this purpose is the leave with 71% response. Also, boiling is the mode of preparation for medical use with 75% response rate and is administered orally (83%) and bathing in some cases (17%). This corresponds with the finding of Osunwole (2009) who reported that this species of plant are highly medicinal because they are used both for sustaining health and curing illness

Table 4, shows the challenges faced by farmers in citrus cultivation in Benue State. It can be seen that majority of the respondents (58%) agree that lack of access to quality inputs is the challenges faced by farmers, 32% strongly agree while 10% disagree. Also, majority of the respondents (63%) agree that poor soil fertility due to over-cultivation or inadequate use of fertilizer is the challenges faced by farmers, 25% strongly agree while 12% disagree. Majority of the respondents (50%) agree that low level of technical knowledge on best practices for growing citrus fruits is the challenges faced by farmers, 38% strongly agree,8% disagree while 4% strongly disagree. Majority of the respondents (46%) agree that inadequate infrastructure like roads is a challenge faced by farmers, 25% strongly agree, 17% disagree while 12% were undecided. This implies that citrus production by farmers in Benue is impeded by lack of infrastructures as well as knowledge of best practices. All this agrees with the finding of Mendelson and Williams (2014) who found that poor infrastructure is a major challenge faced by farmers in citrus production. More so, majority of the respondents (67%) agree that limited access to credit facilities is the challenges faced by farmers, 21% strongly agree, 10% disagree while 2% were undecided.This implied that citrus production by farmers in Benue is constrained by access to loan facilities. This agrees with the finding of Bhat, Jyoti, Manish and Rajinder (2015) who indicated that most farmers are constrained by credit facilities.

CONCLUSION AND RECOMMENDATIONS

From the findings of this study, it can be concluded that males and female in their productive age are into citrus farming. However, farmers in the area are into citrus management practices which include irrigation, pest and disease control, variety selection, fertilizer use and site selection. Despite this engagement, there is low level of productivity going by the annual income generation from the citrus production. This can be attributed to the small scale nature of the farmers in the area alongside the constraints being faced by the farmers. Thus, urgent attention is needed to address these challenges which include among others lack of access to quality inputs such as fertilizers, pesticides and irrigation systems, poor soil fertility due to over-cultivation or inadequate use of fertilizer, low level of technical knowledge on best practices for citrus cultivation, lack of credit facilities and Inadequate infrastructure like roads linking the farms to the market. This will to a large extent improve citrus production in Benue State of Nigeria. To this end, the study recommends the followings:

1. The government should provide quality inputs including fertilizers, pesticides, herbicides etc for farmers to utilize for their citrus cultivation.
2. Training should be carried out on the farmers by extension service providers for a better knowledge and best practice of citrus cultivation.
3. Credit facilities should be extended to farmers owing to their small scale production and limited resources for more productivity.
4. Finally, government should look into the issue of roads linking the farms to the urban market for easy accessibility to farm produce exchange as most of this rural areas lack this major facility.

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Table 1: Distribution of respondents according to their Demographic Characteristic (N 120)

Demographic Characteristics	Frequency	Percentage (%)
Age (years)		
20 – 30 years	50	42
31 – 40 years	40	33
41 – 50 years	25	21
51 years and above	5	4
Gender		
Male	80	67
Female	40	33
Marital Status		
Single	20	17
Married	90	75
Divorced	0	0

Separated	10	8
Educational Level		
No Formal Education	15	13
Primary Education	35	29
Secondary Education	60	50
Tertiary	10	8
Others (specify)	0	0
Household size		
2	9	7
3	12	10
4	55	46
5and above	44	37
Years of farming experience		
1-2years	12	10
3-4 years	28	23
5-6years	30	25
7 years and above	50	42

Source: Field Work, 2023

Table 2: Distribution of respondents according to their information on Farm Management System (N = 120)

Management System	Frequency	Percentage (%)
Farm size		
<1acre	22	18
2 – 5 acres	50	42
6-10acres	30	25
>10acres	18	15
Source of farm labour		
Family	60	50
Co-operative	20	17
Hired	40	33
Access to extension services		
Yes	70	58
No	50	42
Access to credit facility		
Yes	40	33
No	80	67
Access to physical infrastructures		
Yes	30	25
No	90	75
Access to market		
Yes	100	83
No	20	17
Annual income		
₦ 51,000.00 - ₦ 100,000.00	75	63
₦ 101,000.00 - ₦ 150,000.00	30	25

≥₦ 150,000.00	15	12
Citrus management practices		
Irrigation	5	4
Pest and disease control	15	13
Variety selection	10	8
Fertilizer application	20	17
Site selection	10	8
All of the above	60	50

Source: Field Work, 2023

Table 3: Distribution of respondents according to the Ethnobotany of Citrus Production (N = 120)

Ethnobotany	Frequency	Percentage (%)
Is orange a subject of symbolic beliefs?		
Yes	110	92
No	10	8
Is orange plants used for medical purpose?		
Yes	120	100
No	0	0
Traditional uses of citrus		
Animal Forage	15	12
Beverage	20	17
Medicine	30	25
All of the above	55	46
Which parts is used?		
Leaves	85	71
Roots	5	4
Barks	14	12
Fruits	10	8
Seeds	0	0
Stem	6	5
Flower	0	0
What is the way or mode of preparation?		
Squeezing raw	0	0
Cook	20	17
Boil	90	75
Infusion	10	8
How do you administer it to the sick?		
Eat raw	0	0
Oral	100	83
Incision	0	0
Bathing	20	17

Source: Field Work, 2023

Table 4: Distribution of respondents according to the challenges of Citrus Production (N = 120)

Challenges	Frequency	Percentage (%)
Lack of access to quality inputs		
Agree	70	58
Strongly Agree	38	32
Undecided	0	0
Disagree	12	10

Strongly Disagree	0	0
Poor soil fertility due to over-cultivation or inadequate use of fertilizer		
Agree	75	63
Strongly Agree	30	25
Undecided	0	0
Disagree	15	12
Strongly Disagree	0	0
Low level of technical knowledge on best practices for growing citrus fruits	60	50
Agree	45	38
Strongly Agree	0	0
Undecided	10	8
Disagree	5	4
Strongly Disagree		
Limited access to credit facilities	80	67
Agree	25	21
Strongly Agree	3	2
Undecided	12	10
Disagree	0	0
Strongly Disagree		
Inadequate infrastructure	55	46
Agree	30	25
Strongly Agree	15	12
Undecided	20	17
Disagree	0	0
Strongly Disagree		

Source: Field Work, 2023

STUDY OF HORTICULTURAL TREE PLANTS SPECIES DISTRIBUTION AND CONSERVATION STATUS IN THE GREEN ZONE OF BUK RESIDENTIAL AREA

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ABSTRACT
This study was carried out in the green zone of the staff quarters old campus, Bayero university Kano in 2018. The study area located on the coordinate latitude 11^{0}58'11'N, longitude 8^{0}28'34''E. The staff quarters has a total quadrant of 51, in which 42 are full (10,000m^2) each, whereas 9 are third quarter's (7,500m^2). The total number of each species was recorded and the ecological parameter (frequency, relative frequency, abundance, relative abundance, density and relative density) of each species was calculated. Twenty seven quadrants were randomly selected. The results revealed that 387 horticultural tree plants species were recorded. However, Mangifera indica has the highest number of occurrences (19) out of 27 studied quadrant while Vitex doniana and Diospyrus mespiliformis were observed in only one quadrant. The conservation status of the species indicated that, 8 species(Adansonia digitata, Anona squamosa, Anarcadia occidentals, Carica papaya, Psidium guajava, Syzygium gynensis, Tamarindus indica and Taminalia mentali) are vulnerable (VU), 5 species (Citrus aurentifolia, Citrus cinensi, Diospyrus mestilifomis, zizipous moritiana and zizipous spinachristi) are threatened (T), 3 species (Balanite aegyptiaca, Mongifera indica and Moringa oliefera) are stable(S), while 2 species(Borassus eathiopum and vitex doniana) are at endangered (EN).
Keywords: *Species, Frequency, Density, Conservation and Horticulture*

INTRODUCTION

Most family of angiosperm is relatively represented in the savannah region of Nigeria. The genus of some families such as malvacea, Anacardiaceae and fabacea are widely available. Bayero University Kano, old campus with a land size of (893.700.68km^2) is regarded as the green zone of urban Kano. The level of plant trees cover in the green zone is fascinating to most visitors, these tree cover contribute to local weather condition that attract both human and other animal species populations. Conservation status of a species is an indicator of the likelihood of plant species continuing to survive either in the present day or the feature. Conservation status indicates weather the plant exists and how likely to become extinct in the near feature. Many factors are taken into account when assessing conservation status, not simply the number of individuals remaining but the overall increase or decrease in the population overtime, breeding success rates and known threaten (Milles, 2013).

Extensions occur when the motility (and emigration) rate is greater than the birth (and immigration) rate for sufficient long time that the population size reaches zero. When used in the context of the IUCN red list, a taxon is classified as vulnerable when facing a high risk of extinction in the wild in the immediate future (IUCN 2012). Endangerment is the exposure to risk when it comes to living organisms, and used in the context of 'endangered species', it generally means the risk of the species becoming extinct (Miller, 2013). A species is threatened when it is believed to be in danger of extinction. Status assessment in conservation has its roots in the late 1890s when researchers began to use population monitoring as mean to determine how populations of different species change overtime (stem *et al*., 2005). The international union of conservation of nature (IUCN) red list categories and criteria are widely used for its objective and authoritative system for assessing the global risk of extinction for species (mace *et al*., 1991). The red list introduce in 1994, is a list of species which has been evaluated against quantitative criteria to identify the extinction risk of species (Stuart *et al*., 2010). Currently, the IUCN red lists categories and criteria version 3.1 are widely used (IUCN, 2012). The aim of conservation status assessments is to provide information and analysis on the status, trend and threats to species in order to inform and catalyze action for biodiversity conservation (Possingham *et al*., 2002). The criteria have five categories of status namely extinction (EX), critically endangered (CR), endangered (EN), threatened (T) or vulnerable (VU). According to (Onyekwelu et al., 2007) relative density of species can be used to

categories plant into conservation statuses. If the relative density is less than 0.09 the species is said to be critically endangered (CR), if it's between 0.1 to 0.99 is endangered (EN), if the value is between 1 to 3 is threatened (T), if it's between 3 to 10 is vulnerable (VU) and if the value is greater than 10 the species is said to be stable. The economic benefit derives from this species cannot be under estimated. Tree plant species in general face extensive treat or pressure largely from humans for various reasons. No one is certain about the effect of human activities on distribution and density of horticultural tree species.
It's therefore necessary to study the number, density and other ecological parameter that can enable us to determine the current status and predict available data, the short term and along term status of this plant in the area in such a stable area. The objectives of the study were to survey and identification of selected horticultural tree species and to determine the frequency, density, abundance and other ecological parameters for the appropriate conservation strategies of horticultural trees in the study area.

MATERIAL AND METHODS

The study was carried out in the residential area of old campus Bayero University, Kano located on the coordinate latitude 11^{0}58'11'N, longitude 8^{0}28'34''E. Measuring tape, Ranging poles, Rope were used for measurement and data collection. Random sampling methods was used to select the study quadrants, the residential area where divided into different number of quadrant (10,000m^{2}) each. The area has a total quadrant of 51, in which 42 are full and 9 are third quarter's quadrant. Twenty seven quadrants were randomly selected. During this study the number of each species, occurrences of species were counted and recorded.

RESULT AND DISCUSSION

Table 1 shows the horticultural tree plant species present in the study area. Eighteen (18) species where recorded from difference families of the Fabaceae, Myrtaceae, Rutaceae and Rhamnaceae have two species while other families (Malvacea, Anonaceae, Zygophyllaceae, Ebenaceae, Moringaceae, Palmaceae, and Verbenaceae) has single species. Table 2 Shows the ecological parameters of the horticultural tree plant species in the study area. i .e the occurrences of the species, total number of each species, frequency, relative frequency, abundance, relative abundance, density, relative density and conservational status. The occurrence of species shows the number of quadrants in which the species is present out of 27 quadrants. From these studies the conservation statuses of the species are, 8 species are vulnerable, 5 are threatened, 3 are stable, while 2 are at endangered. *Mangifera indica* have the highest number of frequency and is more abundance, *Diospyrus mespiliformis* and *Borassus aethiopum* have lowest frequency and abundance. *Balanite aegyptiaca* and *Mangifera indica* has the highest relative density which shows they are stable while *Borassus aethiopum* have the lowest density. This work correspond with the work of (salami *et al., 2021*)

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Table1: Horticultural tree plant species in the study area 2018

Species Name	Common Name	Local Names	Families
Adansonia digitata(L)	Baobab	Kuka	Malvacea
Anona squamosal (L.)	Sugar apple	Fasadabur	Anonaceae
Balanite aegyptiaca (L.)	Desert date	Aduuwaa	Zygophyllaceae
Borassus aethiopum	African fan palm	Giginya	Arecaceae
Carica papaya (L.)	Pawpaw	Gwandar rabeji	Caricaceae
Citrus aurentifolia (christm)	Lime	Leemo	Rutaceae
Citrus cinensis	Orange	Lemon zaki	Rutaceae
Diospyrus mespiliformis	African ebony	Kanya	Ebenaceae
Mangifera indica(L.)	Mango	Mangwaro	Anarcadiaceae
Moringa oliefera (Lam)	Drumstick tree	Zogale	Moringaceae
Parkia biglobosa (Jacq.)	Locus tree	Dorawa	Fabaceae
Phoenix dactylifera (L.)	Date palm	Dabino	Palmaceae
Psidium guajava (L.)	Guava	Gooba	Myrtaceae
Syzygium guineense (Wild)(DC)	Water berry	Malmo	Myrtaceae
Tamarindus indica (L.)	Tamarind	Tsamiya	Fabaceae
Vitex doniana (Sweet)	Black plum	Dinya	Verbenaceae
Ziziphus mauritiana	Indian jujube	Magarya	Rhamnaceae
Ziziphus spinachristi (L.) (Desf)	Christs thorn	Kurna	Rhamnaceae

Table 2: Horticultural Tree Plants species and ecological parameters

Species Name	Accourance of species	Total no of each species	Frequency	R. Freq	Abundance	R. Abundance	Density	R. density	C. status
Adansonia digitata	15	26	55.6	12	1.73	2.8	1	6.7	VU
Anona squamosal	7	16	25.9	5.7	2.29	3.7	0.6	4.1	VU
Anarcadium occidental	7	12	25.9	5.7	1.71	2.8	0.4	3.1	VU
Balanite aegyptiaca	11	72	40.7	9	6.55	11	2.7	19	S
Borassus aethiopum	1	1	3.7	0.8	1	1.6	0	0.3	EN
Carica papaya	4	35	14.8	3.3	8.75	14	1.3	9	VU
Citrus aurentifolia	3	4	11.1	2.5	1.33	2.2	0.1	1	T
Citrus cinensis	4	8	14.8	3.3	2	3.3	0.3	2.1	T
Diospyrus mespiliformis	1	4	3.7	0.8	4	6.5	0.1	1	T
Mangifera indica	19	72	70.4	16	3.79	6.2	2.7	19	S
Moringa oliefera	5	43	18.5	4.1	8.6	14	1.6	11	S
Psidium guajava	10	21	37	8.2	2.1	3.4	0.8	5.4	VU
Syzygium guineense	2	15	7.41	1.6	7.5	12	0.6	3.9	VU
Tamarindus indica	16	26	59.3	13	1.63	2.7	1	6.7	VU
Terminalia mentali perrier	4	12	14.8	3.3	3	4.9	0.4	3.1	VU
Vitex doniana	1	2	3.7	0.8	2	3.3	0.1	0.5	EN
Zizipus moritiana	4	8	14.8	3.3	2	3.3	0.3	2.1	T
Zizipus spinachristi	8	10	29.6	6.6	1.25	2	0.4	2.6	T
TOTAL	122	387	452	100	61.2	100	14	100	

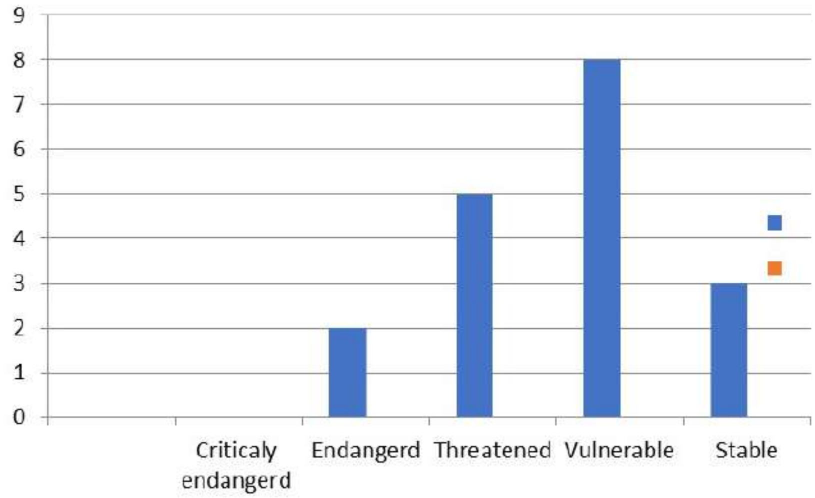

Figure 1: Bar chart showing the conservation status of the species

USE OF ELECTRONIC RESOURCES BY SCIENTISTS IN SELECTED AGRICULTURAL RESEARCH INSTITUTES, IBADAN, OYO STATE

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ABSTRACT
Electronic resources (e-resources) are materials in digital format and they are also known as online information resources. The study was conducted to examine the use of electronic resources (e-resources) for research purposes by scientists working in three distinct research institutes located in Ibadan, Oyo state, Nigeria: Cocoa Research Institute (CRIN), Forest Research Institute (FRIN), and National Horticultural Research Institute (NIHORT). More specifically, it examined number of published research articles, access to e-resources, use and contribution of e-resources to their research work. A total of 100 questionnaires were administered to elicit information from scientists, only 81 were filled returned and analyzed. The respondents were male (53) and female (28) The result reveals that in terms of scholarly output, a significant portion of scientists (58.7%) have published between 1 to 3 journal articles. Conversely, a mere 1.6% of scientists have achieved an impressive tally of over 16 journal publications. Similarly, the number of conference proceedings publications shows a similar trend, with 51.7% of scientists having 1 to 3 publications and only 5.2% with more than 16 conference proceedings publications. Notably, e-resource utilization was prevalent among the scientists, with 48.6% of respondents reporting daily use while 5.4% of scientists do not use e-resources, highlighting the widespread integration of digital resources into their research practices. Furthermore, scientists perceived e-resources as a valuable asset in their research activities. A significant 53.8% of respondents rated the contribution of e-resources to their research as "good," while 30.8% view it as "satisfactory." This underscores the integral role that e-resources play in enhancing the quality and efficiency of research conducted in these research institutes. The findings highlight the importance of digital resources in modern research and outline the need for continued investment in digital infrastructure and skill development among researchers to further harness the benefits of e-resources in scientific exploration.
Keywords: *Research Institutes, online information resources, scholarly output, utilization*

INTRODUCTION

In current information technology, electronic resources are essential research aids that complete print-based resources in any typical library. In terms of significance and usefulness, e-resources have surpassed print resources. The environment, resources, and services they offer users are always changing. In the current digital era, e-resources make up the majority of a library's collection. As a result, the objective of any collection of electronic resources is to offer users a focused, thorough, and rapid information dissemination service.

Literature Review

Numerous researches have been done to determine how users of agricultural scientist use online resources. The Essential Electronic Agricultural Library (TEEAL), Agricultural Online Literature (AGRICOLA), CAB Abstracts, International Information Systems for Agricultural Sciences and Technology (AGRIS), Current Agricultural Research Information System (CARIS), and Abstract on Tropical Agriculture (TROPAG) are a few noteworthy bibliographic databases relevant to African agricultural and food issues as reported by Azubike (1995) and Oduwole and Sowole (2006). According to a study by Bakkiaraj, Sathiyamurthy, and Esmail (2012), e-journals are the most widely utilized e-resources out of all the e-resources. They also discovered that the biggest obstacle to adopting the online services was a lack of IT expertise. Similar to this, Mtega, Wulystan, Dulle, Frankwell, Malekani, Andrew, and Chailla (2015) identified the e-resource sources used by the researchers and personnel in five out of Tanzania's seven agricultural zones. They also evaluated their degrees of information literacy and the variables impacting how they used online resources, and the results revealed that consumption of online resources from well-known agricultural databases remained low. The authors advocated for the development of electronic institutional repositories to increase access to research results by extension personnel, as well as improvements to ICT funding and infrastructure. This would establish a long-lasting connection between agricultural research and farming activities.

Objective of the study are to:

1. Examine the level of use of E – resource by scientists in three research institute
2. Find out the level of access to E-resources by scientists
3. To determine the contribution of E- resources to research work of scientist
4. Find out number of publications of scientists in Journals and proceedings
5. Find out areas of research interest of scientists.

METHODOLOGY

This study investigates the utilization of electronic resources (e-resources) for research purposes by scientists working in three distinct research institutes located in Ibadan, Nigeria: Cocoa Research Institute, Forest Research Institute, and National Horticultural Research Institute. A total of 100 questionnaires were administered to elicit information from scientists, only 81 were filled returned and analyzed. Descriptive statistics was used to analyze the data.

RESULT AND DISCUSSION

Area of research interests of scientists in CRIN, NIHORT, and FRIN (Fig.1), shows that 14.3% of the respondents had an interest in economics, 15.9% had an interest in crop physiology, 14.3% had an interest in soil fertility, 6.3% had an interest in technology, 1.6% had an interest in mushroom, 3.2% had interest in agrometeorology, 3.2% had interest in genetics, 6.3% had interest in food chemistry, 7.9% had in pathology, 3.2% had interest in extension, 4.8% had interest in agronomy, 1.6% had interest in breeding and biotechnology 6.3% had interest in environmental production management and 11.1% in agroforestry. Most of the scientists have their research interest in crop physiology, while there was a limited number of scientists who had research interest in the area of mushroom and breeding & biotechnology.

Majority of the scientists (58.7%) had just 1-3 journal publications, while there was a limited number of scientists (1.6%) who had above 16 journal publications (Figure 2). Few scientists (5.2%) had above 16 publications in conference proceedings which is the highest number of publications and the majority of the scientists (51.7%) had just 1-3 publications in conference proceedings (Figure 4). Figure 4, shows the graphical representation of the use of e-resources by scientists in CRIN, NIHORT, and FRIN. Most of the scientists (48.6%) make use of e-resources daily while a small number of scientists (5.4%) do not make use of e-resources . This shows a significant level of the use of e-resources by scientists in research institutes. The result in figure 5 indicates that 70.9% have access to E-resources in their institute while 29.1% do not have access to E-resources in their institute.

Electronic resources are helpful research tools that supplement traditional print library resources in addition to the benefits mentioned above (Mishra and Panda, 2022). The result in Figure 6 shows that there is a high level of contribution of e-resources on the research work of scientists as 53.8% of the respondents rated its contribution to their research work as good and 30.8% of the respondents rated its contribution to their research work as excellent.

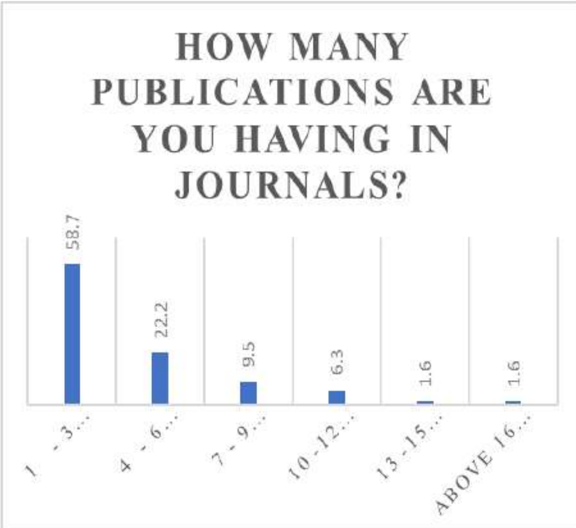

Figure 2: Publications of scientists in Journals

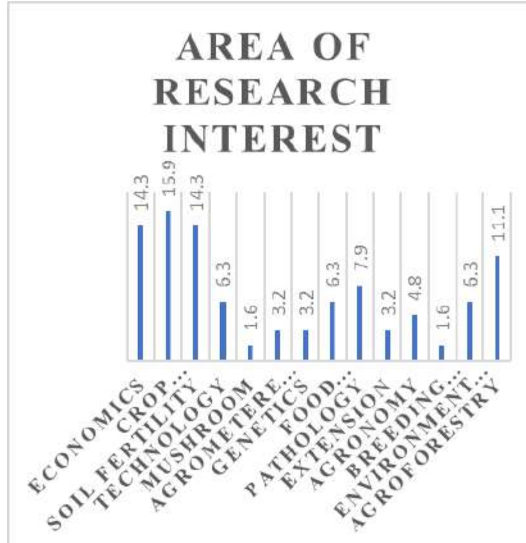

Figure 1: Area of Research interest of scientists

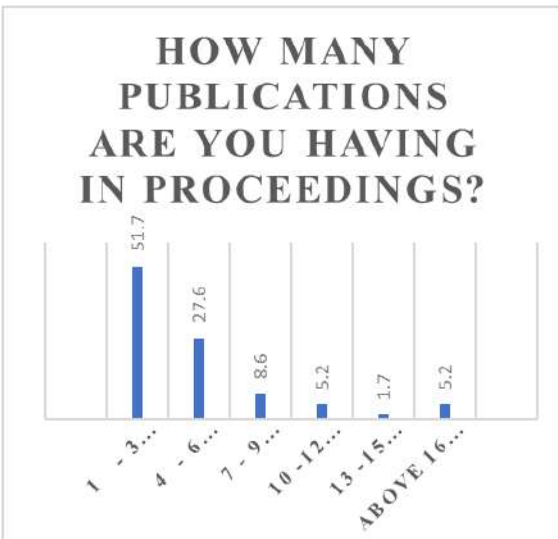

Figure 3: Publications of scientists

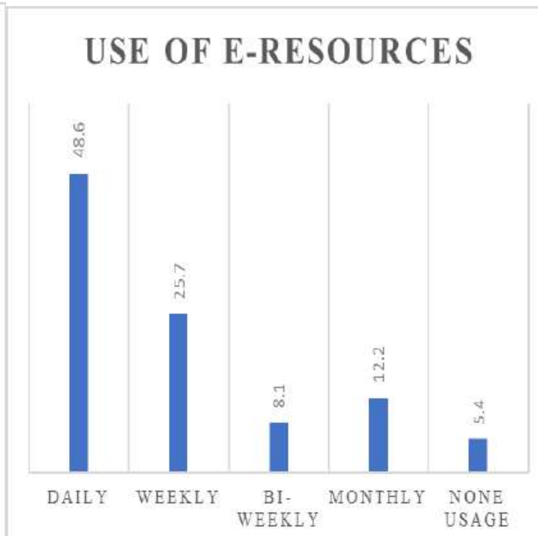

Figure 4: Use of e-resources in proceedings

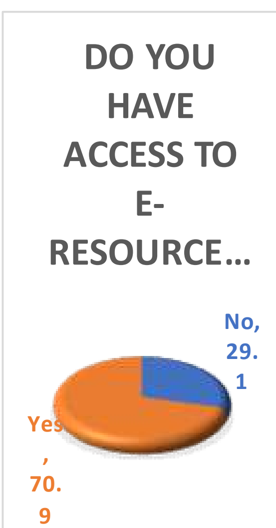

Figure 5: Access to E-resources

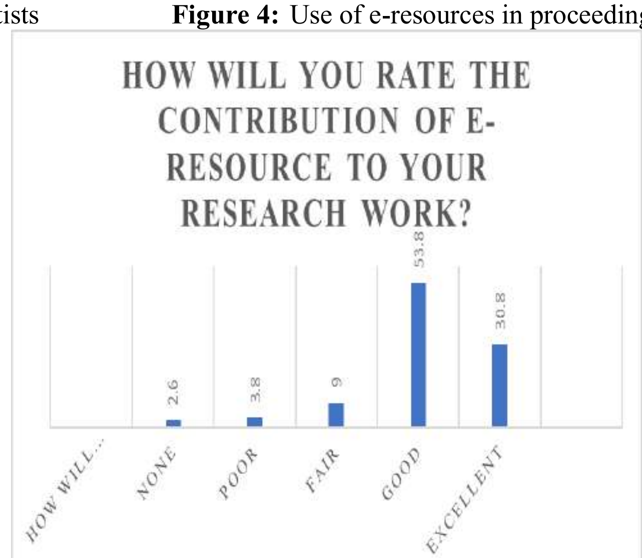

Figure 6: Contribution of e-resources to scientists' research work

CONCLUSION

The study revealed that use of E- resources has positive impact on the research work of scientists. Electronic information resources should therefore be easily accessible and reachable to agricultural scientists in research institutes. Access to quality information would improve the quality and effectiveness of the scientists' research activities. Hence, there should be provision of good institutional Information and Communication technology (ICT) infrastructure that support use of E- resources.

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SCREENING OF HORTITOM TOMATO VARIETIES AGAINST TOMATO FRUIT BORER *Helicoverpa Armigera* Hubner (Lepidoptera: Noctuidae)

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ABSTRACT
Five tomato varieties were evaluated to ascertain their level of resistance against tomato fruit borer Helicoverpa armigera Hubner (Lepidoptera: Noctuidae) under field conditions. The abundance of fruit borer larvae and their infestation, morphological characters and yield was determined. The tomato varieties vary in their leaf thickness, trichome density and rind thickness. Helicoverpa armigera larval population and fruit infestation among the varieties varied significantly. HORTITOM 1 variety was the least infested by fruit borer (5.4). Larval population ranged between 0.3 to 1.7 per plant). HORTITOM 1 was rated as moderately resistant while HORTITOM 2, HORTITOM 3 and Ibadan local was rated moderately susceptible (12, 15.6 and 16.2), Kerewa (22.2) was the most infested and ranked susceptible. Leaf thickness, trichomes density and rind thickness were the morphological traits accessed that confer different level of resistance. The study indicated that the varieties differed in their levels of resistance and this promising source of resistance may be incorporated in the integrated management of tomato fruit borer.
Keywords: *Helicoverpa armigera, Tomato, trichome, HORTITOM*

INTRODUCTION

Tomato *Lycopersicon esculentum* Mill is a major fruit vegetable in Nigeria. One of the major constraints of tomato production in Nigeria is insect pest infestation. The crop is devastated by the fruit borer *Helicoverpa armigera* Hubner (Lepidoptera: Noctuidae) which is noted as polyphagous pest and caused damage to over 181 cultivated and uncultivated plant species distributed in 45 families (Matthews, 1999). The *H. armigera* larvae damage tomato plants by feeding on buds, flowers and fruits. The newly hatched larvae bore into the fruit and feed inside. As a result, the fruits become unfit for human consumption. They are responsible for lowering the yield of tomato (Bhatt and Patel, 2001; Mehrvar, 2009). Proper variety selection and protection of tomato fruits from the attack of fruit borer is an important prerequisite for higher yield and quality of the crop. Management of fruit borer through insecticides is hazardous to human being and insecticides reduce insect predator and pollinator species in the field (Moser and Obrycki, 2009).

Plant morphological characteristics such as trichomes and thickness of the cuticle affect *H. armigera* larval movement and feeding rate (Shelomi *et al*., 2010; Amin *et al*., 2015). The biochemical contents and nutrients in the host plant affect survival, growth and reproduction of phytophagous insects (Browne and Raubenheimer, 2003). Thus the morphological traits and biochemical contents of the plants have important roles in varietal resistance. Cultivation of resistant variety is economical and safer, and it is the most important tool in integrated pest management (IPM). Reduction in insect pest infestation to an acceptable level with the use of resistant variety alone or in combination with other control measures has been reported (Ofuya *et al*., 2023). However, there has been lack of information regarding resistance in commercially available tomato varieties. The present study was undertaken with three varieties of tomato which were developed by National Horticultural Research Institute (NIHORT) to find out their level of resistance against *H. armigera* in the field conditions. The plant morphological characteristics associated with resistance, nitrogen content in the plant, and performances of yield and seed germination of the varieties were also assessed.

MATERIALS AND METHODS

The study was carried out in the experimental field of National Horticultural Research Institute, Ibadan from August 2021 to November 2022. The seeds of HORTITOM 1, HORTITOM 2 and HORTITOM 3 tomato varieties were collected from NIHORT gene bank, commonly grown Kerewa and Ibadan local varieties were used as check in the experiment.

Cultivation of tomato seeds

Seeds of the tomato varieties were sown separately in a nursery tray filled with cocopeat mixed with poultry manure. Seeds were sown on 31st August and the seed rate was 300 g ha^{-1}. Prior to sowing seeds were treated with Thiram to avoid damage from damping off disease. Seeds were sown at a depth of 2-3 cm and covered with a fine layer of cocopeat followed by light watering. The trays were arranged inside a screenhouse and covered with black nylon to maintain temperature and moisture. The nylon was removed immediately after germination had complete. During the last week in nursery, the seedlings were hardened by slightly exposing them to sunlight. The seedlings were cultivated in a randomized completely randomized design with a plot size of 3.0 × 2.0 m. Each variety was cultivated in three plots and there were 15 plots in this experiment. The spacing among the plots was 1.0 m. Seedlings were transplanted in rows three weeks after sowing. Each plot contained three rows and each row had 5 seedlings. The distance between two seedlings was 60 cm. The plants were supported by bamboo sticks to prevent lodging of tomato plant. A blanket application of N-P-K 15:10:10 fertilizer was applied two weeks after transplanting and no plant protection measure was applied in the field.

Screening against fruit borer

The entire experimental field was monitored every week to observe the abundance of fruit borer larvae and fruit infestation. To take count of fruit borer larvae, six plant from the middle of each plot was tagged for data collection at 20, 40 and 60 days after transplanting. The total number of healthy fruits and infested fruits of each variety were recorded at each harvesting stage. Fruits were categorized as healthy and infested based on the absence or presence of pod borer infestation. The damaged and undamaged fruits were harvested six times and percentage of fruit infestation was calculated on number basis. A rating system for fruit damage developed by Kashyap and Verma (1986) was adopted for estimating relative resistance/susceptibility.

Identification of plant morphological characters

Leaf thickness and trichomes population were observed on the terminal leaflet of the fifth leaf in four (4) plants per variety. From each leaflet 1 cm^2 section was taken from 1.5 cm above the base and 0.5 cm from each side of the main vein. Rind thickness was measured on the physiological mature fruits. Three fruits were randomly selected for each variety and from each fruit 1 cm^2 section, located at 0.5 cm from the calyx was taken. Leaf thickness and rind thickness were measured with an ocular micrometer (Carl Zeiss, Germany) at 10X amplification under a microscope (Carl Zeiss, Germany). Number of leaf trichomes was counted under the microscope. At each harvesting stage, data on fruit length, diameter and weight were taken from the healthy and infested fruits. Fruit length and diameter was measured with slide calliper and weight was taken with a digital balance (AG204, Mettler Toledo, Switzerland). The fruit yield recorded in each harvesting stage of a variety was pooled for the entire season and calculated in tons per hectare.

Data collection: The entomological data collection started at flowering stage and was monitored till fruiting. The five accessions were screened for their level of resistance and susceptibility to *H. armigera* infestation. The field was monitored for leaf and fruit damage at 6.00 am Nigeria time. Every larva captured was preserved in a well labelled insect vial containing 75% ethanol for proper identification in the laboratory. The damage rating was done according to the modified scale of Bitew MK 2018. Other insects encountered on the field was also recorded.

Statistical analysis

Data were analyzed by one-way analysis of variance (ANOVA) and the mean values were separated by Duncan multiple range test (DMRT). All the analyses were performed using SAS 2.0.

RESULTS AND DISCUSSION

The present study shows the responses of the screened tomato varieties to fruit borer infestation, there were significant differences in the number of fruit borer present on the tomato plant at different growing stages. HORTITOM 1 recorded the least *H. armigera* larvae (0.3±0.3a) as against other accessions. HORTITOM 2, HORTITOM 3 and Ibadan local were not significantly different in the population of larvae found feeding on the plant (1.3±0.3b, 1.2±0.1b and 1.3±0.3b). Karewa, one of the locally cultivated varieties was found to be significantly susceptible compared to other screened varieties (Table 1). Examining the percentage infestation of the varieties by fruit borer, HORTITOM 1 was less infested with about 5.4% infestation level which ranked it as moderately resistance. Same trend was observed on the population of larvae found boring the leaves and fruit (Table 1).. The screening grouped the varieties into three categories with Kerewa been the most susceptible (22.2%). Table 2 shows some distinct features that confers resistance on the tomato plant. Leaf thickness, trichome density and rind thickness of fruits. HORTITOM varieties were seen to have distinct morphological features, HORTITOM 1 tomato produced significant thicker leaves and significant number of primary trichomes respectively (1.18±0.04 and 5.7±0.3). In the present study, the screened tomato varieties differed in their leaf thickness, trichome density and rind thickness. Among the screened varieties, Kerewa, Ibadan local and HORTITOM 3 possessed lowest trichome density and rind thickness and comparatively lower leaf thickness and the varieties were classified as susceptible, moderately susceptible and moderately susceptible respectively. Tomato plants possess glandular and non-glandular trichomes which are considered as the most important pest resistance factor (Gurr and McGrath, 2001; McDowell et al., 2011; Zhang et al., 2020). There are reports that the presence, density and distribution of the trichome depend on the tomato genotype, organs/tissue, age and environmental conditions (Wilkens *et al*., 1996; Gurr and McGrath, 2001;). Rafiq *et al*. (2008) reported that plant characteristics are known to render the cultivars less suitable or unsuitable for the feeding, oviposition and development of insect pests. There were no differences in the thickness of leaves produced by Ibadan local (1.0±0.01) and Kerewa (1.0±0.03) which may make it attractive to the fruit borers. Trichome produced were significantly different from each other, this trichomes makes both leaves and fruits un- attractive to borers. All the *HORTITOM* varieties produced significant density of trichomes as compared with the local checks. The fruit rind thickness was also considered as a factor in the resistance study. Fruits produced by *HORTITOM 1*variety was seen to have thicker rind 0.73 mm and was significantly different from fruits of other varieties, where Ibadan local produced the least rind measurement 0.35mm.

In the present study, the tested varieties differed in their level of fruit infestation by fruit borer. That is why the varieties are classified as moderately resistant, moderately susceptible and susceptible. Significant healthy fruits were produced across all the tomato varieties in spite of *H. armigera* infestation. HORTITOM 1 produced more marketable fruits (34.4±3.4) with few infested fruits (2.9±0.7) and a 3.9 % yield loss. Marketable fruits from HORTITOM 2 and 3 were significantly different from each other with Kerewa producing the least marketable fruit (14.1±1.1) and unmarketable fruit (0.6±0.1) with a higher yield loss of 11.9 %. The total fruit yield was also significant across all varieties with HORTITOM 1 having the highest total yield (37.4±3.7) and Kerewa producing the least total yield (14.8±1.1). In the present study, the screened tomato varieties differed in their leaf thickness, trichome density and rind thickness. Among the screened varieties, Kerewa, Ibadan local and HORTITOM 3 possessed lowest trichome density and rind thickness and comparatively lower leaf thickness and the varieties were classified as susceptible, moderately susceptible and moderately susceptible respectively. Tomato plants possess glandular and non-glandular trichomes which are considered as the most important pest resistance factor (Gurr and McGrath, 2001;).

General Characteristics

HORTITOM 1: Pure line, indeterminate, rounded predominant fruit, red mature fruits, adapted to Sudan and Guinea Savannah agro-ecological zones, 75-82 days to maturity and good shelf-life.

HORTITOM 2: Pure line, intermediate, slightly flattened predominant fruit, orange mature fruit, adapted to Rainforest, Guinea and Sudan savannah, agro-ecological zones 80-87 days to maturity and medium shelf-life.

HORTITOM 3: Pure line, intermediate, high rounded predominant fruit, pink mature fruit, adapted to Rainforest agro-ecological zone, 79-85 days to maturity and good shelf-life.

HORTITOM 1

HORTITOM 2

HORTITOM 3

KEREWA

IBADAN LOCAL

Table 1: Responses of different tomato accessions to fruit borer larval population abundance and fruit infestation

Tomato varieties	Number of larvae/ plant	% Fruit infestation	Resistant category
HORTITOM 1	0.3±0.3a	5.4±1.5a	Moderately Resistant
HORTITOM 2	1.3±0.3b	12±0.6b	Moderately Susceptible
HORTITOM 3	1.2±0.1b	15.6±2.3c	Moderately Susceptible
Ibadan local	1.3±0.3b	16.2±0.6c	Moderately Susceptible
Kerewa	1.7±0.3c	22.2±2.9d	Susceptible

Sus: Susceptible. Data expressed as mean ±SE. Means within a column followed by same letter(s) are not significantly different by DMRT ($p \leq 0.05$).

Table 2: Variations in leaf thickness (mm), trichomes (number per cm2), rind thickness (mm) among the tomato varieties

Varieties	Leaf thickness (mm)	Trichomes (cm2)	Rind thickness (mm)
HORTITOM 1	1.18±0.04 a	5.7±0.3 a	0.73±0.02 a
HORTITOM 2	0.74±0.02 d	4.0±0.0 b	0.48±0.04 c
HORTITOM 3	0.86±0.02 c	3.3±0.3 c	0.55±0.03 b
IBADAN LOCAL	1.0±0.01 b	2.7±0.3 d	0.35±0.03 d
KEREWA	1.0±0.03 b	2.7±0.3 d	0.55±0.05 b

Data expressed as mean ±SE. Means within a column followed by same letter(s) are not significantly different by DMRT ($p \leq 0.05$).

Table 3: Effect of fruit borer infestation on the yield of different tomato varieties

Tomato varieties	Tomato fruit yield/ three plant			
	Marketable fruits	Infested yield	Total yield	Yield loss (%)
HORTITOM 1	34.4±3.4 a	2.9±0.7 b	37.4±3.7 a	3.9
HORTITOM 2	32.8±3.6 b	1.6±0.1 d	34.2±3.4 b	4.8
HORTITOM 3	27.6±2.6 c	4.2±0.2 a	31.8±2.7 c	9.2
Ibadan local	18.5±4.1d	2.4±0.4 c	20.9±4.3 d	10.8
Kerewa	14.1±1.1e	0.6±0.1 e	14.8±1.1 e	11.9

Data expressed as mean ±SE. Means within a column followed by same letter(s) are not significantly different by DMRT ($p \leq 0.05$).

CONCLUSION

It can be concluded that out of the tested varieties HORTITOM 1 tomato varieties was found to be moderately resistant while HORTITOM 2, HORTITOM 3 and Ibadan local were found to be moderately susceptible and Karewa was susceptible to *H. armigera* . Further work is needed to characterize the mechanisms of resistance in tomato varieties and also to determine the relationship between volatile organic compounds and the preference for each varieties.

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EFFECTS OF ORGANIC MANURE SOURCES ON THE PERFORMANCE OF OKRA (*Abelmuschus esculentus L.*) IN NORTHERN GUINEA SAVANNA OF NIGERIA

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ABSTRACT
Field trial was conducted at Federal College of Horticulture Dadin kowa Gombe State during 2022 wet season to determine the effect of manure source on growth and yield of two varieties of okra. The experiment consisted of two factors: variety (Kwadon and Chalawa) and the organic manure (Poultry, Sheep and Goat, Cow dung and the Control). The two factors and their levels gave 8 treatment combinations which were combined factorially and laid out in a randomized complete block design (RCBD) and were replicated three times. Data was collected on both growth and yield characters and were subjected to analysis of variance (ANOVA) using Genstat statistical package. The results indicated that different manure sources significantly (P<0.05) affected both growth and yield characters of okra. Based on these findings, application of poultry manure significantly increased both growth and yield characters of okra. Therefore, poultry manure should be adopted as source of organic manure in the production of okra.
Keywords: *Cow dung, Manure, Okra, Poultry, and Variety.*

INTRODUCTION

Okra (*Abelmoschus esculentus* L. Moench.) belongs to the family *Malvaceae* (Kumar *et al.*, 2010; Sorapong, 2012)). The crop was originated from Ethiopia in the 12th Century BC but is widely grown all over the world (Akande *et al.* 2010; Akanbi *et al.*, 2010). It is one of the most prominent and lucrative vegetables that can be used in fresh and canned forms (PROTA, 2010; Awe *et al.* 2011). Although an important vegetable crop, yields are usually lower in developing countries compared to developed countries (Olabode *et al.,* 2010; Sorapong, 2012). Okra contains proteins, carbohydrates, vitamin C and plays a vital role in human diet (Sorapong, 2012). Besides, the fruit contains a vegetable mucin that soothes the irritation of membranes of the intestinal tract. Okra has an alkaline reaction; it is good for elderly people because of high sodium content which is known to control certain diseases in the body such as ulcer, asthma, diabetes, and hypertension (Dilruba *et al.*, 2009; Sorapong, 2012).

Besides other factors such as rainfall, temperature, relative humidity, solar radiation, pests and diseases for lower yields and lack of proper fertilizer source are also responsible in reducing yields and quality of okra and other field crops (Kumar *et al.*, 2009; Ufere *et al.*, 2013). In addition, the use of inorganic manures in okra fields have been observed to cause the destruction of soil structure as well as widespread problems of soil acidification (Adilakshmi *et al.*, 2008 and Sorapong, 2012). Therefore, the study was conducted to determine the effects of organic manure source on growth and yield characters of okra in the study area.

MATERIALS AND METHODS

Site Characteristics

The experiment was conducted at Teaching and Research Farm of Federal College of Horticulture Dadinkowa, Gombe State. The area lies approximately 260 m above sea level is located between latitude 10°15' North and longitude 11°15' East. The climate of the area is semi-arid zone, which is characterized by a wet and dry season. October to March is the major dry season. The mean annual rainfall is 1,500mm and the mean temperature is 35°C. (URBDA,2015)

Treatments and Experimental Design

The experiment consisted of two factors: variety (Kwadon and Chalawa) and the organic manure (Poultry, Sheep and Goat, Cow dung and Control). The two factors and their levels gave 8 treatment combinations which were laid out in a randomized complete block design (RCBD) and was replicated three times. The land was first cleared and harrowed twice to obtain a fine tilth.Beds were marked out using a measuring tape, rope and pegs. Each plot measured 3 x 2m (6m^2) in size with 0.5m between the plots and 1m between replicates. Eight plots were obtained in a replicate, given a total of 24 plots. Before sowing the crop, soil samples were taken in a "Z" shape within the experimental area following the procedure of IFDC (2003) at a depth of 0-30cm using a tubular auger. The plants were sown at the rate of three to four seeds per holes at a spacing of 25x60cm Weeds were controlled at regular intervals after planting and insecticide was also applied to control insect pest. Data was collected on both growth and yield parameters. All the data collected were subjected to analysis of variance (ANOVA) using Genstat statistical package and least significant difference (LSD) was used where there was significant difference to separate the means.

RESULTS AND DISCUSSION

The results on Table 1 indicated that there was no significant difference between the varieties of okra regarding the data observed on plant height this might be related to the similarities existed between the two varieties used as reported by Usman *et a.l* (2020). On the other hand, the result is contrary to the findings of Tswanya *et al.,* (2017). Among the organic manure source used for the study there was significant difference where plant grown under poultry manure produced the tallest plant followed by Cow dung, Sheep and Goat and shortest plants were observed under Control. The results is accordance with the findings of many researcher such as Hussaini *et al.* (2010), Hamma and Ibrahim (2012), Adams *et al.* (2004), Enujeke and Egbuchua (2013), Tiamiyu *et al. (*2012) and Olaniyi *et al.* (2008) Olaniyi *et al.* (2008) who all reported that poultry manure seem to promote both growth and yield of okra.

The results on number of leaves of okra on two varieties of okra had indicated that there was no significant difference between the two varieties. The result is contrary to the findings of Tswanya *et al. (*2017) as earlier reported. The different sources of manure had indicated a significant respond where poultry manure produced the highest number of leaves followed by cow dung manure, sheep and goat while the fewer number of leaves was recorded under control plots. The result is accordance with the findings of Hussein *et al*., (2010). The stem girth of two varieties of okra had also indicated that there was no significant different between the two varieties. The result is contrary to the findings of Gudugi (2013) who assessed the effect of cow dung and variety on the growth of okra (*Abelmoschus esculentus* (L. Moench). Whereas the manure source indicated a significant respond among different sources used. Poultry manure produced the thickest plants followed by those fertilised with cow dung and the thinner plants where observed on plots that received no fertilizer (control). The results is in line with the findings of Viharmaa and Thayamini (2012) and Hamma and Ibrahim (2012) and Enujeke and Egbuchua (2013).

The result on number of pods of okra had indicated that there was no significant difference between the two varieties. Manure sources had indicated a significant different where poultry manure produced the highest number pods followed by cow dung manure, sheep and goat manure and the lease number was observed on plots that received no fertilizer (control). The results is accordance with the findings of Premshaker and Rajashree (2009) and that of Pandita *et al.* (2010) and Achieng *et al. (*2010).

The result on pods weight of two varieties of okra had indicated there was no significant difference between the two varieties. On the other hand, the manure sources had indicated a significant different. Poultry manure produced the heaviest pods followed by cow dung manure, sheep and goat manure and the lease was observed on control plots (0kg/ha). The results corroborate with the findings of Premshaker and Rajashree (2009), Islam *et al.* (2011) and Tiamiyu *et al.* (2012).

CONCLUSION

Based on the findings of the research, it could be concluded that, application of poultry manure significantly increased the growth and yield performance of okra compared to other nutrients source. Therefore, farmers in the study area should adopt poultry manure as source of organic manure in the production of okra.

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Table 1: Influence of Organic Manure Sources on Growth and Yield Characters of Okra (*Abelmoschus esculentus* (L.) Moench) in Dadin Kowa Gombe, Gombe State.

Treatments	Plant Height	Number of Leaves	Stem Girth	Number of Pods	Pod Weight
VARIETY					
Kwadon	23.4	13.37	3.06	612.0	1477.0
Chalawa	18.5	12.00	2.66	576.0	1037.0
LS	NS	NS	NS	NS	NS
LSD	6.17	3.351	0.578	220.0	602.3
MANURE					
Poultry	25.9	16.37	3.93	920.0	2317.0
Sheep and Goat	20.9	11.77	2.94	644.0	1113.0
Cow dung	23.8	13.40	3.29	651.0	1162
Control	13.3	9.20	1.27	163.0	435
LS	*	*	**	**	**
LSD	8.72	4.740	0.817	311.20	851.7
Interactions					
VxM	NS	NS	NS	NS	NS

Key LS=Level of Significance LSD=Least Significant Difference V=Variety M=Manure

EFFECT OF CASH SCARCITY ON TOMATO MARKETING IN IBADAN METROPOLIS

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ABSTRACT
This research examined how Nigeria's cash scarcity in 2023 affected tomato marketers in Ibadan metropolis. 36 people involved in the tomato value chain, including marketers, transporters, consumers, and input suppliers were surveyed. The marketers were specifically targeted and used for this study. The results showed that the cash crisis drove up tomato prices by an average of 31%, as reported by marketers. This price inflation was likely caused by consumers having less cash to spend, while sellers tried to protect their profits during the liquidity squeeze. Digital payments through bank apps, USSD codes, and POS machines became more common ways to pay when cash was scarce, while using cash-based ATMs and bank lobbies declined. It was recommended that ensuring that there is an adequate supply of new banknotes before withdrawing the old ones to avoid future cash shortages and associated economic disruptions.
Keywords: *cash-scarcity, tomato marketers, price inflation, currency designs, Ibadan Metropolis*

INTRODUCTION

In recent times, Nigeria has faced economic disruption due to cash shortages. As reported, the cash crunch started in late 2022 and has continued into 2023 (Emele Onu and Tolani Awere, 2023). This shortage was triggered largely by the naira redesign policy unveiled in October 2022 by the nation's Central Bank (Anthony Osae-Brown and Emele Onu 2022). The policy aimed to redesign some key banknotes while setting deposit deadlines and caps on withdrawals. However, the rollout faced challenges - inadequate supply of new notes as old ones were collected, contributing to the cash scarcity. Other drivers included hoarding, bank distress and foreign exchange constraints, as seen in prior shortages (Method, 2018). Consequently, limited cash circulation tended to inflate prices of essentials like food, impacting citizens. Overall, Nigeria's 2023 cash crunch caused economic and social hardship, stemming largely from central bank policies and their problematic implementation. Tomato is an essential crop in Nigeria, but with high perishability. Past studies indicate tomato prices are quite sensitive to distribution expenses and consumer liquidity (Katanga, Danwawu, and Musa, 2018). Given the 2023 cash crisis, tomato value chain actors - transporters, marketers, and consumers and input suppliers in major markets such as Ibadan - likely face severe challenges impacting tomato costs.

Prior academic work shows limited cash circulation amid economic turmoil often inflates food prices or even hyperinflation. Method (2018) documented Zimbabwe's 2016 cash shortage due to illiquidity and currency shortfalls dramatically spiked prices of basics like maize, soybeans, cooking oil. Gabriel (2006) also found significant price hikes during Ecuador's cash crisis despite official data showing low inflation. Experts suggest limited consumer purchasing power coupled with retailers protecting profits drive food inflation during cash shortages. This study examines the effect of cash scarcity on tomato marketers with a view to suggesting strategies to cushion the impact of restricted liquidity on tomato markers as key actors in the tomato value chain.

MATERIALS AND METHODS

The study was carried out in Ibadan Metropolis. Ibadan is the capital of Oyo State, the biggest City in Nigeria and sub-Sahara Africa. It has population of 2,550,593 (Nigeria population Census, 2006). The city is located on the Southern Western part of Nigeria, lying between latitude 70 and 90N of the equator, longitude 30E and 50E of Greenwich Meridian. Primary data was obtained using a structured questionnaire. The respondents were selected using a two-stage random sampling. The first stage involved the random selection of two local government areas in Ibadan metropolis, which are Ibadan North-West, and Akinyele LGAs. The second stage involved random selection of 36 respondents from the selected local governments. The Data collected were analyzed using Descriptive statistics.

RESULTS AND DISCUSSION

Table 1: Socioeconomic characteristics of the respondents

Variables	Category	Frequency	Percentage	Mean
Gender	Male	8	22.2	
	Female	28	77.8	
Marital status	Single	6	16.7	
	Married	28	77.8	
	Widowed	2	5.6	
Age (Years)	≤25	6	16.7	
	26-35	11	30.5	
	36-45	5	13.9	42.64
	46-55	5	13.9	
	>55	9	25.0	
Household size	1-5	20	55.6	
	6-10	8	22.2	6.86
	>10	8	22.2	
Educational level	No formal education	14	38.9	
	Primary education	5	13.9	
	Secondary education	11	30.6	
	Tertiary education	2	5.6	
	Others	4	11.1	

Source: Field Survey (2023)

The result revealed that most of the respondents were female (77.8%), this is because, higher number of marketers in Ibadan metropolis are female, married (77.8%) and within the age group of (26-35) years (30.5%). The average age of the respondents was 42.64 years indicating their activeness in trying to cope during the period of cash scarcity, most (55.6%) of the respondents had 1-5 members in the households with an average of 6.86 members and majority had no formal education.

Table 2: Effects of cash scarcity on the tomato price level increment among marketers in the study area

Price increase range	Frequency	Percentage
0.00 – 0.33	20	56.25
0.34 – 0.66	11	31.25
0.67 – 1.00	5	12.50
Total	36	100

Mean = 0.31
Source: Field Survey (2023)

The result revealed that majority of the marketers (56.25%) experience between 1 to 33% increases in price level of the tomato while the mean increment in tomato price is about 31% which is higher than the 23.75% food inflation rate that was reported by the National Bureau of Statistics in their consumer price Index report for December 2022 (NBS, 2023). This showed that period of cash scarcity rises the price of tomato, and this reduced the purchasing power of the consumer as their income is constant. According to conventional demand theory, increase in price of the tomato will reduce the demand for the tomato, causing the tomato demand to fall below supply and this will lead to increase in postharvest loss and level of food insecurity will increase. This in agreement with the study of Nigatu et al (2020) which find out that increase in price of agricultural commodity reduce the demand for it, tending it to have postharvest loss.

Table 3: Methods of transaction by the marketers during Cash scarcity

Methods	Frequency	Percentage
Transaction using Cash		
Yes	1	2.8
No	35	97.2
Transfer with conventional bank App		
Yes	14	38.9
No	22	61.1
Transfer with USSD		
Yes	17	47.2
No	19	52.8
Using online banking App (Opay, Kuda, PalmPay etc.)		
Yes	12	33.3
No	24	66.7
Using POS		
Yes	12	33.3
No	24	66.7
Using ATM		
Yes	5	13.9
No	31	86.1
Using Banking Hall		
Yes	2	5.6
No	34	94.4
Using neighbors' bank account		
Yes	11	30.6
No	25	69.4

Source: Field survey (2023)

The various methods adopted during the cash scarcity for transactions were conventional bank application which was used by (38.9%) of the respondents, (47.2%) transacted using the bank USSD code, (33.3%) of the respondents transacted using an online banking App like Opay, Kuda, PalmPay e.t.c. while (33.3%) represent those that transacted with POS, these may be due to their conversant with using the systems prior to the period of cash scarcity, (13.9% and 5.6%) transacted using ATM and Banking hall respectively, this is because, there was a limited supply of cash during the scarcity period from the banks directly to customers and (30.6%) transacted using their neighbors' bank account, this could be emanated from unstable network of banks during the period while people looks for an alternative banks with stable network.

CONCLUSION AND RECOMMENDATION

This study investigated how Nigeria's 2023 cash shortage affected tomato marketers in Ibadan metropolis. The findings revealed that marketers increased tomato prices by an average of 31% because of the cash scarcity. Transactions were also hampered by the lack of currency with actors relying more on digital payments such bank applications, USSD, and POS and less on ATMs and banking halls that only accepted cash. It is recommended that currency redesign be done in such a way that ensures that there is an adequate supply of new banknotes before withdrawing the old ones to avoid future cash shortages and associated economic hardships.

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EFFECTS OF GROWING MEDIA ON SEED GERMINATION AND SEEDLING GROWTH OF *Telfaria occidentalis*

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ABSTRACT
A screen house experiment was conducted at the National Horticultural Research Institute (NIHORT), Ibadan to assess the effects of sowing media on the vegetative growth parameters of Telfaria occidentalis. The experiment was laid out in a completely randomized design (CRD) with nine treatments replicated two times. The treatments were different sowing media T1: coco peat, T2: coco peat and topsoil (1:1), T3: spent mushroom compost, T4: spent mushroom compost and topsoil (1:1), T5: sawdust, T6: sawdust and topsoil (1:1), T7: rice husk, T8: rice husk and topsoil (1:1) and T9: sole topsoil (control). Each treatment had 10 seeds sowed in a nursery tray filled with medium. Data were collected on vine length, number of leaves, stem girth and root length. The result revealed that spent mushroom compost mixed with soil in a ratio of 1:1 competed favourably with coco peat which had the longest Telfaria occidentalis vine length of 100 cm and root length of 26.5 cm and the least was observed in rice husk treatment. Spent mushroom compost could therefore be recommended as effective media for raising Telfaria occidentalis in the nursery.
Keywords: *Growing media**,** Telfaria occidentalis, seedling growth, seed germination*

INTRODUCTION
Seed germination and seedling growth are critical stages in the plant's lifespan because it represents the transition from seed dormancy to a self-sustaining plant that is able to photosynthesize (Liaquat *et al*., 2020). The successful establishment of seedlings greatly depends on various environmental factors and the type of substrate of choice *Telfaria occidentalis*, commonly known as fluted pumpkin or "ugu" in West Africa, is a tropical vine of economic and nutritional significance. It is highly valued for its edible leaves and seeds, making it an essential crop for both subsistence and commercial farming (Eseyin *et al*., 2014). Compared to other tropical vegetables, it is a rich source of protein, iron, vitamins, micronutrients and minerals (Ajibade *et al*., 2006). Pre-germination of *Telfaria occidentalis* seed using different growing media is a major cultural practice in its production for enhanced seed germination, seedling quality and field establishment.
Growth media have been reported to have a significant effect on flowering plants and play a vital role in the rate of germination and many growth-related parameters such as plant height, number of leaves, leaf length, stem girth and yield, etc. (Vendrame *et al*., 2005). Baiyeri, 2006 opined that the quality of seedlings determines seedling establishment in the field and the overall crop productivity. The composition and physical properties of the growing medium influence water retention, nutrient availability, aeration, and root development, all of which have a profound impact on the overall performance of seedlings. The choice of suitable growing media is therefore essential for sustainable production of crops with this requirement.
The study therefore evaluates the influence of different growing media on seed germination and seedling growth of *Telfaria occidentalis* for enhanced field establishment and increased crop yield.

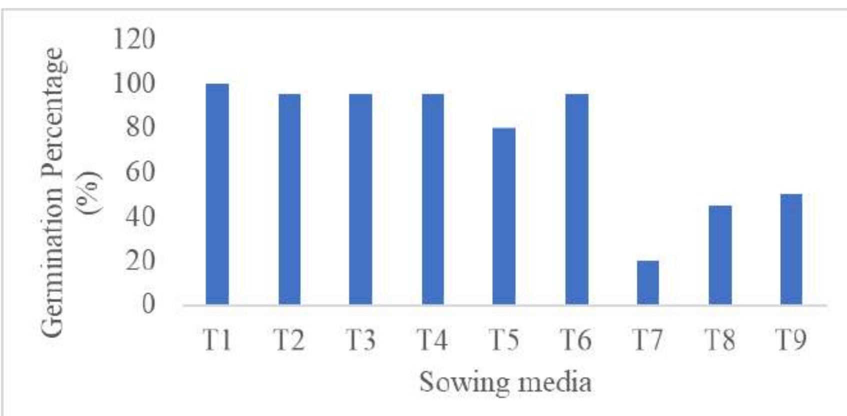
MATERIALS AND METHODS
The experiment was carried out at the experimental screen house of the National Horticultural Research Institute (NIHORT), Ibadan, located on latitudes 7° 40.534 N - 7° 41.069 N and longitudes 3° 84.716 N - 3° 85.294 E. The experimental treatments were arranged in a completely randomized design (CRD); T1: coco peat, T2: coco peat and topsoil (1:1), T3: spent mushroom compost, T4: spent mushroom compost and topsoil (1:1), T5: sawdust, T6: sawdust and topsoil (1:1), T7: rice husk, T8: rice husk and topsoil (1:1) and T9: sole topsoil (control). Ten seeds of *Telfaria occidentalis* were sown in a plastic nursery tray filled with the respective media and replicated two times. Plants were periodically and equally irrigated, but no additional nutrient elements were supplied throughout the nursery time. Data were observed on germination percentage and seedling growth parameters and subjected to analysis of variance (ANOVA) to compare the effects of the sowing media on the successful growth of *Telfaria occidentalis*. The differences between the means were compared, using the Least Significant Difference (LSD) at a 5% probability level.

RESULTS

The highest germination percentage of *Telfaria occidentalis* seeds was observed in coco peat treatment ten days after sowing; however, a similar trend was observed in coco peat and topsoil (1:1), spent mushroom compost, spent mushroom compost and topsoil and sawdust and topsoil. The lowest germination percentage was in the rice husk treatment (Figure 1). The longest *Telfaria occidentalis* vine length at four weeks after sowing was observed in coco peat treatment; however, it was not significantly different from the vine length in spent mushroom compost and top-soil; sawdust and topsoil treatments. The lowest vine length was observed in rice husk and topsoil treatment (Figure 2). A similar trend was observed in root length at the termination of the experiment (Table 1). The highest *Telfaria occidentalis* number of leaves was in rice husk and topsoil treatment and the least was observed in sawdust and topsoil.

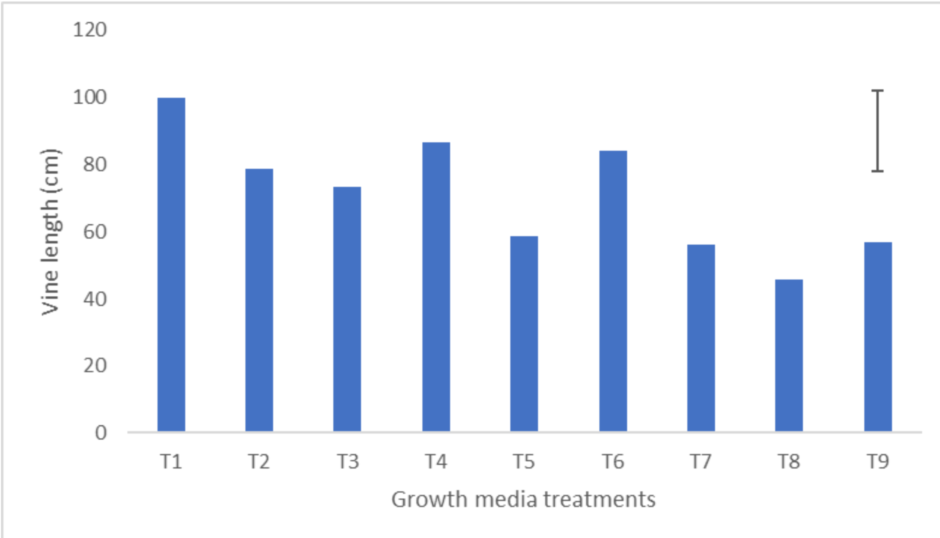
DISCUSSION

The results show that seed germination and seedling growth parameters of *Telfaria occidentalis* were better in a coco peat growing medium. However, spent mushroom compost competed favourably well with it. The comparative performance of spent mushroom compost could be due to its characteristic composition of different types of agricultural waste, residual nutrients and leftover fungal mycelium (Jordan *et al*., 2008). Several studies have confirmed the use of spent mushroom compost as growing media for the seedlings of tomatoes, lettuce and other crops (Marques *et al*., 2014, Lopes *et al*., 2015). This study comforms with the work of Marques *et al*. 2014 on "Review of different types of media and their effects on tomato seedling production". They reported that the most economical treatment for seedling production is the traditional practicing media (soil sand and farmyard manure). In this study, spent mushroom compost could therefore be recommended as the most effective and economical medium for raising *Telfaria occidentalis* in the nursery for good field establishment and high yield.



T1: coco peat, T2: coco peat and topsoil (1:1), T3: spent mushroom compost, T4: spent mushroom compost and topsoil (1:1), T5: sawdust, T6: sawdust and topsoil (1:1), T7: rice husk, T8: rice husk and topsoil (1:1) and T9: sole topsoil (control)

Figure 1: Gemination percentage of *Telfaria occidentalis* seeds as influenced by different sowing media at four weeks after sowing.



T1: coco peat, T2: coco peat and topsoil (1:1), T3: spent mushroom compost, T4: spent mushroom compost and topsoil (1:1), T5: sawdust, T6: sawdust and topsoil (1:1), T7: rice husk, T8: rice husk and topsoil (1:1) and T9: sole topsoil (control)

Figure 2: Vine length of *Telfaria occidentalis* as influenced by different sowing media at four weeks after sowing.

Table 1: Seedling growth parameters and root length of *Telfaria occidentalis* as influenced by different growth media at four weeks after sowing.

	Number of leaves	Stem Girth (mm)	Root length (cm)
Treatments		4 Weeks after sowing	
T1	8	**5.47**	**26.5**
T2	8	**5.52**	25.6
T3	8	**5.47**	22.2
T4	11	4.89	20.6
T5	10	**5.52**	14.2
T6	7	4.81	19.8
T7	12	4.91	14.3
T8	**13**	5.09	13.0
T9	8	5.22	25.8
$LSD_{0.05}$	2	Ns	6.37

T1: coco peat, T2: coco peat and topsoil (1:1), T3: spent mushroom compost, T4: spent mushroom compost and topsoil (1:1), T5: sawdust, T6: sawdust and topsoil (1:1), T7: rice husk, T8: rice husk and topsoil (1:1) and T9: sole topsoil (control)

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MULCH AND ORGANIC FERTILIZER EFFECTS ON SOME SELECTED SOIL PHYSICAL PROPERTIES AND YIELD OF GINGER (ZINGIBER OFFICINALE) IN AN ALFISOL IN IBADAN, SOUTHWEST NIGERIA

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ABSTRACT
Field experiment involving three levels of Chromolaena odorata mulch (CM) (0, 15 and 30 t/ha) and five rates of commercial organic fertilizer (OF) (0, 10, 15, 20 and 25 t ha^{-1}) was carried out at National Horticultural Research Institute, Ibadan. The experiment was a 3 x 5 factorial in a split plot design with three replicates. Ginger rhizomes were planted at a spacing of 20 cm x 25 cm. Bulk density ranged from 1.56 g cm^{-3} (30 t ha^{-1} CM) to 1.79 g cm^{-3} (0 t ha^{-1} CM) and 1.5 g/cm^{3} (25 t ha^{-1} OF) to 1.83 g cm^{-3} (0 t ha^{-1} OF). It also ranged from 1.58±0.01 g cm^{-3} (30 t ha^{-1} CM + 25 t/ha OF) to 1.78±0.01 g/cm^{3} (0 t/ha CM + 0 t/ha OF). Porosity ranged from 32.5% (0 t ha^{-1} CM) to 41.0% (30 t ha^{-1} CM) and 30.8% (0 t ha^{-1} OF) to 43.0% (25 t ha^{-1} OF) in the CM and OF treatments, respectively. The moisture content (MC) ranged from 1.60% (0 t ha^{-1} CM) to 9.30% (30 t ha^{-1} CM) and 1.40% (0 t ha^{-1} OF) to 9.4% (25 t ha^{-1} OF). In the combined treatments, porosity ranged from 33.0±0.4% (0 t ha^{-1} CM+0 t ha^{-1} OF) to 40.1±0.2% (30 t ha^{-1} CM + 25 t ha^{-1} OF). Rhizome yield ranged from 3.6 t ha^{-1} (0 t ha^{-1} CM) to 7.2 t ha^{-1} (30 t ha^{-1} CM) and 4.7 t ha^{-1} (0 t ha^{-1} OF) to 6.9 t ha^{-1} (25 t ha^{-1} OF). The effects of interaction of treatments on MC were not significantly different among the treatments. Rhizome yield was however significantly correlated with BD (r=-0.68), MC (r=0.74) and porosity (r=0.68). Combined applications of mulch at 30 t ha^{-1} and 25 t ha^{-1} of organic fertilizer was recommended for improved yield.
Keywords: *Chromolaena odorata mulch, ginger rhizome, organic fertilizer, soil bulk density, soil amendments*

INTRODUCTION
General low fertility status of soils in the tropics is highly related to the low level of organic matter, rapid depletion of nutrients and poor physical condition of the soil as one of the major constraints to crop production (Agbede and Adekiya, 2009; Okonkwo *et al.*, 2011). Intensively cropped soils are prone to deterioration in soil physical properties with the following resultant effects: increased soil bulk density, reduced porosity, high root penetration resistance, low water holding capacity, low soil water content, reduced soil aggregation, increase in sand and silt fractions over clay fraction, leaching and erosion when compared to the uncultivated state of the soil (Mehdizale *et al.,* 2013). Application of organic fertilizer helps to improve soil structure, water holding capacity, porosity, bulk density, moisture retention and eventual growth and yield of crops (Atakora *et al.,* 2014). The decline of soil organic matter with cropping is a major factor affecting sustainability of many cropping systems in sub-Saharan Africa (Buyanovzky *et al.,* 1984). Studies also indicated that soil physical, biological and chemical properties can sustainably be improved through the improvement of soil organic matter (Usharani *et al*., 2019). This can be done through practices like mulching and addition of manures (Du *et al*., 2022).

Mulching is an effective method of manipulating crop growing environment to increase yield and improve product quality by controlling weed growth, ameliorating soil temperature, conserving soil moisture, reducing soil erosion, improving soil structure and enhancing organic matter content (Iqbal *et al*., 2020). Ginger (*Zingiber officinale* Roscoe) is of the family Zingiberaceae, it is indigenous to the warm tropical climates, particularly South eastern Asia. It is a monocotyledon with a slender perennial herb-like habit, but is usually grown as an annual. It is an erect plant propagated through its rhizomes which are underground. Ginger is an important spice used as a condiment in vegetable preparations. Ginger tea is also used as a carminative and in the symptomatic treatment of colds. The oil and oleoresins obtained from ginger are also used in many food items, soft drinks and beverages (Singh *et al*., 2008). Ginger is basically considered to thrive best on rich medium loams with good supply of humus. High humidity throughout the crop period is necessary. According to Ojeniyi (1995) and Agboola *et al*., (1992), soils in Nigeria suffer deficiencies common to tropical soils. These include low organic matter content, shallow depth and high acidity. About 63% of the agricultural soils in Nigeria are low in productivity and over 90% are Alfisols and Ultisols that are low in organic matter and have low activity clays. There is therefore the need to identify the best rate of organic fertilizer and the level of mulch suitable for ginger production with the ultimate aim of improving its productivity.

MATERIALS AND METHODS

The experiment was conducted at National Horticultural Research Institute, Ibadan (7° 30'N, and 3° 54'E; in an altitude of 234 m above sea level), Oyo State. Ibadan is located in the derived savannah agro-ecological zone. The soil is well drained with fine to coarse texture and brown in colour. It is a sandy loam of basement complex origin in the Ibadan series (Smyth sand Montgomery, 1962) and of the order Alfisol (Askira, 2000). The experimental design used was a split plot design consisting of three levels of mulch as main plots and organic fertilizer treatments as subplots replicated three times. The three different levels of mulch and organic fertilizer were randomized within each replicate main plot. The plot size was 2 m x 2 m. Ginger was planted at a spacing of 20 cm x 25 cm to a depth of 4 - 5 cm. Three levels of mulch employed were 0, 15 and 30 t ha^{-1} and five different rates of organic fertilizer were 0, 10, 15, 20 and 25 t ha^{-1}. The three levels of mulch and five rates of organic fertilizer resulted in 15 treatment combinations. Pre-soil and organic fertilizer analyses were presented in (Table 1 and 2). The annual rainfall was 1680.6 mm. The monthly maximum temperature ranged between 28 – 36 ^{O}C while minimum temperature ranged between 22 – 36 ^{o} ^{O}C

The gravimetric method as reported by Donahue *et al*., (1990) was used for soil moisture content determination. The soil was sampled (using screw auger) in each plot at 4, 8, 12, 16 and 20 weeks after planting at 0 - 15 cm depth of soil and put into container, oven dried at temperature of 105 ºC to a constant weight. Core sampler method as reported by Blake and Hartage (1986) was used for soil bulk density analysis. The soil was sampled using core sampler in each plot at 4, 12, and 20 weeks after planting at 0 - 15 cm depth. Soil samples were oven dried at temperature of 105 ºC to a constant weight. The core size was 7.0 cm in diameter and 6.5 cm in height.

Bulk density was determined using Equation 1

$$\text{Bulk density} = \frac{\text{Soil mass oven dried}}{\text{Soil volume}} \quad (1)$$

Volume of soil sample = Volume of the core (cylinder)

$$= \pi r^2 h$$

Where r = inner radius of the cylinder

h = height of the cylinder

Soil porosity was determined at 4, 12, and 20 weeks after planting using Equation 2

$$TP = \left[1 - \frac{BD}{PD}\right] \times 100 \quad (2)$$

Where TP = Soil total porosity, BD = Soil bulk density, PD = Particle density (2.65 g cm^{-3})

Soil water filled pore space was calculated at 4, 12 and 20 WAP using Equation 3

$$\text{Soil water filled pore space (\%)} = \frac{\text{Volumetric water content}}{\text{Soil porosity}} \times 100 \quad (3)$$

Data were analysed and subjected to analysis of variance using linear model procedure of statistical analysis system (SAS, 2003). Mean were compared using the Duncan's Multiple Range Test (DMRT) at 0.05 level of probability. Correlation analyses were run between the soil physical properties and ginger yield for the cropping period following the procedures of Steel and Torrie (1960).

RESULTS

Soil bulk density was significantly affected by levels of mulch at various weeks after planting. Four weeks after planting, control (0 t ha^{-1}) had the highest mean value of 1.62 g cm^{-3} and 30 t ha^{-1} of mulch gave the least mean value of 1.56 g cm$^{-3.}$ There was significant difference ($P < 0.05$) in levels of mulch at 20 WAP with control also having highest value of 1.79 g cm^{-3} and 30 t ha^{-1} of mulch gave the least value of 1.62 g cm^{-3}. Application of organic fertilizer at different levels had significant effect on soil bulk density at various weeks after planting. Significant difference was observed among organic fertilizer rates with 0 t ha^{-1} having highest mean value of 1.83 g cm^{-3} and 25 t ha^{-1} organic fertilizers had least mean value of 1.61 g cm^{-3} at 20 WAP. The interaction of mulch and organic fertilizer had no significant effect on soil bulk density at 4 WAP and 12 WAP while significant difference was observed in interaction of mulch and organic fertilizer at 20 WAP (Table 1). Table 2 showed the combined effects of levels of mulch and rates of organic fertilizer with plot without mulch and organic fertilizer application having the highest mean bulk density value of 1.78 g cm^{-3} while mulch at 30 t ha^{-1} and organic fertilizer at 25 t ha^{-1} had the least value of 1.58 g cm^{-3}.

Soil porosity was significantly affected by different levels of mulch and organic fertilizer rates. At 4 WAP there was no significant difference between the levels of mulch at 15 t ha^{-1} and at 0 t ha^{-1} on soil porosity. Also, at 12 WAP, there was no significant difference observed between the levels of mulch at 30 t ha^{-1} and at 15 t ha^{-1} on soil porosity. At 20 WAP significant differences were observed among the levels of mulch with 30 t ha^{-1} mulch treatment having the highest value of 38.90 % porosity. There was significant difference ($P < 0.05$) in organic fertilizer rates applied on soil porosity at various weeks after planting with 25 t ha^{-1} organic fertilizer having the highest value of 39.30 % porosity. Moreover, mulch and organic fertilizer interaction had no significant effect on the percentage soil porosity at 4 WAP and 12 WAP, but significant interaction was observed at 20 WAP (Table 3). Mulch applied at 30 t ha^{-1} and organic fertilizer at 25 t ha^{-1} had the highest porosity value of 40.11 % while plot without mulch and organic fertilizer application had the least mean value of 33.04 % (Table 4).

Soil moisture content was significantly affected by levels of mulch and organic fertilizer treatments with 30 t ha^{-1} of mulch treatment and 25 t ha^{-1} of organic fertilizer having the highest mean values of 13.49 % and 13.48 % respectively at 12 WAP while 0 t ha^{-1} mulch and organic fertilizer gave the least mean value of 12.19 % and 12.20 % respectively at 12 WAP. At 20 WAP 30 t ha^{-1} of mulch and 25 t ha^{-1} of organic fertilizer had the highest value of 2.26 % and of 2.46 % respectively. A gradual decrease in soil moisture was observed from 12 WAP to 20 WAP. Moreover, mulch and organic fertilizer interaction had no significant effect on the soil moisture content (Table 5). Ginger mean yields were significantly difference ($P < 0.05$) among the levels of mulch and rates of organic fertilizer applied. Mulch applied at 30 t ha^{-1} had the highest rhizome yield mean value of 7.16 t ha^{-1} and least value by the control. Organic fertilizer treatments had a significant effect on the rhizome yield. Significant mean yield differences were observed among ginger plants fertilized with 25 t ha^{-1} organic fertilizer and organic fertilizer applied at 25 t ha^{-1} that gave highest rhizome yield of 6.91 t ha^{-1} while 0 t ha^{-1} of organic fertilizer recorded the least value of 4.73 t $ha^{-1.}$ Mulch and organic fertilizer interaction had significant effect on the rhizome yield (Table 6). Table 7 shows the combined effect of levels of mulch and rates of organic fertilizer with mulch at 30 t ha^{-1} and 25 t ha^{-1} organic fertilizer treatments having the highest yield mean value of 8.30 t ha^{-1} and mulch at 0 t ha^{-1} and organic fertilizer at 0 t ha^{-1} gave the least yield mean value of 2.60 t ha^{-1}. Table 8 shows the correlation coefficients of the relationships between soil physical characteristics and yield. Yield had significantly negative correlation with soil bulk density and was significantly correlated with soil moisture content and soil porosity.

DISCUSSIONS

The significant differences observed in bulk density as a result of mulching treatments at 4 - 20 WAP could probably be associated with the achievement of crust elimination, improvement in surface aggregation and improved microbial activities thus improving the bulk density, total porosity and the infiltration capacity of the soils (Luna *et al*., 2017). The highest value of bulk density (1.79 g cm^{-3}) recorded at 0 t ha^{-1} of mulch could be attributed to the direct impact of raindrop on the soil which led to the reduction and eventually blockage of soil pores and crust formation. Organic fertilizer at 25 t ha^{-1} produced lowest bulk density (1.71 g cm^{-3}) as compared to the soil with 0 t ha^{-1} organic fertilizer (1.83 g cm^{-3}). These results obtained were similar to what was reported by Erdal (2012) who observed a relation between organic matter and bulk density and showed strong correlation between them. The significant differences observed in the case of soil moisture content could probably be attributed to the beneficial effects of mulch and organic fertilizer treatments which were due to several interacting factors, including improvements in soil quality and resilience. Mulching decreased the rate of decline of soil structure by improving soil moisture and temperature regimes (Lal, 1986), stimulating activity of soil fauna, and decreasing runoff and soil erosion. This is supported by the findings of Kumar (2020) who reported improved structural stability, lower bulk density and improved soil moisture properties with the addition of organic matter.

Furthermore, the significant differences shown in porosity at various weeks after planting could probably be attributed to the surface factors such as soil crust and mulch interact very highly with rainfall characteristics of an area to determine infiltration of water into the soil and this depends on the micro and macro porosity of the soil. The least value of percentage porosity recorded at 0 t ha^{-1} of mulch treatment was attributed to compaction resulting from crust formation that led to the blocking of micro and macro pores dues to direct impact of raindrop. The significant difference observed in ginger yield as a result of mulching and organic fertilizer treatment could probably be associated with the improved soil structure, soil organic matter and soil aggregation, lower bulk density and higher porosity, decreased soil pH and improved soil moisture properties and favourable nutrient status. Mulching improves plant growth, yield and yield quality (Singh *et al.,* 2007). This observation agrees with the findings of Cotching *et al.,* (2002) who stated that ginger is a heavy feeder of nutrient therefore needed proper application of mulch and organic fertilizer to ensure proper yield.

The relationship of some soil physical properties with yield showed that yield was strongly negative correlation with the bulk density, but with strong positive correlation with moisture content and total porosity. Hence, the factors which largely determined the performance of a crop are moisture content, bulk density and porosity of the soil. This association of yield with some soil physical properties was reported by Sainju *et al.,* 2022)

CONCLUSION

Mulching and organic fertilizer treatments influenced soil physical properties and ginger yield. Therefore, mulching and organic fertilizer are imperative in assessing or evaluating some soil physical properties. The combination of both mulch and organic fertilizer either at 30 t ha^{-1} of mulch and 25 t ha^{-1} of organic fertilizer followed by 30 t ha^{-1} of mulch and 20 t ha^{-1} of organic fertilizer and followed by 15 t ha^{-1} of mulch and 25 t ha^{-1} of organic fertilizer better-improved moisture content, lower bulk density and high total soil porosity and gave better yield when compared with either mulching and organic fertilizer used separately. However, the use of mulch at 30 t ha^{-1} and 25 t ha^{-1} of organic fertilizer was recommended.

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Table 1. Effect of mulch and organic fertilizer application on bulk density (g cm^{-3}) at 0 - 15 cm depth

	Weeks After Planting		
Treatments (t ha^{-1})	4	12	20
Mulch (M)			
0	1.62^{a}	1.71^{a}	1.79^{a}
15	1.60^{a}	1.65^{b}	1.64^{b}
30	1.56^{b}	1.64^{b}	1.62^{c}
Organic fertilizer (OF)			
0	1.66^{a}	1.73^{a}	1.83^{a}
10	1.63^{a}	1.68^{b}	1.66^{b}
15	1.60^{b}	1.68^{b}	1.65^{c}
20	1.56^{c}	1.66^{bc}	1.63^{d}
25	1.51^{d}	1.64^{c}	1.61^{e}
M x OF	NS	NS	*

Mean followed by the same letter in the same column under each factor are not significantly different by Duncan's Multiple Range Test at $P < 0.05$ (DMRT). NS = Not significant, * = Significant.

Table 2. Combined effects of mulch and organic fertilizer application on soil bulk density (g cm^{-3}) after planting

	Organic fertilizer (t ha^{-1})					Mulch
Mulch (t ha^{-1})	0	10	15	20	25	mean
0	1.78	1.72	1.69	1.67	1.65	1.70
15	1.73	1.70	1.68	1.66	1.63	1.68
30	1.70	1.68	1.66	1.64	1.58	1.65
Organic fertilizer mean	1.74	1.70	1.68	1.65	1.62	

LSD ($P < 0.05$) for comparing effects of mulch = 0.02, LSD ($P < 0.05$) for comparing effects of organic fertilizer = 0.63, LSD ($P < 0.05$) for comparing effects of mulch x organic fertilizer = 0.01

Table 3. Effect of mulch and organic fertilizer application on soil porosity (%) at 0 – 15 cm depth

	Weeks After Planting		
Treatments (t ha^{-1})	4	12	20
Mulch (M)			
0	39.01^{b}	35.76^{b}	32.49^{c}
15	39.74^{b}	37.70^{a}	38.10^{b}
30	41.02^{a}	38.10^{a}	38.90^{a}
Organic fertilizer (OF)			
0	37.31^{d}	34.90^{c}	30.81^{e}

10	38.39^{d}	36.60^{b}	37.40^{d}
15	39.80^{c}	36.60^{b}	37.70^{c}
20	41.17^{b}	37.40^{ab}	38.50^{b}
25	43.00^{a}	38.10^{a}	39.30^{a}
M x OF	NS	NS	*

Mean followed by the same letter in the same column under each factor are not significantly different by Duncan's Multiple Range Test at P < 0.05 (DMRT). NS = Not significant, * = Significant.

Table 4. Combined effects of mulch and organic fertilizer application on soil porosity (%) after planting

Mulch (t ha^{-1})	Organic fertilizer (t ha^{-1}) 0	10	15	20	25	Mulch mean
0	33.04	34.95	36.09	37.03	37.52	35.73
15	34.78	35.87	36.60	37.55	38.35	36.63
30	35.21	36.58	37.09	38.22	40.11	37.44
Organic fertilizer mean	34.34	35.80	36.59	37.60	38.66	

LSD (P < 0.05) for comparing effects of mulch = 0.02, LSD (P < 0.05) for comparing effects of organic fertilizer = 0.81, LSD (P < 0.05) for comparing effects of mulch x organic fertilizer = 0.02

Table 5. Effect of mulch and organic fertilizer application on soil moisture content (%) at 0 – 15 cm depth

Treatments (t ha-1)	Weeks After Planting 4	8	12	16	20
Mulch (M)					
0	7.42^{c}	8.52^{c}	12.19^{c}	5.35b	1.63^{b}
15	8.99^{a}	9.37^{b}	12.88^{b}	5.86^{b}	1.78^{b}
30	9.29^{a}	10.25^{a}	13.49^{a}	7.11^{a}	2.26^{a}
Organic fertilizer (OF)					
0	7.54^{d}	8.82^{c}	12.20^{b}	5.60^{a}	1.40^{c}
10	8.17^{c}	9.15^{bc}	12.71^{ab}	5.92^{a}	1.71^{bc}
15	8.71^{b}	9.28^{abc}	12.79^{ab}	6.14^{a}	1.85^{b}
20	9.02^{ab}	9.71^{ab}	13.10^{a}	6.33^{a}	2.02^{b}
25	9.39^{a}	9.96^{a}	13.48^{a}	6.56^{a}	2.46^{a}
M x OF	NS	NS	NS	NS	NS

Mean followed by the same letter in the same column under each factor are not significantly different by Duncan's Multiple Range Test at P < 0.05 (DMRT). NS = Not significant, * = Significant.

Table 6. Effect of mulch and organic fertilizer application on yield of ginger

Treatments (t ha^{-1})	Yield (t ha^{-1})
Mulch (M)	
0	3.63^{c}
15	6.22^{b}
30	7.16^{a}
Organic Fertilizer (OF)	
0	4.73^{c}
10	5.06^{d}
15	5.51^{c}
20	6.14^{b}
25	6.91^{a}
M x OF	*

Mean followed by the same letter in the same column under each factor are not significantly different by Duncan's Multiple Range Test at P < 0.05 (DMRT). * = Significant.

Table 7. Combined effects of mulch and organic fertilizer application on yield of ginger (t ha^{-1}) after planting

Mulch (t ha^{-1})	Organic fertilizer (t ha^{-1}) 0	10	15	20	25	Mulch mean

0	2.60	3.20	3.30	3.90	5.30	3.60
15	5.50	5.80	5.90	6.70	7.20	6.20
30	6.10	6.30	7.40	7.80	8.30	7.20
Organic fertilizer mean	4.70	5.10	5.50	6.10	6.90	

LSD ($P < 0.05$) for comparing effects of mulch = 0.2
LSD ($P < 0.05$) for comparing effects of organic fertilizer = 0.3
LSD ($P < 0.05$) for comparing effects of mulch x organic fertilizer = 0.1

Table 8. Correlation coefficient between soil physical properties with ginger yield

	Bulkdensity	Soilmoisture	Soilporosity	Sowpore	Volwater	Yield
Bulkdensity	1.00					
Soilmoisture	-0.53**	1.00				
Soilporosity	-1.00**	0.53**	1.00			
Sowpore	0.12	0.73**	-0.12	1.00		
Volwater	-0.37*	0.95**	.0.37*	0.87**	1.00	
Yield	-0.68**	0.74**	0.68**	0.35*	0.68**	1.00

*, ** = significant at $P < 0.05$ and $P < 0.01$, respectively
Sowpore – Soil water filled pore space
Volwater – Volumetric water content

BALANCING THE SCALES: INVESTIGATING THE INTERPLAY OF TECHNOLOGY AND GENDER IN THE TOMATO VALUE CHAIN IN NIGERIA

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ABSTRACT
The tomato industry is a significant player in the global as well as the Nigerian agricultural landscape. The adoption and utilization of technologies can be gender-biased, affecting women's access to resources, market opportunities, and decision-making power. This study examines the adoption and impact of various technologies on women's participation in various stages of the tomato value chain. This study analyzed the percentage losses, hotspots for losses and technologies adopted by stakeholders to reduce tomato post-harvest. losses in Nigeria. Through a comprehensive stakeholder interviews and mapping, this study explores the complex interplay between post-harvest technologies, gender roles, and women's socio-economic empowerment within the tomato value chain. By identifying barriers and enablers, the study further seeks to inform strategies and policies that foster inclusive and gender-responsive growth, empower women, and promote sustainable development in the tomato industry.
***Keywords**: technology, gender, tomato value chain, women empowerment, Nigeria.*

INTRODUCTION

In Nigeria, tomato is an economic and political crop and is consumed in every household in the country as an important part of the daily diet. Estimated potential production yield is relatively high, at about 20-25mt/ha. There exist a large domestic and regional market (unmet) demand for tomatoes in the country and Nigerians alone consume an estimated 2.3 million tonnes of tomatoes annually. High rate of post-harvest losses is however experienced throughout the tomato value chain of Nigeria. In its 2019 State of Food and Agriculture report, FAO emphasised the importance of gender-sensitive approaches to food loss reduction, stating, 'interventions to improve women's standing and decision-making power in the consumption and sale of household production may help reduce food losses' (FAO,2019, p. 79). In many agricultural contexts, gender disparities exist, with women facing unique constraints and limited access to resources and decision-making power. Such inequalities are also prevalent within the tomato value chain. Even as women play an outsized role in the post-harvest handling and processing stage of the value chain, where considerable food loss occurs, they may also be at higher risks of experiencing high post- harvest loss due to lower access to resources and information as well as lower ability to adopt loss-reduction technologies. These dynamics are also context specific.

Women face constraints when adopting post-harvest reduction technologies as they may have different preferences for Post Harvest loss (PHL)-reduction technologies than men (SDC,2015, Theis et-al, 2017), but the technology design process often does not include the voices of women or prioritizes those of men. These dynamics have potential implications for technology adoption. And because losses occur throughout the value chain, achieving a major reduction in loss levels would require such technologies to be adopted, where relevant, throughout the value chain—e.g., in the warehousing, cold storage, logistical, wholesale, processing, and retail services that link farms to consumers (AGRA, 2018). There are numerous techniques and technologies for reducing post-harvest loss levels. These ranges from simple solutions such as reusable plastic crates for storing and transporting fresh fruits and vegetables, which can significantly lower levels of loss—for example, from 40% to 5% in studies in Nigeria (Kok et-al 2019) and from 15-20% to 4-5% in research in India (WEFORUM, 2014). They also include those that are more technologically complex, such as, processing technologies, or refrigerated trucks and cold-storage rooms. However, gender norms and stereotypes often restrict women's participation in certain activities, such as transportation.

The decision to deploy these potentially impactful interventions, is generally made by individual farmers, entrepreneurs, or business owners within a supply chain. As such, it is important to consider these actors' needs, preferences, and constraints, as well as the relationships between them. These actors comprise both men and women, interacting with one another and embedded within larger social structures that are not necessarily gender neutral—making gender issues relevant to consider. Lack of access to financial services, technology, and training further exacerbates gender-based constraints. Addressing these challenges requires a gender-inclusive approach that empowers women, promotes their participation, and provides equal opportunities throughout the tomato value chain. By integrating gender perspectives and ensuring women's active involvement, the value chain can become more inclusive, equitable, and economically viable. This study is an attempt to contribute to existing studies on gender and post-harvest losses in the tomato value chain in Nigeria and how to mitigate the losses.

METHODOLOGY

Method of Data collection: The data for the study was collected from both primary and secondary sources. Secondary data and information were collected from desk reviews of published literatures and primary data collected with the aid of semi-structured questionnaires, Key-informant interview (KIV) and Focus Group Discussion (FGD)

Sampling procedure: One hundred and seventy-five (175) key actors in tomato value chain actors. a total of 93 value chain actors from the North (Kano and Kaduna states) and 82 from the Southern States of Oyo, Ogun and Lagos were purposively selected for the study. Data collection was done with the use of semi-structured questionnaires. Key informant interview was conducted on one-on-one on basis while Focus Group was used in eliciting information on gender roles within the chain. Tomato farmers, processors, marketers' as well as transporters were the major stakeholders identified and interviewed in this study.

Method of Data Analysis: The data was analyzed using descriptive statistics**.**

RESULTS AND DISCUSSION

Women are often less involved than men in cooperatives and other professional networks; this can further limit access to processing facilities, technologies, and markets, exacerbating PHL (FAO,2019). Women's limited access to assets and financing (Quisumbing et-al, 2014) may also make them less able to adopt PHL-reduction technologies (IFC,2016). It can also limit access to knowledge and social capital, which facilitate technology adoption. Women also generally have lower access to high-quality storage facilities and technologies, which can result in more damage and loss (IFC,2016).

Table 1: Socioeconomic characteristics of Respondents

Characteristic	F (%)				F (%)			
	North				South			
	Farmer	Marketers	Processors	Transporters	Farmer	Marketers	Processors	Transporters
Sex								
Male	45(91.8)	9(64.3)	9(69.2)	17(100)	66(83.5)	18(90.0)	20(66.7)	17(100)
Female	4(8.2)	5(35.7)	4(30.8)	0(0.0)	13(16.5)	2(10.0)	10(33.3)	0(0.0)
Educational Status								
Quranic	12(24.5)	0(0)	2(15.4)	3(17.6)	1(1.3)	0(0)	0(0)	3(17.6)
Primary	4(8.2)	4(28.6)	4(30.8)	2(11.8)	11(13.9)	0(0)	0(0)	2(11.8)
Secondary	28(57.1)	6(42.9)	6(46.2)	0(0)	12(15.2)	10(85.0)	15(50.0)	5(29.4)

Source: Field survey, 2023

Table 1 describes the sex and educational status of tomato value chain actors in the study area. The results show that there are more male tomato farmers in the north (91.8%) than females. These variables have implications on technology adoption as well as post-harvest practices. There are also more male marketers and processors in the north and the transporters are all males. This distribution shows the gender roles in the region as male involvement in the tomato value chain is more is higher than those of the females. In the south, there are also more male farmers than females, but female (90%) marketers are more. There are also more male processors than female ones and all the transporters are males. With respect to educational status, tomato farmers, marketers and processors in the north have primary and secondary school education in addition to Qur'anic education. In the south, all actors have secondary school education with marketers having the highest number (85%) of educated members followed by processors (50%).

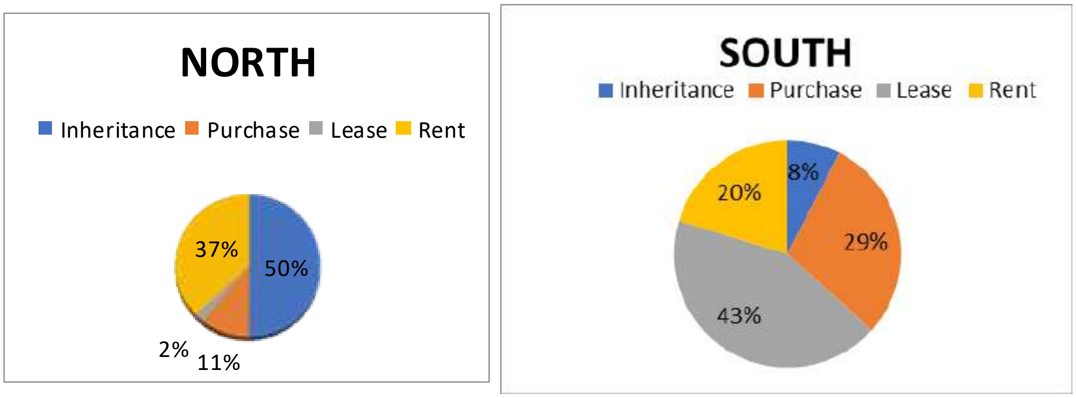

Figure 1: Land ownership structure among tomato farmers
Source: Field survey, 2023

Land is a very important input of factor of production in agriculture. The land ownership structure of tomato farmers is the study areas is as shown in Fig.1. In the northern states of kano and Kaduna, land purchase and leasing is not so common as most (50%) farmers acquired their farmland through inheritance and rentage (37%). This is perhaps one of the reasons, among other factors why the bulk of tomato comes from the north as land is readily available. This form of ownership structure also allows for some relative degree of freedom on production decisions as well as adoption of technologies. However, in the southern part of the country, ownership of land by inheritance is very small as only 8% of farmers cultivate on inherited land. Thus, land used for agricultural activities is acquired through leasing (43%), purchase (29%) and rentage (20%). Most of the land is being used for housing or companies as these states in the south are peri-urban or urban. So, the lands are only released and made available for agricultural activities in the short and medium term only. Thus, the production of tomatoes in the south is relatively small when compared with the quantity of tomatoes from the northern part of Nigeria. In addition, women's ownership of land also typically lags far behind that of men (Doss et-al ,2018), which may make them less willing or able to invest in PHL-prevention equipment or practices**.**

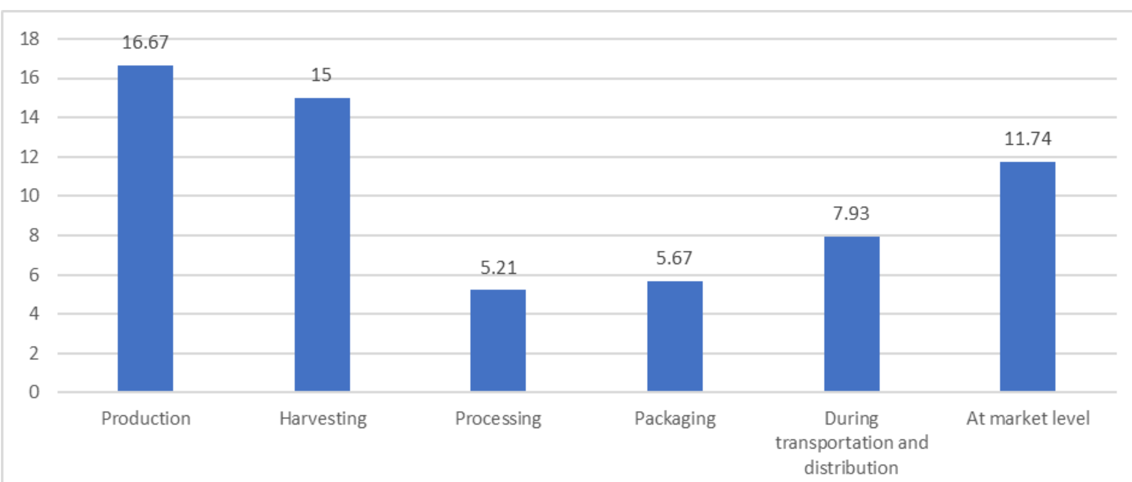

Figure 2: Post -harvest Loss Hotspots in Tomato Value Chain
Source: Field survey, 2023

Tomato post-harvest hot sports is captures in figure 2. Losses in tomato is highest at the farm/production and harvesting stages. This is probably due to poor production and management problems. The method of harvesting could also result in losses as tomatoes are vegetable fruits with delicate skin coat that gets easily damaged when not properly handled. The losses at the market level are also relatively high. Damages at this stage could be from mechanical injury during loading /offloading. Tomato losses at the market also emanates be from poor packaging materials, poor storage facilities at the market store for preserving unsold tomato fruits, amongst other constraints.

During transportation and distribution, losses are also experienced. Delays in delivery due to bad roads and long queues at destination markets all contribute to tomato fruit losses as highly perishable vegetables. Finally, some losses are experienced during value addition in the form of processing and packaging. The method of processing is still majorly rudimentary or traditional; sorting, grading, drying by sun drying. Only a few processors use solar for drying tomatoes. The few tomato processing companies are currently out of operation due to inadequate fruits to feed the plant as farmers prefer to take their produce to the local markets where they get premium prices. This analysis further reveals that there are more women than men in those value chains where post-harvest losses occur. These include harvesting, processing, packaging and at the marketing stage. With respect to production, there are more men, and there are no women involved in the transportation of tomatoes.

Figure 3: Awareness on different PHL technologies on mitigating tomato loss
Source: Field survey, 2023

The level of awareness, among value chain actors, on measues to mitigate tomato losses is captured in Fig. 3. In the north , there is general awareness amongst all actors. Awareness is relatively high among farmers(63,3%) , Marketers (50%)and 41% among transporters. The processors are least (38.5%) aware of tomato losses mitigation intervention. In the north, there are more males than females in all the value chains except in processing where women are more. And this value chain with more women is where awareness on loss mitigation techniques and technology is the lowest. The implication is that tomato women processors in the north may continue to experience more losses unless their capacity is built-up. However, in the south, awareness levels on tomato losses interventions programmes is highest amongst markerters, who are mostly women and this is followed by processors and farmers. Thus, women tomato marketers are more informed about mitigation measures that can be deployed to prevent losses.

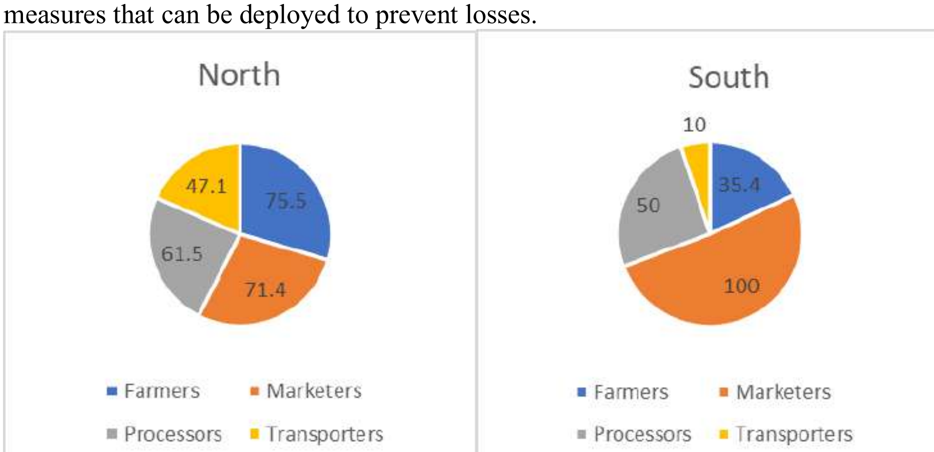

Figure 4: Participation in Tomato Post-harvest Programs/Intervention
Source: Field survey, 2023

In Fig 4, the rate of participation of value chain actors in tomato-post harvest programs is analyzed. Participation rates are generally high in the north among farmers, marketers, processors as well as transporters. This is probably because huge tomato production is done in the north. Similarly in the south, participation in post -harvest programs are highest among tomato marketers since they are the most informed about the various tomato mitigation measures. This is followed by processors and then farmers. Transporters of tomatoes in the south participate in the least at post-harvest programs.

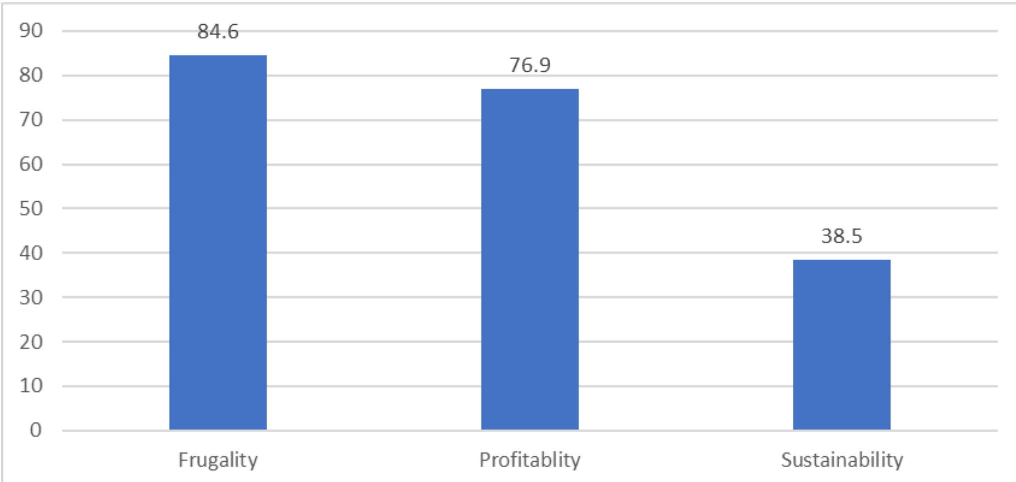

Figure 5: Electricity powered cold room.
Source: Field survey, 2023

Fig 5. represents the opinion or perception of processors on the use of electricity powered cold room as a post-harvest technology. The technology is affordable (provided there is power supply from the national grid), which would make it is both economical and affordable(frugality), and because it will be profitable, but the sustainability of the technology is not guaranteed because of the erratic power supply of electricity which is still a major problem in the country.

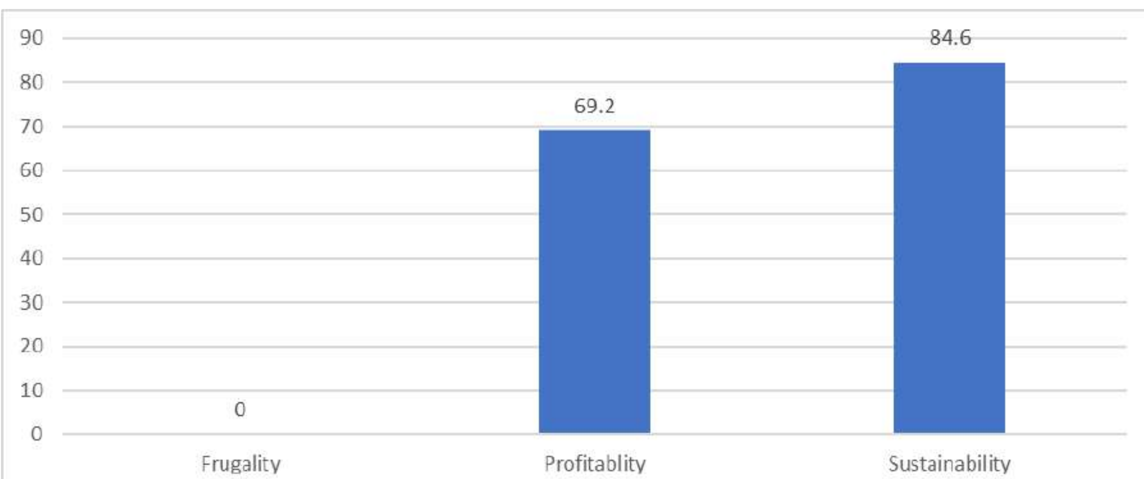

Figure 6: **Solar powered cold rooms**
Source: Field survey, 2023

The perception of processors on the use of solar -powered cold room is captured in fig 6. The processors opined that this technology may not be affordable even as they believe it is a profitable technology which can stand the test of time. That is, it is sustainable.

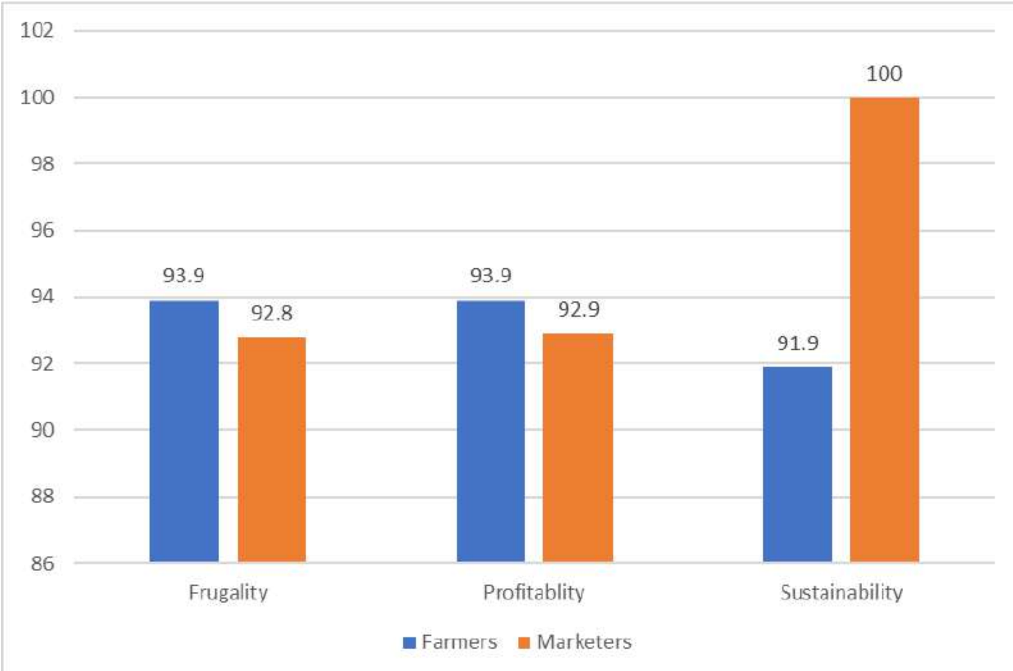

Figure 7: Plastic Crates
Source: Field survey, 2023

The use of plastic trays as an improvement over the raffia baskets used in packing and transportation of tomato was examined. The view of farmers and marketers who use these trays is shown in fig.7. Both actors find the use of plastic rates economical and affordable, improves profitability and the technology is also believed to be a sustainable one.

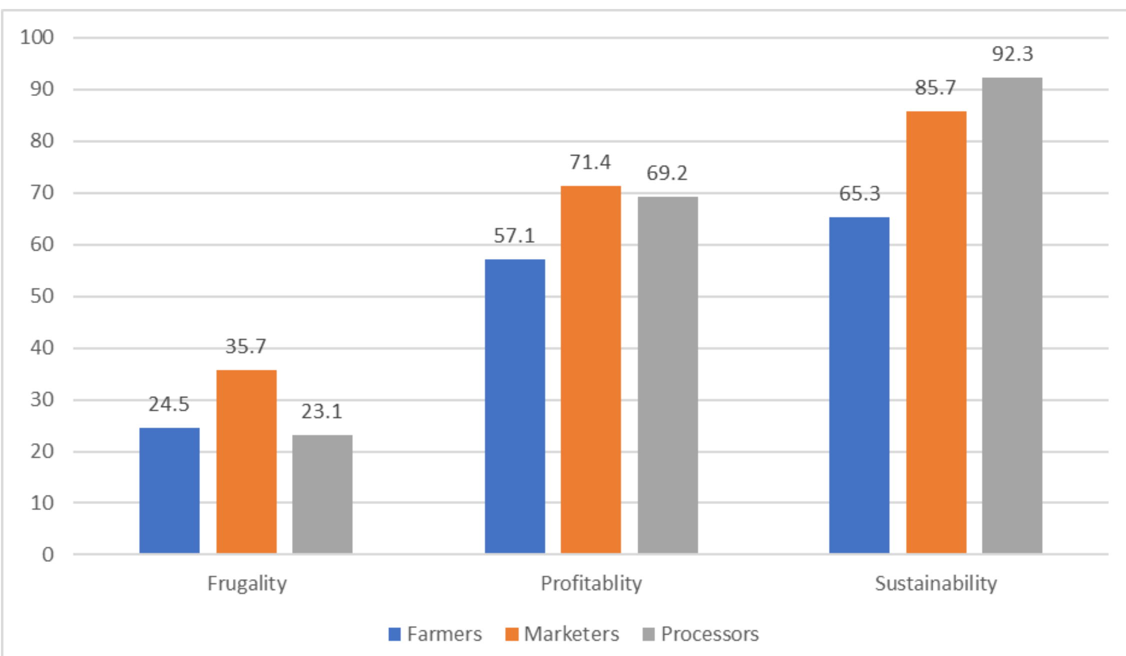

Figure 8: Solar dryer

Fig.8 captures the use of solar dryer as a post-harvest technology in tomato. Farmers, marketers, and processors all believe that the technology is relatively affordable, highly profitable, and sustainable. The technology is particularly good and accepted in the northern part of the country when there is a longer higher of sunlight for most part of the year.

CONCLUSION AND RECOMMENDATION

In addition, gender inclusive strategies such as giving financial support to assist in the acquisition of machinery used in improved production and value-added processing be put in place. Post-harvest loss interventions should be designed based on an understanding of the local gender context, in partnership with women, and with an eye to increasing their empowerment. It is pertinent to also promote capacity building/ training on handling post - harvest losses along the value chain particularly at farm level and processing sites as well as marketplaces.

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ECONOMIC PRODUCTION OF TOMATO (Lycopersicon lycopersicon L.) FRUIT IN DAN-DAURA, KAURU LOCAL GOVERNMENT AREA, KADUNA STATE, NIGERIA

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ABSTRACT
A field experiment was conducted between May and August, 2022 to assess the economic production of tomato fruit in Dan-daura village, Kauru L.G.A in Kaduna state (Lat. 10.69^0, Long. 8.05^0). The objective of the study was to identify the economics of tomato production in the area with the view to ensure its profitability or otherwise. Land was prepared for nursery and seeds planted on 11th April. Seedlings were transplanted between 4th and 7th May, 2022. Harvestings carried out between 30th July and 25th August, 2022. The Input-Output Benefit analysis revealed that, the venture produced a favourable Benefit Cost Ratio (BCR 2.4:1) indicating that every naira invested in the production yielded # 2.40 within the production period. It is therefore recommended that farmers interested in tomato production the area should engage between April / May up to August, as its production cost is low and the selling price is higher as such attracts higher profits.
***Keyword**: BCR, Input-Output: Benefit Analysis*

INTRODUCTION

Tomato (*Lycopersicon lycopersicon L.*) belongs to the family solanaceae, genus Lycopersicon, subfamily Solanaideae and tribe solanaeae where pepper, potato, tobacco and eggplant belong (Habu, *et al*, 2016). It is the second most important remunerable solanaceous vegetable crop after potato. FAO (2009) reported that tomato is a native to South America and widely cultivated in 140 countries of the world with an annual production of 150 million tons. Shobo *et al* (2014) stated that, it is the most important and popular commercial vegetables grown in the tropics and could be grown in green houses as well as in open fields. In global perspective, the major producing countries of tomato are USA, China, Egypt, Turkey and India, with an average yield of 92.42t/ha, 56.86t/ha, 42.25t/ha, 41.89t/ha and 22.83t/ha respectively (FAOSTAT, 2013).

Twanya, et al (2017) was introduced to West Africa and Nigeria in particular at the end of the 19th century. In Nigeria however, the producing area of tomato lies between lat.7.5^0 11^1 and 13.0^0 N and within a range of temperature of 22-30^0C .The average yield there was estimated at 6.34t/ha which is very low compared to the global yield (FAOSTAT, 2013). Tomato crop is very important in terms of diet and economy in Nigeria both the rain fed and irrigated crops. It is currently considered to be one of the main vegetable crops in the world, and constitutes the income of main growers (Omar, 2005). The large scale tomato is grown in Northern Guinea Savannah of Nigeria, where relatively high yield could be realized by planting between June and December. However, planting between March and May results in low yield that cannot sustain demand. Olaniyi *et al* (2010) reported that the low tomato production in Nigeria is due to the differences in crop environmental conditions, lack of high yielding varieties and cultural practices applied to the crop. The bulk of its production is from dry season particularly in Northern states. However, NIHORT (undated) opined that, tomato requires a cool dry climate for optimum production, with temperature range of 21-25^0 C, while a temperature of between15-21^0 C during fruit formation increase yields. On the other hand, Okpara, et al (2017) mentioned that the performance of tomato under high rainfall and humid condition of southern Nigeria is poor compared with Northern dry savannah environment.

Tomato cultivation now move to places and seasons that were originally unsuitable for its productivity, thereby results in the economic importance of the crop (Ibrahim *et al*, 2017). Tomato production as any other crop enterprises, involves a variety of operations which start from land acquisition, land clearance and preparation, planting and /transplanting, weedings, chemical application and harvesting. These explained different cost components incurred by the farmer with the hope of getting some returns. Generally, the overall interest of researchers and policy makers is to reduce production costs and increase output which results to increase in return to farmers.

Objectives of the Study

The main objective of this study is to identify the economics of the tomato production in the area. Specifically,

a. to highlight the cost of producing one hectare of tomato in the area.

b. to explain the yield and benefit of tomato production in one hectare of land.
c. to proffer possible suggestions to the intending tomato farmers in the area.

MATERIALS AND METHODS

The trial was carried out at Dan-daura, village in Kauru L.G. A. Kaduna state (Lat.10.68^0, Long.8.05^0). Dan Syria tomato variety was planted on the nursery on 7th May, 2022. The seedlings were transplanted after three weeks. All agronomic activities were carried out. A total of 130 baskets were realized in nine (9) harvests towards the end of August 2022. The total cost of production stood at # 430,000. And the selling price of the total products was #1, 450,000. NPV, BCR were used. Thus,
BCR = Benefit/ (1+i)n /Cost/(1+i)n. where, cost = # 498,000 and benefit = # 1,648,000.
Where, I is the interest @ 12.5%.
Thus, 1,648,000/ (1+i)n / cost/ (1+i)n.
1,648,000/(1+i) x (1+i)/ 498,000.
1,648,000/498,000 = 3.31
So, the Benefit Cost Ratio (3.31) indicates that the venture is favourable, since in every Naira invested, # 3.31 will be realized within the period of production (Table 3).

RESULTS AND DISCUSSION

Table 1: Production Cost of Tomato per Hectare in Kaduna state.

Input / Material	Quantity	Cost (#)
Seeds	12 tins @ # 2000/ tin	24,000
Fertilizer	4 Bags NPK @25,000 and 4 Bags Urea @ 19,000	# 100,000 and # 76,000
Land fee/ Rent	1 season	60,000
Cost of Land preparation: Harrow and Ridging	1 hectare	28,000
Nursery Preparation	A portion of land	8,000
Transplanting	8 mandays @ # 1,500	12,000
Weeding	Three times @ # 16,000	48,000
Fertilizer application	Twice @ # 2,000	4,000
Harvesting	260 Basket @ # 300/ Basket	78,000
Transportation	Vehicle fuelling	60,000
TOTAL COST		**498,000.**

Table 1 indicates the quantity of items/ materials used and the amount spent for the operation. From the table, it revealed that a total of # 498,000 was spent in the purchase of inputs and the operation carried out in one hectare of land in the study area.

Table 2: Yield – Benefit per Hectare in Kaduna State.

Frequency of Harvest	Number of Basket	Price per Basket (#)	Total Price (#)
1	28	7,000	196,000
2	12	8,000	96,000
3	36	6,500	234,000
4	36	7,000	253,000
5	48	6,500	312,000
6	40	5,000	200,000
7	32	6,300	201,600
8	20	6,000	120,000
9	8	4,500	36,000
TOTAL	260	-------	1,648,000.

Table 2 indicates the yield and the cost of the yield at the time of the harvests. It can be seen from the table that, the tomato fruits do not ripe at the same time. So in this operation, the frequency of harvests were spread to nine time which gave the total output to 260 baskets in one hectare, and sold at the total cost of # 1,648,000.

Table 3: Input – Output Benefit

(Cn) Cost of Production (#)	Total Yield (Basket/ha)	Revenue (#)	Discount Factor (12.5%)	Benefit Cost Ratio (BCR).
498,000	260	1,648,000	206,000	3.31

Cn = Total cost of production
Discount factor (12.5%).
Benefit Cost Ratio = Benefit/(1+i)n / Cn/ (1+ I)n
Bn/ (1+i)n/ x (1+i)n/ Cn/(1+i)= 1,648,000/498,000 = 3.31

CONCLUSION

Tomato fruit as an essential ingredient in the diet of both rural and urban dwellers as well as an important raw material for food industries. It is known to grow mainly between June and December in Nigeria. But during that time, farmers rush in its cultivation, this leads to glut in the markets. The result of this finding revealed that, the low fruit yield during the end of dry season towards the onset of rainy season and the resultant increase in price at that period, compensate the loss encountered by farmers. Because, a basket at the time of glut can be sold at as low as # 500 - # 1000. While, in our finding, there was no harvest among the nine a basket sold at a price lower than # 6000, which price of a basket is equivalent to the price of six to twelve basket at a glut period. The finding therefore recommend that farmers interested in tomato production in the area should engage between April / May up to August, as its production cost is low and the selling price is higher as such attracts higher profits.

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COST AND BENEFIT OF SMALL-SCALE SOAP PRODUCTION USING PLANTAIN/BANANA STALKS

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ABSTRACT
Alkali produced from Plantain/Banana wastes can be utilized for production of household items such as soap thereby reducing environmental pollution. The study evaluated costs and returns in small scale processing of Plantain/Banana wastes into paste and liquid gel soap. Data on quantity of input requirements and price, output and price were compiled in a series of trainings on empowerment of youth and women on soap production organized by National Horticultural Research Institute. The data was analyzed using profitability indicators such as Benefit to Cost Ratio (BCR) and Rate of Return on Investment (ROI). The total cost and revenue incurred in processing 200 kg of Potash into paste was ₦1,196,600 and ₦2,100,000 while total cost and returns of ₦1,360,200 and ₦3,000,000 was incurred in processing 200 kg of Potash into liquid soap. Benefit to Cost Ratio (BCR) obtained in Liquid gel soap (2.2) and Rate of Return on Investment (1.2) was greater than BCR obtained in paste soap (1.8) and Return on Investment (0.8). The BCR and ROI indicated profitability of the enterprises (Paste and liquid gel production). The study recommends adequate training of the stakeholders on the processes to kindle interest in the natural soap processing using plantain wastes.
Keywords: *Plantain waste, Paste soap, Liquid gel, Profitability, Rate of returns on Investment,*

INTRODUCTION

Plantain/banana represent the world's second-largest fruit crop (Okoli, 2020). It is used in the food industries for the manufacture of chips, flakes, cakes, thereby creating important opportunities to the populace directly or indirectly and invariably income for small holder farmers (Kainga and Seiyabo, 2012). Plantain/Banana is an economic crop which has a relatively high value product in common with most horticultural crops. Almost all the parts of the Plantain/banana plant, for example, fruit, peel, leaf, stem, stalk, and inflorescence (flower), can be utilized in agriculture and cottage industries. They are used in numerous food and non-food-related applications such as thickeners, colorants and flavorings, macro and micro-nutrient sources, livestock feed, fibers, bioactive compound sources, and organic fertilizers (Okoli, 2020). The major wastes of plantain and banana processing in Nigeria are their peels and stalks and the peels account for 40% of the total weight of fresh bananas or plantains and these peels are currently either used as fertilizer or discarded in many countries (Eun-Hye *et al,* 2010). Plantain/Banana stalk waste, could be burnt to produce edible ash or alkali for local soap production in some cultures (Okoli, 2020); but in areas where these are not feasible, these wastes end up polluting the environment (Williams, 2001).

The Plantain/Banana stalks waste is normally disposed in municipal landfills, which contribute to the existing environmental problems (Prashanthi and Chaitanya, 2020). While Warra *et al* (2009) has observed that alkali content of potash obtained from ashes of plants origin were high and good for soap production. Production of soap using agricultural wastes is a veritable source of gainful employment for individuals. It is believed that if plantain/banana stalks could serve as a supplement in soap production, it will go a long way in converting the wastes into wealth. Past empirical studies focussed on use of Plantain peel ash as source of alkali and concluded that solid soap, could be made from ash-derived alkali (Onyegbade *et al*, 2002) while Nnyia *et al (*2023) examined the preparation and physicochemical analysis of local black soap from coconut oil and plantain peel biochar. Their overall results show good soap properties suitable for domestic purposes. None of the aforementioned studies estimate the cost and return involved in the natural soap production. The study therefore evaluate cost and return in soap production using plantain wastes in order to ascertain the viability for prospective investors.

MATERIALS AND METHODS

The study was carried out at National Horticultural Research Institute, Ibadan. Paste soap and liquid gel soap were produced from Plantain fruit stalks. Plantain fruit stalk was collected from Oje market, Ibadan. The fruit stalks were washed with distilled water, sun dried for 168 hours and then ashed in a furnace and stored. The ash was dissolved in water to form alkali and then processed into soap through saponification. For the economic analysis, information was collected on the variable input materials requirement and depreciation estimated for fixed inputs. Budgetary analysis and profitability indicators were employed to determine the viability of the products. The profit indicators: benefit to cost ratio and rate of return on investment were employed in the analysis.

RESULTS AND DISCUSSION

The cost, returns and profitability indicators of producing natural paste soap and liquid gel soap is presented in Table 1 and Table 2. Processing of 200 kg of potash obtained from plantain/banana stalks is capable of generating 280 kg of natural paste bar soap. The variable inputs in the production are plantain/banana stalk ash, cooking gas, packaging materials, Nose masks, and labels. Other include labour that will be utilized in the operation. Depreciation value was calculated for fixed items such as Plastic overhead water tank with metal stand, Industrial plastic drums for extraction, paint buckets (25 ml), hydrometers, scoop bowls (long handle), long cooking iron spoons, long cooking wooden stirrers, metal sieves, plastic sieves, normal weighing scale, safety goggles, industrial gloves, rain booth and mortar and pestle. The estimated cost and revenue in processing of 200 kg potash into paste soap were ₦1,196,6000 and ₦2,100,000 per 200 kg of potash respectively. The net profit was ₦903,400 per 200 kg of potash processed while rate of return to investment was 0.8 with Benefit to cost ratio of 1.8. The benefit to cost ratio of 1.8 implied that for every one naira spent on the enterprise, ₦1.8k will be realized while the rate of return on investment of 0.8 indicated that every naira invested in processing of potash to paste soap returned ₦0.80k as profit. The profit level obtained showed the profitability of processing potash into paste soap. Processing potash from plantain/banana wastes into the soap will go a long way in managing environmental pollution that would have resulted from the wastes.

The total cost incurred in processing 200 kg of Potash into liquid gel were ₦1,360,200 per 200 kg of Potash processed while total revenue of ₦3,000,000 per 200 kg potash processed was estimated. The net profit of ₦1,639,800 was obtained in the processing of potash into liquid gel soap. Rate of return on investment of 1.2 while the benefit to cost ratio was 2.2. The benefit to cost ratio of 2.2 indicated that for every ₦1 invested in the business, ₦2.2 will be realized. The return per naira invested was ₦1.2 k indicated that the enterprise is profitable (Table 2).

CONCLUSION AND RECOMMENDATION

Succinctly, processing of plantain/banana stalks into value added products are profitable and will go a long way in minimizing environmental pollution due to the large volume of the waste. However, Liquid gel soap had higher ROI compared to the paste soap. The study recommends adequate training of the stakeholders on the processes to kindle interest in the natural soap processing using plantain/banana fruit stalks.

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Table 1: Cost and Return in Paste soap production using Plantain waste

Item	**Amount**	**Cost as % of Total Cost**
Material Input		
200 kg of Potash	200,000	16.7
Energy (360 kg)	295,200	24.7
Palm kernel oil (240 L @ 1000/litre)	240,000	20.1
Label for paste soap	16,800	1.4
Bowl for paste soap	19,600	1.6
Labour Cost		
Labour for extraction and concentration of Ash, Boiling/Saponification and packaging	320,000	26.7
Transportation cost	5,000	0.4
Fixed Cost		
Depreciation on tools	100,000	8.4
Total cost	**1,196,600**	
Total Revenue		
From 1,200 litres of Alkali/Extract and 240 litres of Palm kernel oil 280kg of paste will be produced @ 7,500/kg	**2,100,000**	
Net Profit	**903,400**	
Benefit to Cost ratio	**1.8**	
Return on Investment (NR/TC)	**0.8**	

Source: Compiled from NIHORT's training

Table 2: Cost and Return in Paste soap production using Plantain waste

Item	**Amount**	**Cost as % of Total Cost**
Material Input Cost		
200 kg of Potash	200,000	14.7
Energy (360 kg)	295,200	21.7
Palm kernel oil (240 L @ 1000/litre)	240,000	17.6
Packaging material for liquid gel	60,000	4.4
Label 600 labels	60,000	4.4
Labour cost		
Labour for extraction and concentration of Ash, Boiling/Saponification and packaging	320,000	23.5
Labour to dissolve paste into liquid	80,000	5.9
Transportation cost	5,000	0.4
Fixed input cost		
Depreciation on tools	100,000	7.4
Total cost	**1,360,200**	**100**
Revenue		
600 litres of gel @ 5,000/litre	**3,000,000**	
Net Profit	**1,639,800**	
Benefit to Cost ratio	**2.2**	
Return on Investment	**1.2**	

Source: Compiled from NIHORT's training

GENETIC DIVERSITY IN *OCIMUM* SPECIES AS REVEALED BY SCoT MARKERS

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ABSTRACT
Members of the genus Ocimum are difficult to characterise due to the presence of many species, subspecies and varieties which do not differ significantly in morphology. Using molecular markers to evaluate genetic diversity in basil population produces reliable results. This study evaluated genetic relationship in eight Ocimum species using ten Start-Codon targeted polymorphism (SCoT) primers. Polymorphic Information content (PIC) and gene diversity were used as discriminatory parameters to assess the level of informativeness of the primers used at differentiating the species studied. A total number of 117 amplified bands were produced, out of which 28 were polymorphic. SCoT 13 and SCoT 3 produced highest and lowest PIC and gene diversity values respectively. Unweighted Pair Group Mean with Arithmetic (UPGMA) grouped the species studied into two clusters, where members within each group are more closely related. The findings of this study ascertained the suitability of SCoT markers at evaluating genetic diversity in basil population.
Keywords: *Basil, Markers, SCoT, Polymorphism, Primer*

INTRODUCTION

The genus *Ocimum* (basil), considered the largest in the family *Lamiaceae*, contains over 150 species of annual and perennial herbs and shrubs, distributed across tropical and subtropical parts of Asia, Africa, Central and South America (Abuhashem *et al*., 2023). In addition to being rich source of high economic essential oils and aromatic compounds, *Ocimum* species are valued as culinary herbs, insect repellants, herbal drugs and attractive ornamentals (Baczek, 2019). However, high level of cytological, chemical and morphological variability exists in the genus, forming the basis of the various classifications (Alves *et al*., 2019). While chromosome number is a dependable trait for species identification, the genus *Ocimum* exhibits chromosome number variations, making cytological identification difficult (Edet and Aikpopodion, 2014). In addition, environment largely affects morphological and chemical traits, making the results obtained in such studies not exclusively usable, thereby propelling the need for a more stable, widely applicable system of classification made possible by molecular markers (Labra *et al*., 2004).

Molecular markers are useful in the study of genetic diversity existing between plant species in the best possible manner (Tiwari *et al*., 2016). Rios Rodriguez *et al*. (2021) reported that markers provide a more detailed and accurate method of tracking genetic variation within basil population. Recently, the use of markers in crop improvement has been upgraded with the development of more informative types such as Target Region Amplification Polymorphism (TRAP) (Hu and Vick, 2003), Start-Codon Targeted Polymorphism (SCoT) (Collard and Mackill, 2009), etc. In Nigeria, Odesola *et al* (2021) reported considerable genetic diversity from 25 *Ocimum* genotypes using ISSR primers. Gupta *et al* (2021) however reported that SCoT markers gave higher polymorphism and resolving power than ISSR markers in their study of genetic relationship between 36 *Ocimum* accessions. Igwe *et al*. (2017) also reported that SCoT markers are better at resolving genetic diversity and relatedness than ISSR due to their longer primer length, higher annealing temperature and polymorphism. This study was therefore conducted to further explore the efficiency of SCoT markers at studying genetic relationship among *Ocimum* species collected across three South-western states in Nigeria.

METHODOLOGY

Eight *Ocimum* species collected from different locations in Oyo, Ogun and Ekiti states, Nigeria were used for this study. The seeds were planted for maintenance and stability in a screen house at National Horticultural Research Institute (NIHORT), Ibadan. Genomic DNA was extracted from approximately 200 mg of young fresh leaves of the *Ocimum* species using modified cetyltrimethylammonium bromide (CTAB) procedure (Mignouna *et al*., 1998). DNA quality was done using agarose gel electrophoresis. Only samples of high quality were used for SCoT Polymerase chain reaction (PCR). A total of 10 polymorphic SCoT primers were used in this study. PCR amplification for SCoT reactions was carried out in a 25 µl volume in a 96-well microliter plate. The total reaction volume contained 25 ng of template DNA, 2.5 µl each of dNTPs, 10×PCR buffer and 25 mM $MgCl_2$, 2.0µl of 5µM of primer, 1 unit of Taq DNA polymerase (Bioline). The plate was subsequently placed in a Eppendorf Mastercycler Nexus Thermal Cycler (USA Scientific, Inc.) for amplification, where cycling conditions were initial duration at 94°C for 5 min, followed by 40 cycles consisting of denaturation for 30 secs, annealing at 50-60°C for 1 min, extension at 72°C for 45 secs and final extension at 72°C for 10 min. Ten microlitre (10 µl) of the PCR amplicons were resolved with 1.5% agarose gel containing 0.5 mg/mL ethidium bromide and viewed under Vilber Lourmat E-Box CX5.TS UV Trans-illuminator. The molecular weights of amplified bands were estimated using 100bp DNA ladder (bioline) as standard.

Estimation of diversity among the 8 studied *Ocimum* species was done by scoring for the presence or absence of amplified bands as '1' or '0' manually and respectively across the 10 SCoT primers, to generate a binary matrix from the gel pictures of the markers used. Scoring was done only for clear, unambiguous and reproducible bands. To distinguish between the *Ocimum* species studied, polymorphic information content (PIC) and gene diversity were determined. NTSYSpc (Rohlf, 2005) and Power marker statistical soft wares were used to construct UPGMA dendrogram using hierarchical clustering.

RESULTS

Table 1 showed the distribution of the *Ocimum* species used. The eight species comprised three *O. basilicum*, two *O. canum*, two *O. tenuiflorum* and a species of *O. gratissimum*. *Ocimum basilicum* (B_1) is distinct with its lack of purple colour while the other two had purple colouration but *O. basilicum* (B_2) has prominent hairy raceme in addition. *Ocimum canum* (C_2) is hairier with small leaves compared to *O. canum* (C_1). The two *O. tenuiflorum* species had varying colours. While *O. tenuiflorum* (Tp) is purple, *O. tenuiflorum* (TG) is green in colour. The SCoT markers used showed considerable level of polymorphism. A total of 117 amplified bands were observed, out of which 28 were polymorphic (23.93%; Table 2). SCoT 13 showed both the highest polymorphic information content {(PIC), (0.5815)} and gene diversity (0.6563) while SCoT 3 showed the least PIC (0.3047) and gene diversity (0.3750), with average PIC and gene diversity values of 0.4771 and 0.5500 respectively (Table 2). The number of alleles detected varied from 2 (SCoT 3, SCoT 28) to 3 (SCoT 1, SCoT 13, SCoT 16, SCoT 22, SCoT 33, SCoT 35 and SCoT 36; Table 2). Major allele frequency ranged from 0.3750 (SCoT 13) to 0.7500 (SCoT 2 and 3), with an average of 0.5625 (Table 2). The phylogenetic analysis separated the 8 *Ocimum* species into two groups, where *O. basilicum* (B_1), *O. basilicum* (B_2), *O. basilicum* (B_3) and *O. gratissimum* (GR) belonged to Group 1 while *O. canum* (C_1), *O. canum* (C_2), *O. tenuiflorum* (TG) and *O. tenuiflorum* (TP) belonged to Group 2 (Figure 2). Members within each group showed a higher level of relatedness than members in the other group.

DISCUSSION

Estimating genetic diversity and taxonomic relationship among *Ocimum* species is necessary for the conservation of its gene pool and design of appropriate crop improvement program per time (Makmur *et al*., 2020). Using molecular approach in the assessment of this diversity offers the advantages of providing data that is not environment-dependent, can be objectively analysed and obtained within a relatively short time (Jonah *et al*., 2011). Development of new alternative markers such as SCoT, in which polymorphism is generated from genic regions in the genome have resulted from recent advancement in genomics (Tiwari *et al*., 2016). Bhawna *et al*. (2017) stated that amplification products by these markers might be related to traits and their functional genes. Abuhashem *et al* (2023) stated that huge success has been recorded in the use of SCoT markers to distinguish between closely related basil plant species and cultivars, making them invaluable in the study of genetic relationships in the genus *Ocimum*.

The present study on the molecular characterisation of *Ocimum* species collected from different parts of Nigeria, revealed the level of inter-specific relatedness and diversity in the genus. Considerable amount of genetic differences, as deduced from the average gene diversity (0.5500) and PIC (0.4771) was observed among the eight *Ocimum* species studied. Gupta *et al* (2021) reported average PIC of 0.65, following the assessment of 36 accessions of *Ocimum*, using 18 SCoT markers. Their result, although slightly higher than the result obtained in this study, may be due to the utilization of large number of materials. Using SCoT for intensive diversity studies of *Ocimum* species in Nigeria will help in the reliable identification of several genotypes spread across the country and possibly, novel traits that can be used in future breeding programmes.

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Table 1: Collection Details of *Ocimum* species studied

Sample Code	Scientific Name	State	Coordinate
B_1	*O. basilicum*	Ekiti	N 07º37'16.302" E 05º12'00.197"
B_2	*O. basilicum*	Ekiti	N 07º37'09.810" E 05º12'03.407"
B_3	*O. basilicum*	Ogun	N 06º45'04.140" E 02º50'40.776"
TP	*O. tenuiflorum*	Oyo	N 07º25'23.327" E 03º50'25.566"
TG	*O. tenuiflorum*	Oyo	N 07º27'03.539" E 03º51'54.233"
C_1	*O. canum*	Ogun	N 06º46.879' E 002º51.067'
C_2	*O. canum*	Ogun	N 06º46.02' E 002º46.01'
GR	*O. gratissimum*	Oyo	N 07º27'01.367" E 03º51'53.928"

Table 2: Marker parameters used in the analysis of the *Ocimum* species

S/N	Primer Name	Primer Sequence	No of alleles	PIC	Gene Diversity
1	SCoT 1	CAACAATGGCTACCACCA	3	0.5547	0.6250
2	SCoT 2	CAACAATGGCTACCACCC	3	0.3706	0.4063
3	SCoT 3	CAACAATGGCTACCACCG	2	0.3047	0.3750
4	SCoT 13	ACGACATGGCGACCATCG	3	0.5815	0.6563
5	SCoT 16	ACCATGGCTACCACCGAC	3	0.5112	0.5938
6	SCoT 22	AACCATGGCTACCACCAC	3	0.5112	0.5938
7	SCoT 28	CCATGGCTACCACCGCCA	2	0.3589	0.4688
8	SCoT 33	CCATGGCTACCACCGCAG	3	0.4683	0.5313
9	SCoT 35	CATGGCTACCACCGGCCC	3	0.5547	0.6250
10	SCoT 36	GCAACAATGGCTACCACC	3	0.5547	0.6250
	Mean		2.8	0.4771	0.5500

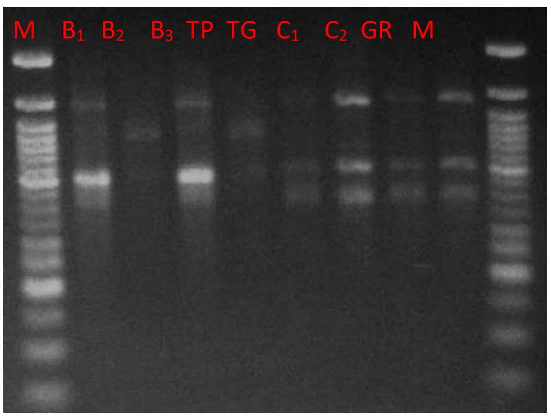

Figure 1: DNA profile of eight *Ocimum* species resolved by SCoT 16; M stands for 100 bp ladder.

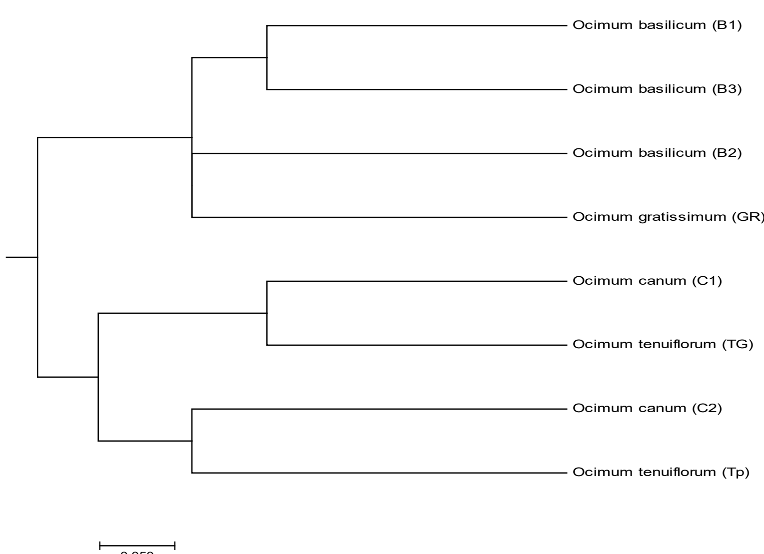

Figure 2: UPGMA dendrogram of *Ocimum* species by SCoT markers

PRELIMINARY STUDY OF PINEAPPLE SUCKER PRODUCTION FROM STEM USING DIFFERENT GROWTH MEDIA

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ABSTRACT
Pineapple is an important tropical fruit crop all over the world, however its field genetics and breeding has not been extensively explored. Pineapple stems where cut into 3 equal parts from the leaf producing regions-proximal, median and distal. These cuttings were further done horizontally and vertically for each region. The ratoons were planted in different growth Media – Topsoil, Sawdust and 50/50 Topsoil with Sawdust. Sole topsoil media recorded the highest number of suckers (5.8611) while the lowest sucker production was recorded in topsoil and sawdust mixture (3.8611). The highest number of overall suckers were recorded at the distal position which was split horizontally before sowing. From the study, it shows that the optimum sucker production was achieved when the distal region of the ratoon was cut horizontally and sown in sole topsoil.
Keywords: *Pineapple, Stem, Sucker, Sole Topsoil, Sawdust.*

INTRODUCTION

Pineapple (Ananas comosus var. comosus) is a monocotyledon perennial plant in the family Bromeliaceae (da Silva et al., 2013; Reinhardt *et al*., 2018). Pineapple is an important tropical fruit, which is rated third most produced fruit in the world (Chotangui *et al.,* 2019). This fruit crop lacks proper study in the field genetics and breeding; however, few improved varieties are available which in MD2 (Bartholomew *et al.,* 2010, Tang *et al*., 2014). Pineapple is mainly propagated asexually through crowns, slips and suckers (Hossain, 2016) in Nigeria, the use of crowns and slips in vivo are most common. The commonest varieties cultivated in Nigeria include, 'Sugarloaf', 'Queen' and 'Smooth Cayenne'; the latter is the commonest and most cultivated in the country (Chotangui *et al.,* 2019). Nigeria is ranked among the highest producer of this fruit in the world, with the production of more than 40% pineapple production in the continent (FAO, 2013) but the production has dropped over the years (FAOSTAT, 2017).

One of the major constraints in pineapple production is the lack of enough quality planting materials that are relatively uniform in age and/or sizes (Ranawana and Eeswara, 2008; Agogbua and Osuji, 2011; Dennis and Okpeke, 2018). Unavailability of planting materials has been attributed to one of the impediments of technical efficiency in pineapple farming business in Nigeria, crumbling the livelihood of many farmers that depends of pineapple production (Baruwa, 2013). Adegbite and Adeoye (2015) reported that pineapple farmers' productivity will increase with an increase in numbers of being suckers cultivated. In-vitro sucker production could have solved the problem but the cost implication remains the impeding factor.

Most farmers often resort to the use of planting materials obtained from cultivated fields which may be infected and are always not uniform. In vivo propagation of pineapple still remains the simplest and cheapest means sucker production in order to breakeven in pineapple production business. Harnessing the buds present on pineapple stem (ratoon) to increase production of suckers is imperative in solving technical efficiency of pineapple production in the country. Consequently, this study aims to study different media for production of pineapple suckers from ratoons while potency of the bud's position on the stem were also examined.

METHODOLOGY

The was carried out in National Horticultural Research Institute (NIHORT), Ibadan using a screenhouse. The stems were cut into three equally from the leaves producing region respectively and labelled proximal, median and distal (Plate 1). Some of the split ratoons were sown whole (W) while some were further divided into two (S) before sowing either vertically (V) or horizontally (H). The ratoons were buried into different growth media which are Topsoil, Sawdust and 50/50 Topsoil and Sawdust. Watering was done when necessary. Sprouted suckers were removed when they attained 15 cm height while the number of suckers produced per treatments were recorded. Data were analysed using descriptive data analysis.

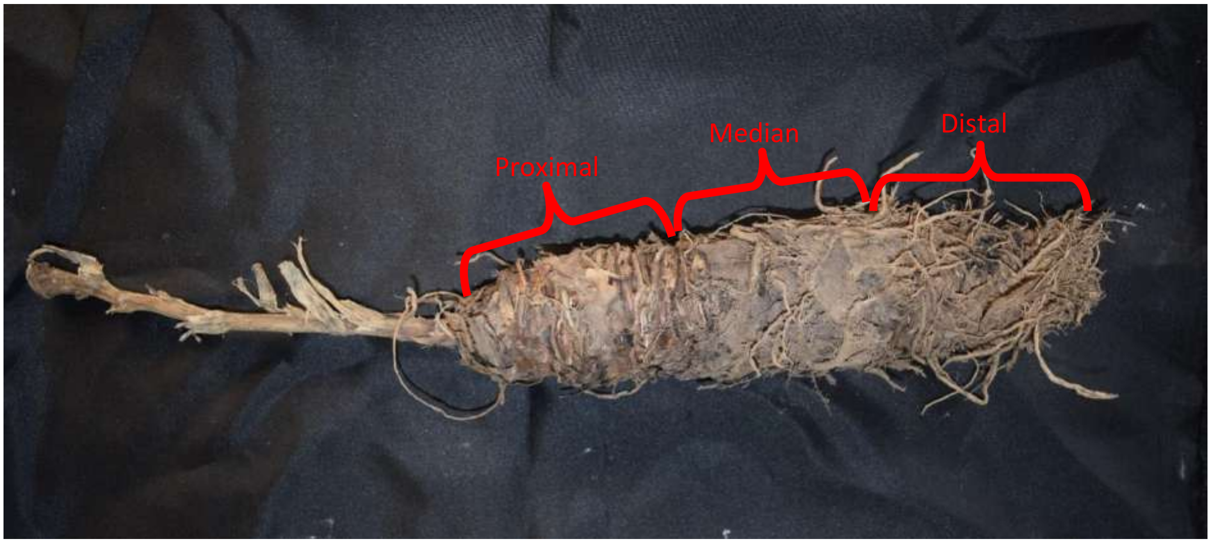

Plate 1: Pineapple stem (ratoon) and the label showing divisions of the stem

RESULTS AND DISCUSSIONS

The highest number of suckers were produced in sole topsoil media (5.8611 suckers) while the lowest sucker production was recorded in Topsoil and sawdust mixture (3.8611 suckers). The increase in highest number of suckers production from topsoil media could be as a result of higher temperatures which could aid sprouting of dormant axillary buds compare to other media. Hepton (2003) reported the importance of temperature in sucker production through pineapple ratoons. The ratoons planted sown whole produced less than less of the ratoons split into two before sowing (Table 1; Figure 1). The sectioning of the stems can further aid in suppression of lateral buds hormones for the initiation of axillary buds. Reinhardt et al. (2018) and Maerere (1995) reported that the techniques of pineapple macro propagation is dependent on inhibiting lateral buds for the development of axillary buds.

The overall position where suckers' production was recorded was at the proximal; however, the highest number of overall sucker and was recorded at the distal split horizontally sown ratoon (10.11 suckers; Table 1; Figure 1). This result corroborates the report of Reinhardt et al. (2018) and Hepton (2003) that presences of dry matter on pineapple stem is a good indication of starch reverses for initiation of axillary buds. Reduction in sucker production recorded in distal position in other treatments may be as a result of limited period allotted for this experiment.

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Table 1: Pineapple Sucker Production from Different Media, Buds position and Treatments.

		Media			
Treatment	**Position**	**Topsoil**	**Topsoil+Sawdust**	**Sole Sawdust**	**Average**
	Proximal	2.3333	0.3333	4	2.2222
Vertical Whole	Median	0	6	1.3333	2.4444
	Distal	1	0	0.3333	0.4444
	Proximal	3.3333	3.3333	7.6667	4.7778
Vertical Split	Median	2	3.6667	7.6667	4.4444
	Distal	6.6667	3	1.6667	3.7778
	Proximal	6	2	7.6667	5.2222
Horizontal Whole	Median	6.3333	0.6667	2.3333	3.1111
	Distal	5.6667	0.33333	0	2.000
	Proximal	12	8	6.3333	8.7778
Horizontal Split	Median	11.6667	8	6	8.5556
	Distal	13.3333	11	6	10.1111

Average	5.8611	3.8611	4.25

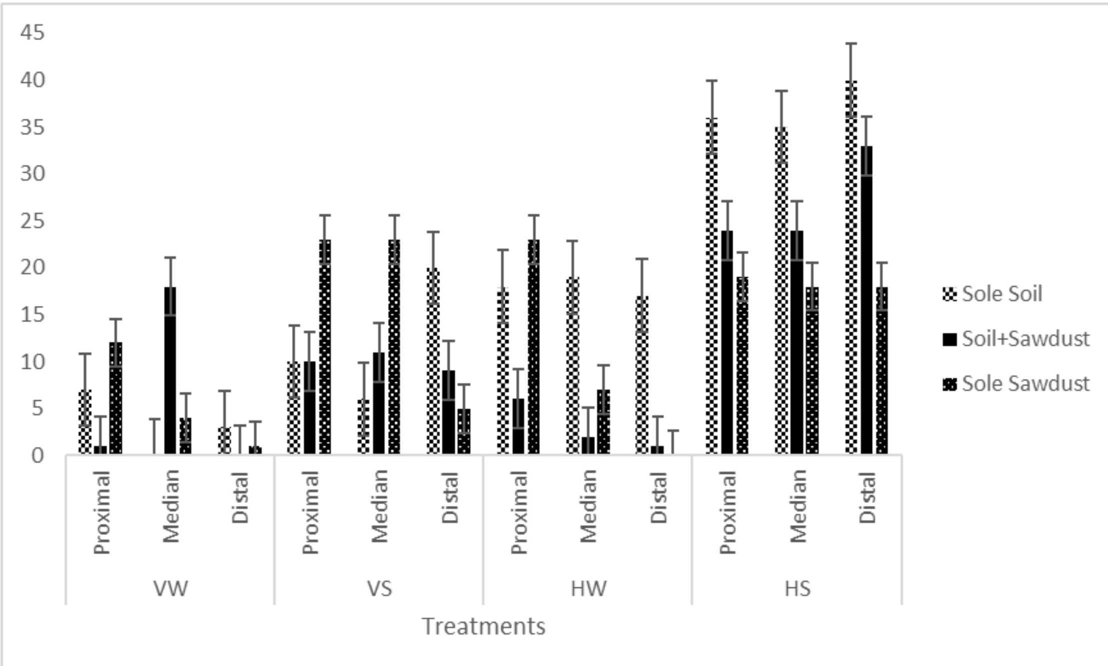

Figure 1: Pineapple sucker production at different stem buds using different media.

ATTENUATION OF ETHANOL LEAF-EXTRACT OF *PHYLLANTUS RETICULATUS* ON DEXAMETHASONE INDUCED OXIDATIVE STRESS IN ALBINO RATS.

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ABSTRACT

This study was carried out to evaluate the attenuation effect of ethanol leaf-extract of Phyllantus reticulatus on dexamethasone induced oxidative stress in albino rats. Thirty (30) rats were used and was divided into six groups of five rats each (Aa, Ab, Ac, Ae, Af, and Ca). They were allowed to acclimatize for two weeks and were given feed and water, with their weight taken every morning. Different dose (30 ug/kg) of dexamethasone was injected into the rats for 4 days depending on their body weight through intra-peritoreally (IP) so as to induce oxidative stress. 10 g of the extract was dissolved against 100 mL of water. The extract was administered orally for 14 days to treat the rats. Blood sample of the rats was collected for laboratory analysis before and after the treatments inorder to check the oxidative stress indices. The results revealed that malondialdehyde (MDA) level (141.67 ± 6.81) before treatment increased unlike the normal control group (50.67 ± 1.53) while after the treatment, the MDA levels (41.31 ± .70) were significantly (p<0.05) lower compared to negative control group (140.44 ± 44). The result also revealed the effect of the extracts on reduced gluthathione in dexamethasone-induced rat, the treated rat increased significantly (p<0.05) after the treatment (117.21 ± 3.45) when compared to the negative control before treatment (33.68 ± 3.64). From our results, this study revealed that the ethanol leaf extract of Phyllantus reticulatus has a therapeutic effect on dexamethasone induced oxidative stress.

Keywords: *Oxidative Stress, Malondialdehyde, Albino Rats, Gluthathione, Antioxidant*

INTRODUCTION

Plants remains the valuable starting material in drug development which include allopathic medicine, herbal medicine, homoeopathy and aroma therapy (Ajibesin, 2011). The distribution of these important plants cut across all plant family, the knowledge which plants has been passed down through generations of traditional medicine practices. *Phyllanthus reticulatus* remains an important traditional medicinal plant whose different plant part has been used in treatment. *Phyllanthus reticulatus* is a multi-potential plant which has the capacity to heatstroke, helminthiasis, oral infections, oral lesions in the mouth, tooth and tongue (Ariful *et al*., 2010). *Phyllanthus reticulatus* has been proved to show antidiabetic, antiviral, anticancer, antiplasmodial, hepatoprotective, antibacterial and anti-inflammatory activities. The plant contains tannic acid, terpenoids, flavonoids, phenolic compounds and steroids as main chemical constituents (Sharma *et al.*, 2013). The issues of oxidative stress and its modulation by antioxidants currently have received more attention than ever before. Oxidative stress is the result of an imbalance in pro-oxidant/antioxidant homeostasis that leads to the generation of toxic reactive oxygen species (ROS), such as hydrogen peroxide, organic hydro peroxides, nitric oxide, superoxide and hydroxyl radicals etc.

Despite, the belief that oxidative stress is detrimental and should be treated or prevented, several recent studies, meta-analyses, and systematic reviews (Bjelakovic *et al*., 2007; Hereberg *et al.,* 2004; Bjelakovic *et al*., 2008) were unable to confirm the expected benefit of supplemental antioxidants. Some studies even found deleterious effects related in individuals randomized usage of supplemental antioxidants which is referred to has antioxidant paradox (Halliwell et al., 2000). The search for natural antioxidants from plants would continue to be a dominant research interest for many years. These antioxidant molecules often neutralize or quench the reactive oxygen species (ROS) by either hydrogen atom transfer or single electron transfer mechanisms. Several chemical and biochemical protocols have been used in the evaluation of plant extracts as antioxidants. Thus, the capacity to scavenge ROS and free radicals or inhibits lipid peroxidation can be measured quantitatively as the strength of antioxidant activity. This study aims to evaluate the attenuation effect of ethanol leaf-extract of *Phyllantus reticulatus* on the treatment of induced oxidative stress in albino rats. Thus, the objectives of this study is to access the effect of ethanol leaf-extract of *Phyllantus reticulatus* on the levels of malondialdehyde and reduced glutathione in the induced albino rats.

METHODOLOGY

The leaves of *Phyllantus reticulatus* was collected from hilltop waterworks road in Abakaliki Ebonyi State. The leaves were washed and air dried at room temperature for three (3) weeks. The dried leaves were then grinded into powdered, stored in airtight container which were kept in refrigerator ($4^{O}C$). 100 g of the sample was weighed and poured into a container, 1000 mL of ethanol was then added to it and stared in other to get a homogeneous mixture and this was allowed to stay for two (2) days. White muslin was used to sieve the sample to get the extract in liquid form. The ethanol was allowed to evaporate leaving extract in the container which was then stored in a refrigerator for usage. A total number of 30 albino rats were used for this study. They were allowed to acclimatize for two weeks and fed with commercially available rat feed and clean water. The albino rats (n=30) were divided into six (6) groups (Aa, Ab, Ac, Ae, Af and Ca); group Aa, Ab, Ac, Ae, and Af were administered dexamethasone depending on the weight of the rat for four (4) days in other to induce oxidative stress while group Ca was the normal control which was given only normal saline. Two (2) rats were taken from each treatment after 2 weeks to ascertain the effect of oxidative stress induced.

Group Aa, Ab and Ac were administered with the ethanol leaf extract of *Phyllantus reticulatus*, Ae was given only standard drug (Amlodipine) while Af and Ca remained Negative and Normal control groups respectively. Group Aa, Ab and Ac were treated with 200 mg/kg, 400 mg/kg, 600 mg/kg respectively. The treatments were administered for 2 weeks after which blood samples were collected for analysis of malondialdehyde (MDA) and reduced gluthathione.

Biochemical analysis

For determination of test for malondialdehyde, 5 mL of serum was mixed with 4.5 mL of normal saline and 1 mL of sample was mixed with 3 mL of TCA. The mixture was then centrifuged and 2 mL of the supernatant was taken and mixed with 1 mL of TBA. The mixture was then boiled for 20 minutes and its absorbance taken at 530 nm. Determination of the Activities of Reduced Gluthathione was carried out using 1 mL of the supernatant from MDA mixed with 2.5 mL of phosphate buffer and 0.5 mL of DTNB, its absorbance was taken at 412 nm.

RESULTS AND DISCUSSION

In malondialdehyde, the result of the effect of ethanol leaf-extract of *Phyllantus reticulatus* on the level of malondialdehyde (MDA) as shown in figure 1 revealed that before the treatment, there was a significant increase ($p > 0.05$) among negative control, standard drug, 200 mg/kg, 400 mg/kg and 600 mg/kg when compared with the normal control. Administration of ethanol leaf-extract of *Phyllantus reticulatus* after treatment reveals a significant decrease ($p <0.05$) in the level of MDA which was toward the normal control.

In reduced gluthathione, the result of the effect of ethanol leaf-extract of *Phyllantus reticulatus* on reduced gluthathione (GSH) concentration as shown in figure 2 revealed that before the treatment, the level of GSH significantly decreased ($p < 0.05$) in negative control, standard drug, 200 mg/kg, 400 mg/kg and 600 mg/kg when compared to the normal control. Administration of the extract brought about a significant increase ($p < 0.05$) in the level of GSH. The malondialdehyde (MDA) and reduced gluthathione results obtained from this study are in line with the report of Alizadeh and Kheirouri (2019) who studied the effect of administration of Curcumin on human beings, stating that MDA level significantly reduced while GSH level increased after treatment. Glutathione (GSH) is a thiol and tripeptide which is synthesized by glycine, cysteine, and glutamate in the liver and acts as a vital factor in metabolic protective functions, including the reduction of hydroperoxides, the quenching of free radicals, and the detoxification of xenobiotics (Wu *et al.,* 2004). The GSH-dependent antioxidant system consists of GSH and an array of functionally related enzymes, including glutathione S-transferase (GSH-ST), glutathione peroxidase (GSH-Px) and glutathione reductase (GSH-Rd). GSH-ST is not only capable of conjugating a number of potentially toxic electrophilic xenobiotics to the nucleophilic GSH, but can also catalyze reactions to reduce peroxides. Glutathione can reduce hydroperoxides as well as H_2O_2 but also oxidizes GSH. Glutathione then reduces oxidized glutathione (GSSG) to the GSH.

CONCLUSION

Ethanol leaf extract of *Phyllantus reticulatus* has the potential to attenuate dexamethasone induced oxidative stress in rats

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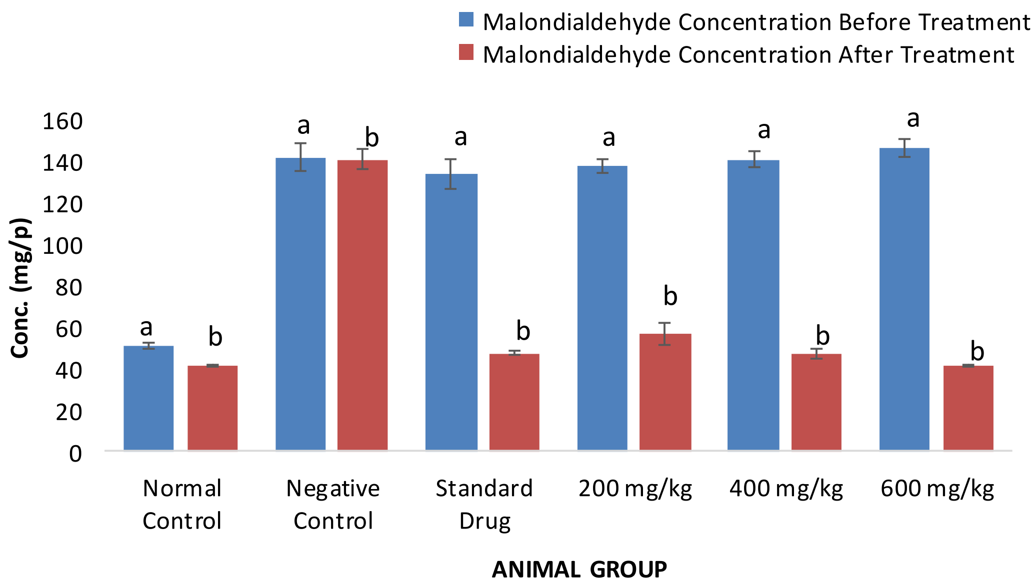

Figure 1: The effect of ethanol leaf-extract of *Phyllantus reticulatus* on malondialdehyde concentration in rat induced oxidative stress.

Data are presented into six different groups. The groups with the same alphabet 'a' on them are those that were not treated while those with alphabet 'b' were treated.

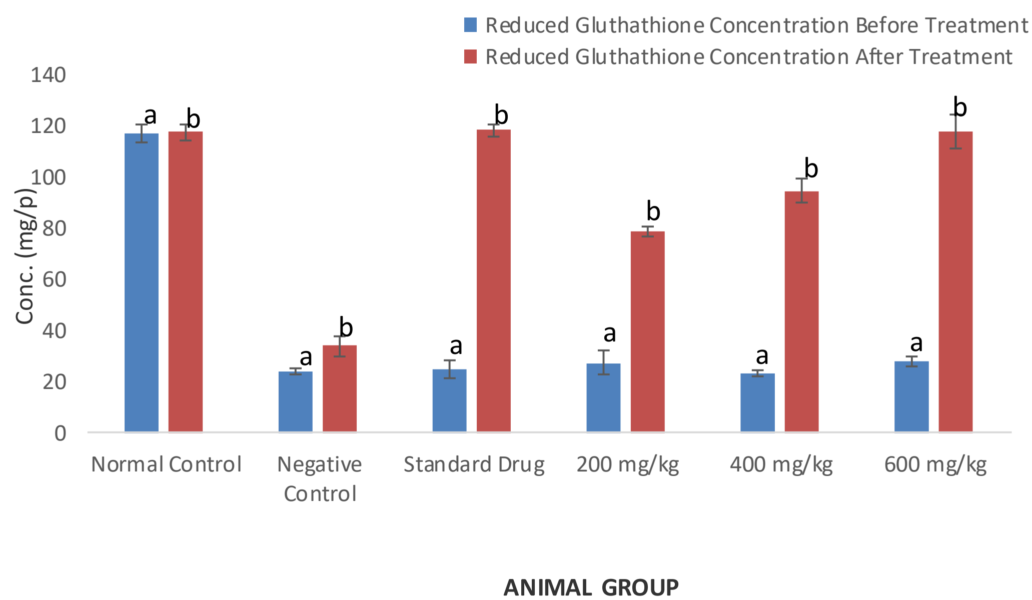

Figure 2: The effect of ethanol leaf-extract of *Phyllantus reticulatus* on reduced gluthathione concentration in rat induced oxidative stress.

Data are presented into six different groups. The groups with the same alphabet 'a' on them are those that were not treated while those with alphabet 'b' were treated.

SEX DIFFERENCES IN PHYTOCHEMICAL AND NUTRITIONAL COMPOSITIONS OF FLUTED PUMPKIN (*Telfairia occidentalis*) LEAVES

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INTRODUCTION

Fluted pumpkin (*Telfairia occidentalis*), commonly known as ugwu in Nigeria, is a nutritious leafy vegetable widely cultivated in the southern and eastern parts of the country [1]. This green leafy vegetable is highly consumed and used in preparing different types of meals, and even the squeezed green leaves (green drink) are normally taken as traditional medicine [2] due to their high nutrient content. The role of vegetables cannot be overestimated, as they play a significant role in humans nutrition. Vegetables are indispensable constituents of the human diet, supplying the body with minerals, vitamins, dietary fibre, certain hormones, and precursors in addition to protein [2]. *T. occidentalis* belongs to the family *Oliffieaceae* and the sub-family *Cucurbitaceae* [3]. The shrub is a dioecious plant whose sex is not known until after flowering. The female plant has very broad leaves with a big stem and is usually more succulent, producing fruits that contain seeds, while the male plant produces only flowers with smaller leaves and tiny stems [3]. Akwaowo *et al*. [4] reported that the older leaves of fluted pumpkin were higher in percentage crude protein, crude fat, ash, and crude fibre, while the younger leaves were higher in moisture content and carbohydrate.

The leaves are rich in proteins, oil, vitamins, and minerals that are advantageous to human health, though they have a low crude fibre content. They are also very rich in folic acid, calcium, zinc, potassium, cobalt, copper, iron, and vitamins A, C, and K [5]. The leaves have both medicinal and nutritional values [6], while the young leaves can be sliced and stored in a bottle to which salt and coconut water are added and subsequently used for the treatment of convulsions [7]. While previous research has investigated the phytochemical and nutritional profiles of *T. occidentalis* leaves, limited attention has been given to the potential sex-based differences in these properties. Investigating such differences is essential for a comprehensive understanding of the plant's chemical composition and its potential implications for dietary and therapeutic applications. This research aims to bridge the existing knowledge gap by comparing the phytochemical and nutritional properties of male and female *Telfairia occidentalis* leaves.

MATERIALS AND METHODS

Collection and identification of plant materials

Fresh leaves of 20 accessions of *Telfairia occidentalis* (male and female), were taken from an experimental plot at the National Horticultural Research Institute (NIHORT), in Ibadan, Oyo State, Nigeria. The plants were identified by a Plant Breeder from Genetic Resource Unit, National Horticultural Research Institute (NIHORT), Ibadan, Oyo State, Nigeria

Preparation and treatment of *Telfairia occidentalis* leaves

The leaves were separately and thoroughly washed with water and dried in a dehydrator at 40 ºC for 48 hours to avoid loss of active compounds. The dried leaves were ground to powder using an electric grinder. The powder samples were then stored in appropriately labelled, airtight bottles for further use [20].

Proximate Analysis of leaves of Male and Female *Telfairia occidentalis*

Determination of protein content

The crude proteins were determined by the macro Kjeldahl method as described in literature [21]. Briefly, 2g of the sample was introduced into a Kjeldahl digestion flask together with 10g of copper sulphate and sodium sulphate in the ratio of 5:1. 25 mL of concentrated sulphuric acid was added to the digestion flask and the digestion was carried at about 1500 °C in the fume cupboard until frothing ceased. A clear and light blue coloration was observed. The digest was cooled and diluted up to the mark with distilled water in 100 mL volumetric flask. 10 mL of the diluted mixture was poured into the distillation apparatus and 18 mL of 40% of sodium hydroxide was added. 25 mL of 2% boric acid was added into the receiving conical flask and two drops of bromocresol green and methyl red mixed indicator was added. The distillation was continued until boric acid solution turned from pink to yellowish green. After the distillation, the solution in the conical flask was titrated against 0.1N hydrochloric acid until the end point was reached. A blank was taken using the same procedure using only with distilled water. The protein was calculated as:

$$\text{Protein (\%)} = \frac{TV \times 0.014 \times 100(mL) \times 0.01 \times 100 \times 6.25}{\text{Weight of the sample (g) Aliquot used for distillation (ml)}}$$

where,
TV = Titre Value

Determination of crude fat content

The fat content was determined as described in literature [22]. Briefly, 5g of sample was mixed with 0.88mL of ammonia solution and 10 mL of 95% ethanol and mixed well. 25 mL of diethyl ether was added to the mixture and shaken vigorously for 1 minute. This was then followed by addition of 25 mL of petroleum ether and shaken vigorously to mix well. The mixture was then left to stand for an hour to allow aqueous and organic phase to separate. The fat extract (organic phase) was collected and the solvent was removed by distillation. The fat in the flask was dried in the oven at 100 ºC for 30 minutes and the solvent was removed completely. The flasks were then cooled in a desiccator and were weighed for their mass of fat. The percentage fat was calculated by the following formula.

$$\text{Crude fat (\%)} = \frac{W4 - W3}{W2 - W1} \times 100$$

where; W1 = Weight of empty thimble, (g) W2 = Weight of thimble + sample, (g); W3 = Weight of empty flask, (g) W4 = Weight of flask + fat, (g)

Determination of Crude Fibre

The crude fibre was determined according to the procedure reported in literature [23]. It was determined as the fraction remaining after digestion with standard sulphuric acid and sodium hydroxide. Briefly, 2g of the sample was hydrolysed in a beaker containing 299 mL of 1.25% of sulphuric acid and then boiled for 30 minutes. The mixture was filtered under vacuum and the residue was washed with hot distilled water for 3 times and then boiled again for 30 minutes with 200 mL of 1.25% of sodium hydroxide and filtered again. The digested sample was washed with hydrochloric acid to neutralize sodium hydroxide and then with hot distilled water for 3 times. The residue was taken into a crucible, dried at 100 ºC for 2 hours in an oven, the sample was cooled in a desiccator and then weighed. The sample in the crucible was incinerated at 500? for 5 hours until all carbonaceous matter were burnt. Finally, the crucible containing the ash was cooled in the desiccator and weighed.

The percentage crude fibre was calculated by the following formula;

$$\text{Crude fibre} = \frac{W1 - W2}{W} \times 100$$

where: W1 = Weight of the sample before ashing, g; W2 = Weight of the sample after ashing, g; W = Weight of the sample, g

Ash content determination

The ash content was determined by direct heating method as described in literature [24]. Briefly, 2g of each one of the yoghurt samples was weighed in dried glass crucibles separately. The samples were then incinerated to ash in a muffle furnace for 3 hours at 550 ºC. The crucibles were then removed, cooled in desiccator and the weight of the ash was determined. The percentage ash content was calculated by the following formula.

$$\% \text{ ash} = (Z-X/Y-X) \times 100$$

where; X=weight of empty crucible; Y=weight of crucible + sample; Z=weight of crucible + ash

Determination of moisture content

The percentage of moisture content was determined by oven method as described in literature [24]. Briefly, 2g of yoghurt samples was dried in the oven for 24 hours at 100 °C. The percentage moisture content was calculated by the following formula.

$$\text{Moisture content (m.c \%)} = \frac{Wm}{Wm + Wd} \times 100$$

where; *m.c.* = moisture content, percent wet basis; Wm = mass of water evaporated, g; Wd = mass of dry matter, g

Determination of carbohydrates content

Carbohydrates were determined using a mathematical function below as described in literature [24].

CHO=100 - % (ash + protein + fat + crude fibre + moisture)

Phytochemical analysis of leaves of the male and female *Telfairia occidentalis*

Determination of tannins

Tannin determination was done according to the method of AOAC with some modifications. 1mL of the extract was filtered into a 100 mL volumetric flask, followed by adding 20 mL of distilled water, 2.5 mL of Folin-Denis reagent and 10 mL of 17% aq. Na_2CO_3 was also added and thoroughly mixed together. The mixture was made up to 100 mL with distilled water, then mixed and allowed to stand for 20 min. The bluish-green color developed at the end of the reaction mixture of different concentrations ranging from 10-50 ppm. The absorbance of the tannic acid standard solutions as well as sample was measured after color development at 760 nm using the AJI-C03 UV-VIS spectrophotometer. Results were expressed as mg/100L of tannic acid equivalent using the calibration curve: Y = 0.003x - 0.0084, R2 = 0.9818, where x was the absorbance and Y was tannic acid equivalent.

DPPH scavenging assay

The method of Shen *et al* [29] was used for the determination of scavenging activity of DPPH radical in the extract solution. A portion of 0.135 mM DPPH prepared in methanol containing 0.5 mL of the extracts. The reaction mixture was vortexed thoroughly and left in dark at room temperature for 30 min. The absorbance was measured spectrophotometrically at 517 nm. The scavenging ability of the plant on DPPH was calculated using the equation:

DPPH scavenging activity (%) = [(Abs control – Abs sample)]/ (Abs control)] ×100, where Abs control is the absorbance of DPPH + methanol; Abs sample is the absorbance of DPPH radical + sample extract or standard. The results were expressed in % % inhibition = DPPH scavenging activity (%).

Determination of total carotenoid content

Total carotenoid content was quantified according to the method outlined by Campos *et al*. [25]. About 1 g sample was homogenized in 20 mL acetone and the solution was filtered. The process was repeated until attaining complete removal of colored pigments. Acetone was evaporated and dry sample extract dis-solved in 60 mL petroleum ether, filtered, transferred to 100 mL volumetric flask and volume completed with petroleum ether. Then, 2 mL of this solution was placed in a test tube with 8 mL petroleum ether. Absorbance was read at 475 nm using UV-Vis spectrophotometer and concentration was calculated with a standard β-carotene curve.

Ascorbic acid determination

Ascorbic acid content was determined applying AOAC official method 967.21 [26]. Sample (5 g) was homogenized in 100 mL metaphosphoric acid-acetic acid solution in ratio of 1.0: 0.5 and filtered. The resulting solution was titrated using phenol-2,6-dichloroindophenol dye (prepared using 50 mg 2,6-dichloroindophenol and 42 mg $NaHCO_3$ in approximately 50 mL water and dilute to 200 mL with water) until light pink color was obtained persisting for at least 5 seconds. Ascorbic acid solution was used to standardize the dye.

Total antioxidant assay

The antioxidant power of LTE and standards was evaluated by the phosphomolybdenum reduction assay according to the procedure described by Prieto *et al*. [27] A reagent solution prepared contained ammonium molybdate (4 mM), sodium phosphate (28 mM), and sulfuric acid (0.6 M), mixed in 1:1:1

ratio, respectively. Accurately, 0.3 mL of the concentrations of the extracts was mixed with 3 mL of the reagent solution. The mixtures were incubated for 1 h at 95°C after which the absorbance of the green phosphomolybdenum complex formed was measured at 695 nm against a blank. For standards ascorbic acid, concentrations of 20–100 µg/ml were used. Each concentration was prepared in triplicates. A mixture containing 0.3 mL methanol and 3 mL reagent solution was used as a blank.

Extraction and determination of phytate

The principle of this method relies on a conversion of free phytic acid and a colorimetric measurement of the liberated organic phosphorus. Sample (2.0 g) was extracted with 40 ml of 2.4% HCl (68.6 ml of 35% hydrochloric acid in total volume of 1 litre of D2O) under constant shaking at room temperature (25°C) for 3 h. All extracts were then filtered using Whatman No. 1 filter paper. The content of phytate was determined by using a spectrophotometric method, with an absorbance (A) wavelength at 640 nm, outlined in Nkama, and Gbenyi, [28]. The amount of phytic acid was calculated from the organic phosphorus by assuming that one molecule of phytic acid (containing six molecules of phosphorus (P)) was digested as per the equation below [28]:

Phytate mg/g sample

$$\text{Mean } \frac{K'' * A * 20m}{0{:}282 * 1000}$$

Where, A = absorbance; ''K'' = standard P (µg)/ [A/volume (ml)]; phytate = 28.2% P; 20 = extract volume (ml) of 1 g sample; 1000 = conversion from µg/g to mg/g. The results were reported in percentage of phytate in 100 grammes of sample.

Determination of mineral composition

The sample was investigated for elemental composition by using atomic absorption spectrophotometer (AAS- Bulk Scientific model AVG 211) after ashing (0.5g of the sample) and acid digestion. Appropriate working standard solution was prepared for each element. The calibration curves were obtained for concentration versus absorbance. The data were statistically analysed by using fitting of straight line by least square method. Laboratory procedures for the preparation and determination of micronutrients were used as outlined by Paul *et al*. [18] for samples

RESULT AND DISCUSSION

Compositional values of phytochemicals in male and female *T. occidentalis* leaves

The male and female *T. occidentalis* leaves contain varying levels of certain phytochemical components such as vitamin C, tannin, and total antioxidant (Table 1), while total carotenoid, phytate, DPPH, and Iron chelating were relatively equal quantities in both male and female, with a difference of less than 0.1. As shown in Table 1, vitamin C and total antioxidant content were higher in the male leaves (36.64 g and 561.61 g, respectively), while in the female leaves, tannin (60.87 g) was higher. Male and female *T. occidentalis* contain several vital phytochemicals, as seen in this study. The study agreed with the earlier findings by Temitope *et al*. [8] that the pumpkin contains tannin and other phytochemicals that may inhibit inflammation and tumour growth and boost the production of detoxifying enzymes in the body. Vitamins found in the *T. occidentalis* leaves of the male were in higher amounts than in the female plants [8]. Hussaine *et al*. [9] explained that most of the phytochemicals are secondary metabolites produced in plants and do not participate in metabolic processes within the plants but are the result of metabolic activities in the plant.

Compositional values of proximate in male and female *T. occidentalis* leaves

The proximate contents of the male and female leaves are represented in Table 2. With more than 40% of carbohydrates were the most prominent components present in both male and female leaves, followed by crude proteins (21.13% and 21.05%) and crude fibres (15.00% and 14.92%). The Ash content mean values in male and female leaves were 9.91 and 10.00%, respectively. Moisture content (6.29% and 6.27%) and lipid content (6.09% and 6.25%) of the male and female *T. occidentalis* leaves sampled were generally low when compared with the values obtained by Idris [10], who got 87%, although a slight increase in protein, ash, fiber, lipid and CHO content was observed in the leaves of female plant. This report contrasted the values presented by Usunobun and Egharebva [11], who obtained 7.45%, 6.60%, and 10.94%, respectively, which were closer to the values obtained in this study.

The values obtained for the various proximate contents between the male and female *T. occidentalis* were very close. The findings in the study agree with the report by Mohd *et al*. [12], Kajihausa *et al*. [13], Adeyeye and Omolayo [14], and Temitope *et al*. [8], who noted that the ash, protein, carbohydrate, lipid, and moisture content of the two sexes compared in the study were within the same range. Kajihausa *et al*. [13] reported an ash value of 8.19 to 10.75. Adeyeye and Omolayo [14] obtained a higher ash value (12.3%), which is not in agreement with the results of this study. The crude fibre content obtained in the study agree with the values reported in the study carried out by Temitope *et al*. [8]: 14.32–29.60% (female) and 14.42–27.01% (male). The results of this study agree with the lipid values reported by Usunobun and Egharebva [11], which are 6.46% and 4.22% by Adeniyi *et al*. [15]. The male and female pumpkin leaves contained a low amount of fat, making them suitable for weight reduction [8].

Rao and Netwmark [16] mentioned that crude fibre has the advantage of aiding digestion, reducing high cholesterol levels, reducing high blood pressure, combating diabetes, and preventing breast cancer. Similar to the ash content, crude fibre content between the male and female *T. occidentalis* was not significantly different. Protein is an important part of the diet responsible for the growth and replacement of worn-out tissues. The female plant obtained higher protein levels as reported by Ajibade *et al*. [5] for protein and fat, which agreed with the results of this study. Ajibade et al. [5] also observed that the male plants had higher fibre and ash contents, which disagreed with the ash value being higher in the female plant leaves in the present study. Ash content reported for female *T. occidentalis* had a higher value than that reported for male *T. occidentalis*, which showed that the female plant leaves contained a higher amount and content of minerals than their male counterparts [12].

Mineral Composition of Male and Female *T. occidentalis* leaves

Table 3 shows the mineral composition of male and female *T. occidentalis*. Zinc, sodium, iron, potassium, and calcium were the minerals extracted, and the amount of mineral content was higher in male leaves than in female leaves. The test obtained presented no trace of lead in the two sexes sampled. The findings agreed with those of Idris [10], who reported that the amount of sodium in the female *T. occidentalis* leaves is low when compared to the male leaves; Adeyeye and Omolayo [14] (Fe: 6.4 mg/100g); and Verla *et al*. [19] (Fe: 7.64 mg/100 g), but it is not in agreement with results of Temitope *et al*. [8] where the minerals obtained from the male and female *T. occidentalis* leaves were the same for calcium, sodium, manganese, and zinc.

Calcium is needed for strong skeletal buildup and formation. The amount of calcium in the body is determined by the ratio of Phosphorus to calcium, as a high amount of phosphorus leads to calcium loss through the urine. Verla *et al*. [19] mentioned that the elements sodium and potassium maintain osmotic balance in body fluids, regulate the uptake and adsorption of glucose, and also enhance the retention of protein. Iron is an important constituent of haemoglobin and is responsible for the transport of oxygen from one part of the body to another [8].

CONCLUSION

This finding highlights the differences in phytochemical and nutritional composition between male and female *T. occidentalis* leaves. Male leaves were found to possess higher levels of vitamin C, total antioxidants and minerals compared to female leaves. These compounds are important for their potential antioxidant, and immune-boosting properties. On the other hand, female leaves exhibited higher tannin content, which has been associated with anti-inflammatory and potential anti-tumor effects. The proximate analysis of the leaves revealed that both male and female *T. occidentalis* leaves had similar ranges of ash, protein, carbohydrate, lipid, and moisture content.

Results from this study show that male and female *T. occidentalis* leaves are rich sources of beneficial phytochemicals and essential nutrients. They could have implications for dietary and therapeutic applications, potentially contributing to antioxidant activity, anti-inflammatory effects, and overall health improvement. However, further research is needed to fully understand the bioavailability and potential health benefits of the identified compounds in *T. occidentalis* leaves.

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Table 1: Phytochemicals composition in male and female *T. occidentalis* leaves

Constituent	Sex	Mean	Range	Std. Deviation
Total Carotenoid ug/g	Female	4.61	3.95 – 5.60	0.45
	Male	4.62	4.04 – 5.38	0.41
Vitamin C mg/100g	Female	36.64	15.85 - 59.93	10.24
	Male	39.51	17.00 - 61.08	13.59
Tannin mg/100g	Female	60.87	33.86 - 85.14	14.35
	Male	58.76	28.71 - 82.43	15.00
Phytate mg/100g	Female	53.23	35.29 - 67.02	9.40
	Male	53.49	32.35 - 67.86	9.50
Total Antioxidant mg/100g	Female	527.90	251.76 - 672.94	106.93
	Male	561.61	383.53 - 711.76	90.12
DPPH % Inhibition	Female	53.15	30.79 - 76.58	13.59
	Male	53.98	33.68 - 73.95	11.15
Iron chelating	Female	4.61	336.08 - 638.16	89.47
mgFeSO4 Eq/100g	Male	4.62	308.08 - 646.16	90.44

Table 2: Proximate Composition of *T. occidentalis* leaves

Proximate	Sex	Mean	Range	Std. Deviation
Protein g/100g	Female	21.13	14.32 - 29.60	3.86
	Male	21.05	14.42 - 27.01	3.31
Ash g/100g	Female	10.00	8.90 - 10.65	0.41
	Male	9.91	8.80 - 10.67	0.52
Fiber g/100g	Female	15.00	13.33 - 16.63	0.64
	Male	14.92	13.11 - 16.72	0.89
Moisture g/100g	Female	6.27	5.38 - 7.62	0.62
	Male	6.29	5.50 - 7.32	0.56
Lipid g/100g	Female	6.25	5.19 - 7.51	0.64
	Male	6.09	5.09 - 8.14	0.76
CHO g/100g	Female	41.34	31.17 - 49.01	4.38
	Male	41.74	32.96 - 51.96	4.28

Table 3: Mineral composition ranges in male and female *T. occidentalis* leaves

Constituent	Sex	Mean	Range	Std. Deviation
Zn Mg/100g	Female	6.34	4.90 - 10.10	1.16
	Male	8.13	4.50 - 16.70	3.43
Na Mg/100g	Female	69.25	4.00 - 160.00	42.17
	Male	79.15	6.00 - 246.00	50.20
Fe Mg/100g	Female	33.45	21.10 - 54.90	9.60
	Male	42.54	17.50 - 88.90	18.59
Pb Mg/100g	Female	-0.18	-4.00 - 3.00	1.84
	Male	-0.55	-5.00 - 2.00	1.60
K Mg/100g	Female	1469.19	722.50 - 2152.50	378.79
	Male	1523.88	1087.50 - 2380.00	363.62
Ca Mg/100g	Female	1043.50	220.00 - 2120.00	578.91
	Male	1230.50	220.00 - 2860.00	638.48

TECHNICAL EFFICIENCY OF TOMATO PRODUCTION IN YAMALTU-DEBA LOCAL GOVERNMENT AREA OF GOMBE STATE

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ABSTRACT
The study investigated technical efficiency of tomato farmers in Yamaltu-Deba Local Government Area of Gombe State. A multistage sampling technique was used to select eighty tomato farmers from the study area. Information was obtained from the sampled farmers through the use of a structured questionnaire. Stochastic Production Frontier Analysis (SPFA) with Cobb-Douglas functional form was used to analyze the technical efficiency of the farmers. The result revealed the tomato farmers in the study area were technically efficient with mean technical efficiency level of 0.87. Fertilizer use, organic manure, pesticide and farm size enhanced tomato output and technical efficiency of the farmers at 1% and 10% alpha level. Return-to-scale of 0.32 was estimated, implying the farmers operate in the stage two of production where doubling the input lead to less than double in the output. Farmers should therefore pay attention to their input combination to avoid diminishing returns.
Keywords: *Production function, tomato, stochastic frontier, inefficiency*

INTRODUCTION

Tomato (*Lycopersion esculentum* mill) is one of the leading vegetable crops in Nigeria. The crop is high in nutritional values and it is rich in vitamins, mineral and fibre. It is widely used in varieties of dishes as raw, cooked or processed products in Nigeria. The production of tomato started experiencing increase from 1.79MT in 2010 until 2015 when it hit the production volume of 4.22 MT. However, the country could not sustain the increase as the production value declined to 3.57 in 2021 (FAOSTAT, 2021). The decline in production volume has raised an important policy question such as what factors are responsible for the dwindling production figure of tomato in the country. The answer perhaps could be in the technical efficiency of the farm or the farmers which is referred to as the ability of a farm to produce as much as output with the level of inputs, given the existing technology (Erena *et al*, 2021). The study therefore seeks to support literatures in production efficiency by analyzing the technical efficiency of tomato farmers in Yamaltu-Deba Local Government Area of Gombe State. Specifically, the study described the socio-economic characteristics of tomato farmers; estimated the determinants and levels of technical efficiency of tomato farmers in Yamaltu-Deba Local Government Area of Gombe State.

MATERIALS AND METHODS

Study Area

The study was carried out in Yamaltu-Deba Local Government Area (LGA), Gombe State. Yamaltu-Deba is one of the eleven Local Government Areas in the State with its headquarters in Deba. According to NBS (2009), the result of 2006 census indicated a population of 255,726 for Yamaltu-Deba LGA. The LGA covers an area of about 1,981 square kilometers and lies at latitude $11^0$31' N and longitude 11˚24' E with the temperature ranges from 20^0C to 31^0C and mean annual rainfall of 750mm. The soil is rich clay-loam, making it ideal for agricultural activities (Saleh *et al*., 2021). The LGA is known for cultivation of a wide range of vegetables, fruits and cereals. It hosts parts of the lake Dadinkowa and shares boundaries with parts of Borno State to the North, Balanga LGA to the South, Gombe and Akko LGAs to the East (Erie *et al*, 2019). The target population was tomato producers.

Sampling technique

A multistage sampling technique was used in the choice of individual respondent. The first stage was purposive selection of Yamaltu-Deba LGA from eleven LGA in Gombe state. Yamaltu/Deba was selected because it is known for production of tomato. The second stage was random selection of two belts within the LGA based on size of tomato production- Dadinkowa and Kwandon. The third stage involved random selection of forty tomato producers from each belt, making a total of eighty. However, data from seventy-seven respondents were found useful for analysis.

Data source and analysis

Primary data were used for this study. Data were collected by the use of well-structured questionnare. Respondents were asked to indicate socio-economic characteristics and production variables (quantities of inputs used and output).

Data analysis involved the use of descriptive and Stochastic Production Frontier Analysis (SPFA). The descriptive analysis was used to analyze socio-economic characteristics of farmers while SPFA with Cobb-Douglas functional form was used for estimating the determinants and levels of technical efficiency.

$$Y_i = f(X_i, \beta)e^{v_i - u_i} \ldots\ldots(1)$$

$$\ln Y_i = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + \beta_7 \ln X_7 + v_i - u_i \ldots\ldots(2)$$

where,

Y_i = Observed individual *ith* farm output of tomato (Kg)

X_1 = Farm size (ha)

X_2 = Quantity of seeds (Kg)

X_3 = Fertilizer (Kg)

X_4 = Organic manure (Kg)

X_5 = Herbicides (litres)

X_6 = Pesticides (litres)

X_7 = Labour (man days)

$\beta_{i's}$ =Technology parameters to be estimated

ln = Natural log

The v_{is} are random error variable that are assumed to have normal distribution $iid\,N(0, \delta_{vi}{}^2)$. The u_{is} are non-negative random variable having half of normal distribution $iid\,N^+(0, \delta_{ui}{}^2)$ which measures technical inefficiency effects.

Accordingly, Technical efficiency (TE) of individual tomato farmer is defined as the ratio of observed output (Y_i) to the corresponding frontier output (Y_i^*), conditioned on the level of input used by farm. Technical inefficiency is therefore defined as the amount by which the level of production is less than the frontier output. The model for TE will be expressed as:

$$TE = \frac{Y_i}{Y_i^*} = \frac{f(x_i;\beta).\exp(-u_i)}{f(x_i;\beta)} = \exp(-u_i) \ldots\ldots(3)$$

where, Y_i is the observed and Y_i^* is the frontier output. Technical efficiency takes value between 0 and 1 i.e $0 \leq TE \leq 1$.

In addition, the study measured technical inefficiency, u_i , of the tomato farmers. The technical inefficiency effects are as follows:

$$\ln Y_i = f(\alpha + \beta) + e_i \ldots\ldots(4)$$

$$u_i = \alpha_0 + \alpha_1 Z_1 + \alpha_1 Z_1 + \alpha_1 Z_1 + \alpha_1 Z_1 + \alpha_1 Z_1 + \alpha_1 Z_1 + \alpha_1 Z_1 + \alpha_1 Z_1 + v_i + u_i \ldots\ldots(5)$$

Where,

Ui = technical inefficiency of equations 4 and 5 respectively

α_i = Vector of parameters
Z_1 = Age of tomato farmers (years)
Z_2 = Marital status (Married 1, otherwise 0)
Z_3 = Education (years)
Z_4 = Household size of the farmer
Z_5 = Membership of association (1 if farmer belongs to association, 0 otherwise)
Z_6 = Extension visit
Z_7 = Training
Z_8 = Record keeping (1 if farmer keeps record of farming activity, 0 otherwise)
e = Random error

The u_i is non-negative random variable having half of normal distribution $iid\, N^+(0, \delta_{ui}^{\ 2})$.

RESULTS AND DISCUSSION

Socio-economic characteristics distribution of respondents

The distribution of socio-economic in table 1 revealed that most of the producers were within the age range of 20-39years with mean age of 37years. This is an indication that the farmers in the study area enjoys involvement of young persons in farming activities. About eighty-one percent of the respondents were male, indicating that men engage more in the tomato production in the study area. This is in conformity with finding of Saleh *et al,* (2021) and Usman and Bakari (2013) who reported the mean age of approximately 40years in their study areas. Over 68% of those engaged in tomato production were married with the mean household size of 11 persons, implying that most of the respondents have advantage of supply of family labour. The result is in line with Pius *et al*, 2006 who opined that farmers with sizeable family could engage them to their farm business. Eighty-three percent of the respondents had formal education, indicating that majority of respondents were literate and this could assist them in effective communication in doing their business (Asogwa and Okwoche, 2012). In term of experience, 54.6% had spent between 6 and 15 years the tomato farming, indicating a relatively high knowledge in tomato production. The greater the year of farming experience, the more knowledgeable the farmer is in minimizing costs and maximizing the profits.

Table 1: Socio-economic characteristics of the tomato farmers in the study area

	Frequency	**Percentage**
Sex		
Male	62	80.5
Female	15	19.5
Age (years)		
<20	4	5.2
20-29	19	24.7
30-39	23	29.9
40-49	15	19.5
50-59	14	18.2
>59	2	2.6
Mean = 37		
Marital status		
Single	24	31.2
Married	53	68.8
Educational level		
None	13	16.9
Primary	12	15.6
Secondary	18	23.4
Tertiary	34	44.2

Household size		
1- 5	17	22.1
6-10	30	39.0
11-15	16	20.8
16-20	8	10.4
21-25	2	2.6
25-30	4	5.2
Mean = 11		
Years of experience		
1-5	28	36.4
5-10	31	40.3
11-15	11	14.3
16-20	6	7.8
21-25	1	1.3
Mean = 9		

Source: Field survey, 2021

Summary of quantity of input used by tomato farmers

A tomato farmer in the study area harvested an average output of 5,758.78kg from 1.08ha of land and about 5.63kg tomato seeds. The farmer applied an average of 130.24kg of fertilizer, 21.94 litres of herbicides, 43. 37litres of insecticides and utilized average of 481.94 mandays per hectare (Table2).

Table 2: Summary of quantity of input used by tomato farmers

Variables	Mean
Average farm size for tomato (ha)	1.08
Seed (kg)	5.363
Fertilizer (kg)	130.24
Herbicides (litres)	21.94
Insecticides (litres)	43.37
Labour (manday)	481.94
Output (kg)	5,758.78

Maximum Likelihood Estimate for the Stochastic frontier

The result of stochastic frontier analysis and the inefficiency model are presented in table 3. The variance parameters for sigma squared (σ^2) and gamma (ϒ) are 0.0304 and 0.978 respectively for tomato farmers and are significant. The sigma squared is an indication of goodness of fit and correctness of the distributional form assumed for composite error term while the gamma shows that about 97.8% of total variation is due to technical inefficiency and 2.2% accounts for random shocks. The result further shows that the coefficient of the parameter estimates of farm size was positive and significant to output at 10%, use of organic and inorganic fertilizer was positive and significant at 1% and insecticide have positive significant influence on tomato output at 1%. While the coefficient of the parameter estimates of herbicide had negative and significantly effect on output at 10%. This implies that a unit increase in farm size, organic and inorganic fertilizer, and insecticide will increase tomato output by 0.016, 0.058, 0.072 and 0.162 respectively. However, a unit increase in quantity of herbicide will reduce the output by 0.119. The estimated elasticity of all the inputs are less than one, indicating decreasing returns to scale. This implies that the farmers operate in the stage two of production, and should be careful to know when to stop increasing input because increase in input combination by 1% will result to less than 1% increase in total output.

The lower panel of Table 3, presents the estimated parameters of the inefficiency model in the stochastic frontier production function of tomato farmers. The signs of inefficiency model of the stochastic frontier production function had important implications on technical efficiency. The result revealed that only the coefficient of the parameter estimate of membership of association was positive and statistically significant to technical inefficiency which implies that membership of professional association reduces efficiency of the farmer. This is against the *apriori* expectation and may be due to the fact that some decisions being taken by the executives are having negative influence on the activities of the members. Although record keeping, training, household size and marital status were not statistically significant but had negative signs. The negative signs indicate parameters that reduce technical inefficiency of the farmer, and thus increase their efficiency.

Table 3: Maximum Likelihood Estimate for the Stochastic frontier

Variables		**Coefficient**	**SE**	**T-value**
Constant		0.151	0.056	2.69
Farm size	X_1	0.016	0.102	1.65*
Seed	X_2	0.013	0.011	1.26
Fertilizer	X_3	0.058	0.014	3.93***
Organic manure	X_4	0.072	0.013	5.36***
Herbicide	X_5	-0.119	0.063	-1.89*
pesticide	X_6	0.162	0.062	2.60***
Labour	X_7	0.118	0.008	1.47
Inefficiency variables				
Age	Z_1	0.186	0.018	1.03
Marital status	Z_2	-0.566	0.541	-1.05
Year of education	Z_3	0.001	0.035	0.04
Household size	Z_4	-0.043	0.029	-1.49
Membership of association	Z_5	0.897	0.483	1.89*
Extension visit	Z_6	0.240	0.689	0.35
Training	Z_7	-0.066	0.633	-0.11
Record keeping	Z_8	-0.603	0.590	-1.02
Variance parameter				
Sigma-squared (σ^2)		0.0304	0.017	1.733*
Gamma (γ)		0.978	0.024	40.61***
Log-likelihood		93.756		
Wald chi2(34)		463.22		
Sample size		77		
RTS		0.32		

Source: Computed from field survey data, 2021. *** = Significant at 1%, ** = Significant at 5% , * = Significant at 10%, RTS-Returns To Scale.

Distribution of technical efficiency estimates for tomato farmers in the study area

Frequency distribution of technical efficiency of the farmers shows the efficiency of the farmers ranges from minimum value of 0.58 and maximum value of 1 with the mean technical efficiency value of 0.87 (Table 4). This shows that if the farmers with minimum efficiency are able to achieve the maximum level of efficiency, they would be able to save 42% of production resources. Likewise, the efficient farmers will be able to save 13% of their usual production input. The mean technical efficiency value also indicates that tomato farmers in the study area were technically efficient (Coelli *et al*., 2015).

Table 4: Frequency distribution of technical efficiency estimates for tomato farmers in the study area

Efficiency range	Frequency	Percentage
Less than 0.50	-	-
0.51-0.60	1	1.30
0.61-0.70	5	6.49
0.71-0.80	10	12.99
0.81-0.90	25	32.47
0.91-100	36	46.75
Total	77	100.00
Mean TE= 0.87		
Minimum= 0.58		
Maximum= 1		
Standard deviation= 0.10		

Source: Computed from field survey data, 2021

CONCLUSION

Based on the findings, the study concludes that farmers were technically efficient and could improve their output and efficiency through proper input combination. Fertilizer and pesticide contributed largely to output in the study area, the study therefore recommends policy that will encourage input distribution to farmers in order to boost tomato production. Training of farmers should be encouraged as this could improve their efficiency.

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SEROLOGICAL DETECTION OF TOMATO SPOTTED WILT VIRUS ON *CAPSICUM* IN EDO STATE, NIGERIA

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ABSTRACT
Loss of crop production due to microbial plant pathogens poses serious threat to food security. Implementing appropriate management strategies against pathogens only produces positive results, following reliable detection and adequate understanding of their dynamics. Global yield losses in pepper production have been attributed to viral pathogen infection. About 68 viruses are associated with yield loss on Capsicum spp. A diagnostic survey was conducted on protected Capsicum spp. at Wells Hosa Farm, Benin city, Edo state, Nigeria to determine the prevalent viruses at the surveyed location. Enzyme-linked immunosorbent assay (DAS and TAS-ELISA) detected tomato spotted wilt virus (TSWV) in the samples tested at incidence rate of 71.4%. Molecular analysis for detection of Begomoviruses, based on amplification of a 500 bp fragment did not discover the virus in all the samples tested.
Keywords: *Pepper, DAS and TAS-ELISA, TSWV, Begomovirus, PCR*

INTRODUCTION

Pepper (*Capsicum* spp.), belonging to the family *Solanaceae*, is among the economically valuable vegetable crops, ranked second after tomato globally (Akpan *et al*., 2023). In human diet, it is an excellent source of minerals, micronutrients (Ca and Fe), vitamins (A, C and E) and natural antioxidants. *Capsicum* spp can be eaten raw in salad, cooked or processed. Nigeria is the largest producer of pepper in Sub-Saharan Africa, where it is regarded as the third most important vegetable after onion and tomato (Adetula and Olakojo, 2006). Cultivated peppers are relatively susceptible to about 68 viruses, which cause important production losses globally (Ojinaga *et al*., 2022). Members of the genera *Cucumovirus*, *Potyvirus*, *Orthotospovirus* and *Begomovirus* cause significant damages to *Capsicum* spp. (Jo *et al*., 2017). Ayo-John and Odedara (2017) reported incidence of Cucumber mosaic virus (CMV, *Cucumovirus*) and Pepper veinal mottle virus (PVMV, *Potyvirus*) across three south-western states in Nigeria. Tomato spotted wilt virus (TSWV), a member of *Orthotospovirus*, has a large host range, including tomato, amaranth and pepper (Wang *et al*., 2022). Incidences of TSWV are well documented in North and South-west Nigeria (Alegbejo, 2015). *Begomoviruses* constitute the largest group of plant-infecting single-stranded DNA viruses, transmitted by whiteflies of *Bemisia tabaci* complex and affecting diverse plants in tropical and sub-tropical regions, including vegetable crops such as *Capsicum* spp. (Zerbini *et al*., 2017; Leke *et al*., 2015). This study was conducted to determine the incidence and distribution of selected common plant viruses, namely CMV, *Potyviruses*, *Begomovirus* and TSWV in a protected commercial farm in Benin city, Edo state, Nigeria.

MATERIALS AND METHODS

Survey and collection of virus-infested samples

Survey was randomly conducted in five pepper-growing green houses at Wells Hosa Farm, Benin city, Edo state, in December, 2020. Leaf samples from as many parts showing virus-like symptoms were collected alongside the asymptomatic samples. Each sample was placed inside sample bottle containing silica gel and cotton wool for proper storage prior to the commencement of laboratory works.

Enzyme-linked Immunosorbent Assay (ELISA)

Serological testing was performed using Double (CMV, *Potyviruses*) and Triple-Antibody Sandwich (TSWV) ELISA. Microtitre wells of ELISA were coated with 100µl of appropriately diluted immunoglobin G (IgG: 1:1000) for the three viruses under test in carbonate coating buffer (0.015 M Na_2CO_3 and 0.034 M $NaHCO_{3,\ pH\ 9.6}$). Plates were incubated at 37^0C for 2h and afterwards washed three times with PBS-T (Phosphate saline buffer containing 0.05v/v Tween-20). ELISA plates were tapped and allowed to dry. Afterwards, 100µl aliquot of extracted sap of infected pepper, alongside negative and positive controls, obtained following thorough grinding of the concerned samples with conjugate buffer (0.1g egg albumin, 1g polyvinylpyrollidone) was dispensed into the wells and incubated overnight at 4^0C. Contents of well were decanted and plates washed and allowed to dry as described previously. For the detection of TSWV, 100 µl of appropriately diluted monoclonal antibody (Mab: 1: 1000) in conjugate buffer was added and incubation observed for 1 h. Afterwards, 100 µl of enzyme-labelled antibody (IgG-alkaline phosphatase) cross-adsorbed using healthy pepper leaf sap extract was dispensed in each well and incubated for 1 h. Wells were washed as aforetime and 100 µl of 1 mg/ml para-nitrophenyl phosphate (PNP) dissolved in substrate buffer (97 ml/L, pH 9.8) was added to each well and the content incubated for 4 hours after which spectrophotometric readings were taken at 405nm using ELISA plate reader (EL×1000, Global Diagnostics, Belgium).

DNA Extraction and Polymerase Chain Reaction (PCR) Assay

Total genomic DNA was extracted from the collected leaf samples, following modified CTAB protocol (Mignouna *et al*., 1998). DNA pellets were re-suspended with 50µl sterile distilled water and stored at 4^0C. Extracts were evaluated for the presence of *Begomoviruses* by PCR using degenerate primers AVcore-FP (5'-GCCHATRTAYAGRAAGCCNAGRAT-3') and ACcore-RP (5'-GGRTTDGARGCATGHGTACANGCC3'). PCR cycling condition included initial denaturation at 94°C for 2 mins, followed by 35 cycles consisting of denaturation at 94°C for 1 min, annealing at 60°C for 2 mins, extension step at 72°C for 2 mins and final extension at 72°C for 10 mins. Extracted and amplified DNA fragments were electrophoresed on 1.2% agarose gel in 0.5×TBE buffer, stained with ethidium bromide at 80 V for 30 min and visualized under a UV transilluminator.

RESULTS

Table 1: Reactions of tested samples to DAS- and TAS-ELISA

S/N	Sample Identity (GH)	Reactions to DAS (CMV,Potyviruses) TAS (TSWV)		
		CMV	Potyviruses	TSWV
1	6	-	-	-
2	6	-	-	-
3	8	-	-	+
4	8	-	-	+
5	10	-	-	+
6	13	-	-	+
7	13	-	-	+

"GH'' indicate Green House where sample was picked, "- and +'' indicate negative and positive reaction respectively

Table 2: ELISA result from leaf samples collected from different Greenhouses

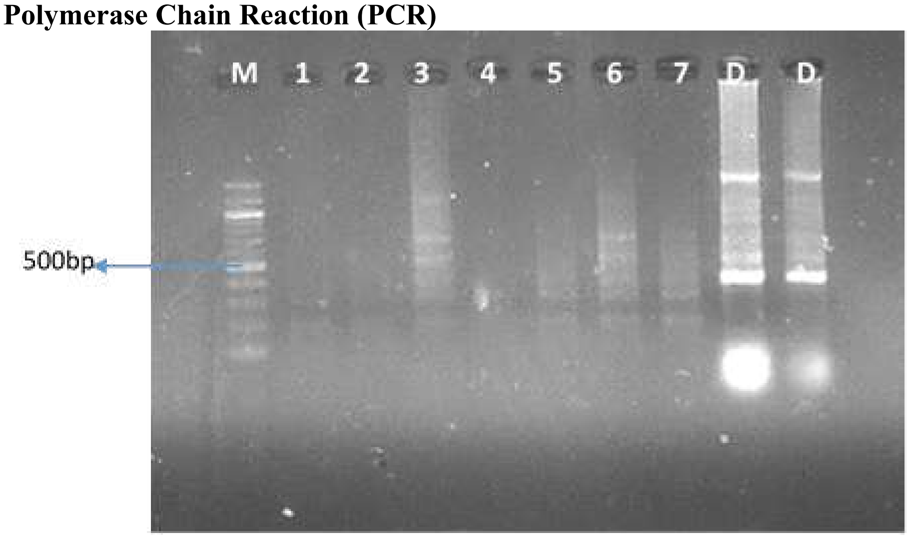
		Optical density (nm/100 µL)a		
Sample ID	**GH***	**CMV[z]**	**Potyvirus**	**TSWV[z]**
1	6	0.239	0.172	0.392
2	6	0.266	0.169	0.738
3	8	0.204	0.200	1.438[a]
4	8	0.154	0.146	0.993[a]
5	10	0.171	0.178	1.553[a]
6	13	0.240	0.156	3.208[a]
7	13	0.212	0.219	2.587[a]
	Buffer	0.183	0.188	0.316
	NC*	0.217	0.174	0.485
	PC*	2.509[a]	2.494[a]	2.987[a]

[a]Sample was considered CMV, Potyvirus and TSWV positive when mean absorbance (A405 nm) was two times greater than the absorbance from uninfected plant controls.
[z]CMV= cucumber mosaic virus, TSWV=tomato spotted wild virus
*GH= Green house, NC= Negative control, DC=Disease control

Serological Analyses

The sampled pepper plants exhibited a wide range of symptoms, including mosaic pattern of light and dark green, leaf deformation, veinal chlorosis, leaf curl and wrinkling under the protected environment. Serological analyses of all samples tested using specific antibodies for CMV and Potyviruses were negative to the viruses in the two genera. However, out of the 7 samples tested, 5 were found positive for TSWV, with incidence of 71.42% while the virus was not discovered in 28.57% of the samples. Disease incidence was estimated as the percentage of the number of symptomatic over the total number of leaves analysed. Samples were considered positive when the ELISA reading obtained was at least twice that of the healthy control used in the study.

Polymerase Chain Reaction (PCR)



Lane M=100 bp DNA ladder, 1&2=GH6-7, 3&4=GH8, 5=GH10
6&7=GH13, D=Disease control

Figure 1: Detection of begomovirus at expected band size of 500 bp

PCR Analysis

Begomovirus detection by PCR was confirmed only in the positive (diseased control) samples used in the study, yielding 500 bp amplicon size. Obtaining the expected band size in the diseased samples stands to confirm the validity of the PCR result.

DISCUSSION

Viral diseases constitute a major biotic constraint to pepper production, affecting both yield and quality of fruits produced (Nono-Womdim, 2001). Transmission and spread of viruses in pepper poses great danger to its sustainable cultivation and vegetable farming at large (Arogundade *et al*., 2012). Out of about 68 viruses associated with *Capsicum* spp., about 15 have been identified in Africa (Kenyon *et al*., 2014). Cucumber mosaic virus and *Potyviruses* have been reported among the most prevalent in SSA (Dafalla, 2001). Our result however did not detect either CMV or *Potyviruses* in the sampled location. This could be attributed to the absence of aphid vectors (the transmission agents of these viruses) in the protected green houses. TSWV has been listed as one of the viruses affecting *Capsicum* spp. even under protection (Simon *et al*., 2016). TSWV is transmitted exclusively by a number of thrips, especially *Frankliniella occidentalis* (Whitfield *et al*., 2005). The presence of thrips in GH 8,10 and 13 explains why our results tested positive to TSWV in the concerned green houses. Jones (2005) also reported transmission of TSWV through mechanical inoculation and grafting.

The use of chemical control measure for TSWV has not been highly recommended, as thrips have been reported to develop resistance to synthetic insecticides over time (Chattopadhyay *et al*., 2017). Breeding of resistant cultivar to TSWV, harbouring the pepper resistant gene Tsw has been considered more efficient (Gunes and Gumus, 2019). Screening of planting propagules for TSWV and thrip infestation, regular monitoring of thrip infestation, removal of reservoir weed host around pepper cultivation and roguing of infected pepper stands, are some of the control measures that have been recommended for the management of TSWV (Zitter and Daughtney, 1989).

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DESIGN, CONSTRUCTION AND PERFORMANCE EVALUATION OF ZERO ENERGY COOLING CHAMBER ON THE STORAGE OF TOMATOES

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ABSTRACT
Cool storage can prolong the shelf life of produce hence, this study deals with the construction of ZECC with modifications in its design and construction in order to achieve this purpose. Temperature measuring tests were conducted on it to determine the capacity of the structure to lower temperature. Zero Energy Cooling Chamber was designed, constructed, and evaluated. The chamber is a double-walled structure made of bricks having a cavity filled with mixtures of river sand, charcoal and sawdust. The evaluation showed that temperatures inside the chambers ranged from 10^0 ^{O}C to 15^0 ^{O}C lower than the outside ambient temperature and the relative humidity was 80%. The rise in humidity and fall in temperature was achieved by watering the cavity to ensure appropriate cooling of the chamber. The ZECC was evaluated over a period of 21 days with Roma tomatoes. For these periods of 21 days, loss in weight was calculated to be 29 % in the cooling chamber and 67.5 % under ambient conditions. Moreover, firmness, total soluble solids and colour were maintained over these 21 days.
Keywords: *Loss in weight, relative humidity, temperature control. Tomato storage and zero energy cooling chamber (ZECC),*

INTRODUCTION

Evaporative cooling is generally known to be an efficient and economical system and means for reducing temperature and increasing relative humidity in an enclosure. This effect was extensively tried to increase the shelf life of horticultural produce in some tropical and subtropical countries. (Lal Basediya *et al.,* 2013). Methods of evaporative cooling and their application for the preservation of fruits and vegetables are among other methods of evaporative cooling. A zero-energy cooling system could be used effectively for short-duration storage of fruits and vegetables. This reduces the storage temperature but also increases the relative humidity of the storage device which is essential for maintaining the freshness of the commodities. Fruits and vegetables are stored at a lower temperature because of their highly perishable nature. (Lal Basediya *et al.,* 2013)

Zero Energy Cooling Chamber (ZECC) is a cooling chamber which works through the principle of an evaporative cooling chamber. Cooling is required to maintain the freshness of fruits and vegetables during storage. Spoilage of fresh fruits and vegetables has been a long-term problem in tropical countries. Cool storage however prolongs the shelf life of fresh produce, whereas refrigeration equipment which serves alternative purposes is expensive to buy, expensive to run, and expensive to maintain. A practical, low-cost alternative for on-farm fruit and vegetable storage which employs the cooling power of evaporation is affordable and generally acceptable by farmers. (Lal Basediya *et al.,* 2013). Vegetables are the fresh and edible portions of herbaceous plants. They are important food and highly beneficial for the maintenance of health and the prevention of diseases. They contain valued food ingredients which can be successfully utilized to build up and repair the body. Vegetables are valuable in maintaining an alkaline reserve in the body. They are valued mainly for their high carbohydrate, vitamin and mineral contents from different kinds of vegetables (Hanif *et al.,* 2006)

The main importance of fruits and vegetables is that they provide vitamins and other nutrients that help for the proper functioning of the body. Hence, fruits and vegetables are essential building blocks of any diet, it is not only that they are loaded with vitamins and minerals which are essential for healthy living, but they also give satisfaction as part of the balanced diet (Peter E. M. G. *et a.,* 1997). Evaporative cooling was found to be an efficient and economical means of reducing temperatures and increasing humidity in a man-made enclosure where the humidity is comparatively low (Dadhich *et al.,* 2008) Evaporative cooling is a well-known system to cool a specified environment with the aid of an adiabatic process, in which ambient air is cooled as a result of transferring its sensible heat to the evaporated water carried with the air. In the evaporative-cooled structure, the maximum advantage of the natural environment was employed to lower the temperature of the outside ambient air to a considerably low level. The evaporative cooling storage system is easy to operate, efficient and affordable most especially for peasant farmers in developing countries like Nigeria where other methods of preservation are quite expensive and unaffordable (Ihekoronye *et al*., 1985). This study was carried out by designing and constructing an adaptable ZEEC for farmers, to determine the water-holding capacity of the ZECC cavity material and to examine the post-harvest qualities of fruits and vegetables stored in the chamber.

MATERIAL AND METHOD

Zero Energy Cooling Chamber:

A Zero Energy energy-cooling chamber was constructed from clay soil made of bricks. The clay soil was sieved, pounded and moulded with the aid of a mould constructed to specification at the back of the processing unit of the National Horticultural Research Institute, Jericho, Ibadan. The bricks were set and arranged to form a double wall brick that had a cavity in between. The cavity was filled with layers and mixture of river sand, coco-peat and charcoal with sawdust. The inside was further divided into four chambers that could accommodate four different horticultural crops. This structure was raised over a single row of brick floors and a double layer of brick wall on the sides having an interspace of 8 cm filled with sawdust. The top of the storage space was covered with coconut leaves in bamboo roofing covered with tarpaulin. The cool chamber will be saturated with water for the first time thereafter sprinkling of water carried out once in the morning and once in the evening and was enough to maintain the required temperature and humidity. These chambers will help to maintain a very high humidity of 95 % throughout the year and reduce the temperature of the chamber during summer months. These chambers are ideal for storage for a short period and helpful for small and marginal farmers to store their produce. (Ashitha *et al*., 2010)

Cooling chambers work on the principle of evaporative cooling. Evaporative cooling is the reduction in temperature resulting from the evaporation of a liquid, which removes latent heat from the surface from which evaporation takes place. (Ashitha *et al*., 2010) Evaporation of water produces a considerable and appreciable cooling effect emphatically establishing that the faster the evaporation the greater the cooling. This indicates that when the temperatures are the same, no net evaporation of water in the air occurs, which means that there is no cooling effect. The principle of working of this system is 'when a particular space is conditioned and maintained at a temperature lower than the ambient temperature surrounding the space, there should be the release of some moisture from outside the body'. This maintains low temperature and elevated humidity in the space compared to the surroundings. The evaporative cooling chamber fulfils all these requirements and is of great importance to small farmers in rural areas (Dadhich *et al*., 2008)

MATERIALS

The following materials are used to construct a specialized model of ZECC.

- Bricks,
- Composite mixture of river sand, sawdust and coco peat,
- Charcoal,
- PVC pipes,
- Bamboo shoot, net taped a wood species and coconut leaf
- Clay mortar and
- Tarpaulin

Construction Procedure

The following procedure is adopted to construct a specified model of ZECC.
- An existing water tank was connected to enable a constant supply of water.
- Floor of size 348cm × 348cm was made.
- The double wall was erected at a height of 90 cm having a cavity of 17cm.
- PVC pipes (2 inches diameter) are installed horizontally along the square shape of the cavity in order that it will enable water to run through the cavity.
- the square-constructed double wall which accommodates 280cm x 280cm was further divided into four and
- the four chambers were averagely 130 cm x 130 cm each,
- before the installation of PVC pipes, perforations were made on its surface and the perforations were such that it was channelled through the upper layer of the cavity to percolate the materials fixed in the cavity in the process to ensure cooling.

Design and Consideration of the Cooling Chamber

The cooling chamber is square in shape and designed to specifications.

In geometry, a Square is a flat figure or shape which has four equal sides and every angle is a right angle, i.e. 90°. From this, it follows that the opposite sides are also parallel. It is also described as a rectangle which has two adjacent sides having equal lengths. The area of a square can therefore be found by measuring the amount of space occupied within the square.

$$A=L^2$$

where L is the length of sides in cm

since L = 280cm

$$A = 280^2 = 280cm \times 280cm$$

$$A = cm^2$$

The volume of a Square formula is the volume of a column with a squared face, a polygon with 4 equal sides of length (L) and height (H).

$$V = L^2 H$$

Where L=280cm and H= 90cm

$$V = 280^2 \times 90$$

$$V = 7,056,000cm^3$$

For the volume of the cavity, $V = L \times B \times H$

Right and Front = Left and Rear

So we calculate right as

$$V_r = L_r \times B_r \times H_r$$

$$V_r = 348cm \times 17cm \times 90cm$$

$$V_r = 532,440cm^3$$

For the front, $V_f = L_f \times B_f \times H_f$

$$V_f = 314cm \times 17cm \times 90cm$$

$$V_f = 480,420cm^3$$

Total volume, V_t the cavity contains = Right +Front + Left + Rear

$$V_t = V_r + V_f + V_l + V_{re}$$

$$V_t = 532,440 + 480,420 + 532,440 + 480,420$$

$$V_t = 2,025,720\ cm^3$$

Examination of Lateral pressure and Bending

Equations (1) and (2) are the lateral pressure calculation formula for the material poured by general internal vibro-compaction for which its mixture is ≤75 mm and the depth is ≤0.5 m. The equation can be used for walls when the pouring speed is <0.8 m/h and the pouring height is <1.5 m. In the equation, "p" is the horizontal pressure (Kn/m^2), "R" is the pouring speed (m/h), and "T" is the material temperature in the formwork (°C). "C_w" is the unit weight factor with a value of 1 corresponding to the unit weight ranging from 22.5 to 24 N/m^3, which was used based on the Building Code. "C_c" is the chemical additive factor with a value of 1. (Singh *et al.,* 2006)

$$P = Cw\ Cc\ [(7.2 + 790R)/T+18\} \quad (1)$$

$$Cw = Cc = 1 \quad (2)$$

$$P = 7.2 + (790 \times 1.2) / (31+18) = 19.5kN/m2$$

The flexural strength was calculated using a thickness of 200 mm and a lattice bar spacing of 2800 mm. The following equations show the results of the working load moment (M), bending stress (σ), allowable tensile stress under crack width limitation (ft), and flexural reinforcement (Mu). (Vala and Joshi, 2010)

$$M = pL2/8 = [19.5(2.8)2\ ]/8 = 19.11\ km$$

$$\sigma=M/Z=M/(bh2/6) = 6(19.11)\ /0.93(0.2)2 = 3082.3\ kN/m2 = 3.1\ MPa$$

$$=3.1\ MPa > 1.4\ MPa - o.k. \quad (3)$$

Equations (13)–(16) show the shear performance based on the PCDW lateral pressure examination results. "Vu" is the ultimate shear force in the cross-section, and "∅" is the strength reduction factor.

$$V=pL2=19.5(2.8)2=109.2\ kN \quad (4)$$

$$Vu=1.2\times109.2=131.04\ kN \quad 5)$$

$$\emptyset Vn=\emptyset(16)fck{-}{-}{-}\sqrt{}bwd=0.75(16)35{-}{-}\sqrt{}(1000)(30)(10-3) \quad (6)$$

$$=22.19\ kN>11.13\ kN-o.k.$$

Experimental Procedure

Maximum and Minimum temperature and relative humidity were recorded inside and outside the chamber for three weeks. The inside temperature and its humidity and the outside temperature and its humidity were determined with the aid of a hygrometer and thermometer.

A comparative study was made for the storage of tomatoes inside the cooling chamber and in the ambient condition and their weight loss; colour changes and freshness were observed to know how long it will take to reach perishable state.

RESULT AND DISCUSSION

Temperature and Humidity

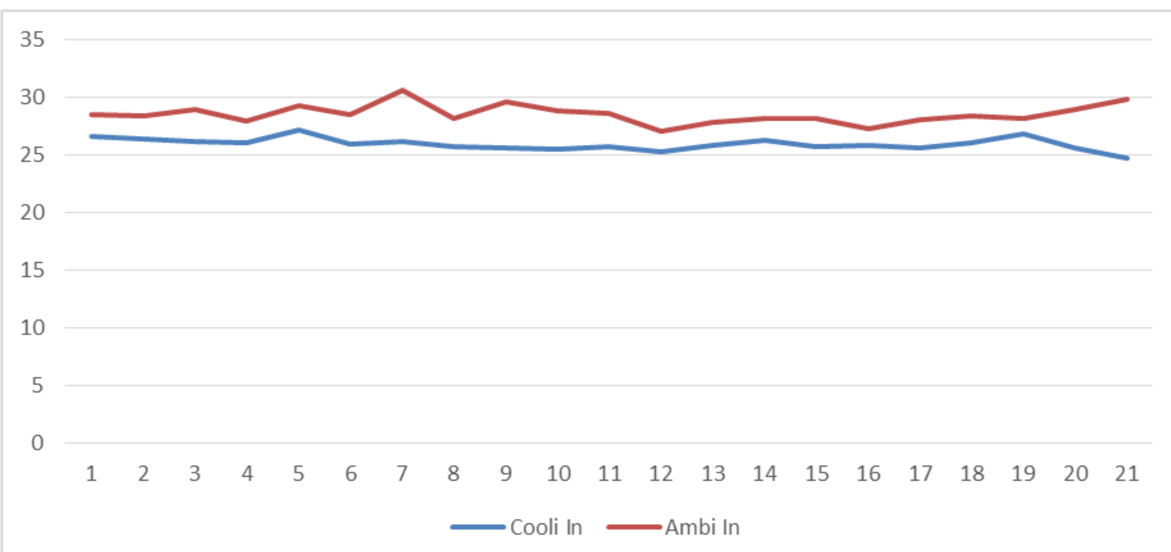

Figure 1: Temperature profile in the colling room and ambient per time

As presented in Figure 1, the temperature was measured inside, outside and inside the room during different time intervals over the period of 21 days. The temperature readings were taken after the watering of the Zero-energy cooling chamber. The outside temperature varies with time and intensity of sunlight but the inside temperature remains nearly the same at all the time of temperature measurement in a day. The day-to-day variation in temperature inside the chamber is considerably low. From the experimental study conducted on an energy-cooling chamber, it was clear that Zero energy energy-cooling chamber can reduce the inside temperature from 10^0 °C to 15^0 °C lower than the outside temperature. And also it can maintain a constant temperature inside the chamber.

Comparative Study

Weight Loss

The record of weight loss of tomatoes kept inside the chamber was determined. Percentage loss in weight (PLW) was determined by weighing the tomatoes over an interval of time during storage with the equation used by [6, 7] as stated below and was compared with the ambient.

$PLW = (W1 - W2)/ W1 \times 100$

where W1=Weight of the sample before storage, Kg and W2=Weight of the sample after storage, Kg.

% Loss in Weight for cooling chamber after 21 days = (1 – 0.71)/1 x 100= 29%

% Loss in Weight for ambient after 21 days = (1 – 0.33)/1 x 100= 67.5%

Colour Variation

Colour chat was used to identify the observed colour changes as it applied from the chat over the period of 21 days.

Total Soluble Solids

The total soluble solids also known as brix were maintained at 4 over the period of 21 days for the cooling chamber whereas it was stylishly decreasing from 4 to 2.5 over the period of 21 days.

Firmness

Firmness was measured with the aid of a penetrometer and was retained at 7 for the cooling chamber while it deteriorated to 4 over the period of 21 days.

CONCLUSION

The rise in humidity and fall in temperature was achieved by watering the cavity to ensure appropriate cooling of the chamber. The ZECC was evaluated over a period of 21 days with Roma tomatoes. For these periods of 21 days, loss in weight was calculated to be 29 % in the cooling chamber and 67.5 % under ambient conditions. Moreover, firmness, total soluble solids and colour were maintained over these 21 days.

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Table 1: Loss in Weight for cooling chamber after 21 days

	Initial Weight (g)	Final Weight (g)
Bowl 1	1.00	0.64
Bowl 2	1.00	0.77
Average	1.00	0.71

Table 2: Loss in Weight for ambient after 21 days.

	Initial Weight (g)	Final Weight (g)
Bowl 1	1.00	0.37
Bowl 2	1.00	0.28
Average	1.00	0.33

COMPARATIVE STUDY ON RAPID CLONAL PROPAGATION OF *Telfairia occidentalis* USING SEMI-AUTOTROPHIC HYDROPONIC (SAH) COMMERCIAL SUBSTRATE AND COMPOSTED SAWDUST

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ABSTRACT
Clonal propagation is a vegetative technique used in the propagation of plants without seed. This study was designed to compare the response of two cultivars of Fluted pumpkin (Telfaria Occidentalis) cultivation using three different substrates which includes: Semi Autotrophic Hydroponic, Composted sawdust and sawdust only. There were two treatment hormones which consisted of synthetic hormone Indole Butyric Acid (IBA) and natural hormone (coconut water). The experiment was a closed randomised design (CRD). The percentage increase in growth parameters revealed that Calabar cultivar pre-treated with synthetic hormone (IBA) and planted in SAH had the highest increased vine length of 51.5 %, and Calabar cultivar pre-treated with coconut water planted in SAH with 50.8 % while the highest vine length increased for Yoruba cultivar pre-treated with coconut water with 47.6 %. Highest percentage increase in number of leaves was observed in pre-treated Calabar cultivar in SAH and there were significant man treatment differences due to the substrate, treatments, and interaction between the cultivars. This study revealed that high nutrient concentrated media and growth hormones greatly supported Telfaria plants growth and leaves production.
Keywords: *Clonal propagation, Coconut water, Composted sawdust, Semi Autotrophic Hydroponics and Tefaira occidentalis.*

INTRODUCTION

Fluted pumpkin (*Telfairia occidentalis*) belongs to the family of Cucurbitaceae, a dioecious climbing perennial vine which is partially drought tolerant (Imosemi, *et. al* 2010). *Telfiaria occidentalis* is cultivated for its edible leaves, stems, and seeds as a backyard plant particularly by the Igbo tribe. And spread to other parts of the country as the Igbos migrates from one part to another. (Akoroda, 1990). Ghana and Cameroon was the major producer in Africa (Kayode, *et. al.* 2011) but the cultivation skewed towards the southern part of Nigeria. Both the leaf and seeds are rich in both macro and micronutrients such as carbohydrates, protein, essential oils, vitamins, minerals, and fibre (Ellah, *et al.,* 2016).

Seed propagation is the major means of propagating *T. occidentalis*; however, the seeds are recalcitrant in nature, which causes shortage of seeds and in turn make the seeds expensive. Although, tissue culture technique has been used for rapid clonal propagation of *T. occidentalis* (Akinyemi and Esuola, 2012, Esuola and Akinyemi, 2011, Esuola and Akinyemi, 2010) but this technique and the output seedlings were expensive for most farmers. Rapid clonal propagation of *T. occidentalis* can be harnessed for rapid multiplication of this crop which allows true to type, faster growth and plant uniformity propagations when compared to seeds propagated techniques. Roots initiation through vine cuttings of fluted pumpkin with the use of indole butyric acid (IBA) was reported by Acha, *et. al*. (2004) but the cost implication and availability of the hormones to farmers has been a major impediment. This makes the need to develop a multiplication technique for fluted pumpkins which are less expensive and readily available for farmers use is imperative. Consequently, this study focused on the rate of fluted pumpkin multiplication improvement through stem cuttings with the use of different substrates as influenced by natural hormones.

METHODOLOGY

The experiment was carried out at the National Horticultural Research Institutes (NIHORT), Ibadan vertical farmhouse, using two cultivars of *Telfairia occidentalis* ("Calabar" and "Yoruba" cultivars). Seeds of the cultivars were collected from vegetable programme/project 5 experimental field and were sown in sawdust substrate for sprouting. Vines from pre-germinated seeds were excised using sterilized surgical blades and pre-treated separately in synthetic hormone (Indole Butyric Acid (IBA)) and natural hormone (coconut water). These pre-treated vines were planted in three different media which includes sawdust only, commercial SAH compost and composted sawdust. The experiment was laid out in a complete randomised design (CRD). The germinated vines were monitored for growth attributes for 6 weeks. Data were collected at 2, 4, and 6 weeks after planting (WAP) on vine length (cm), number of nodes, number of leaves, and leaf length (cm).

RESULT

The data obtained (Table 1) showed the percentage increase in the agronomic parameters of the fluted pumpkins cultivars vines that were pre-treated with different hormones the in different media. The highest percentage increase in vine length (51.5 %) was recorded in Calabar cultivar pre-treated with synthetic hormone and planted in SAH commercial compost, while the same cultivar pre-treated with natural hormone (Coconut water) and planted in the same media had 50.8 % (Table 1). This could be because of the higher nutrient concentrations in SAH which would have supported better elongation of the vine. On the other hand, the highest percentage increase in vine length recorded for the Yoruba cultivar pre-treated with coconut water and planted in composted sawdust was 47.6 % (Table 1). This could be attributed to low essential elements present in the composted sawdust, this agrees with the findings of Agbede (2008) who found out that the number of crops significantly increased with increase in the concentration of nutrients in the substrate. Moreover, the highest percentage increase in number of leaves was observed for the Calabar cultivar pre-treated with coconut water and sown in SAH compost (Table 1), while there was no increment in the number of leaves for the Yoruba cultivar with same treatment (Table 1). SAH media for the Calabar cultivar produced 50 % and 51.6 % increment in the number of nodes using IBA and coconut water pre-treatments respectively (Table 1). The data also showed that there was no increment observed in the number of nodes for the Yoruba treated cultivar. Hence, IBA, coconut water and SAH compost could be noted to contain ingredients for plant growth that helps to support better leaf production. This trend was reported by Esuola and Akinyemi, (2010) in which they stated that plant growth hormones increases leaf and multiple shoot production in *Telferia occidentalis*.
Data on Table 2 showed that there were significant differences in the substrates and treatments used for this study. Also, there were interactions between both the substrates and the treatments, which mean differences were significantly different for both cultivars (Table 2). This submission was supported by the findings of Esuola and Akinyemi (2011) that there was significant increase in growth parameters of Ugu grown in-vitro under the influence of various regimes of growth hormones.

CONCLUSION

In this study, the use of commercial SAH compost (Dizengoff) with or without coconut bio-fortification was highly useful for rapid clonal propagation of *T. occidentalis* vine cuttings after six weeks of planting compared to using sawdust only or its compost.

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Table 1: Percentage increase in growth parameters of Calabar and Yoruba Cultivars Fluted pumpkin (*Telferia occidentalis*) as affected by growth hormones and growth media substrate.

Treatments	Vine length			Number of leaves			Number of nodes		
	SAH	Sawdust only	Composted sawdust	SAH	Sawdust only	Composted sawdust	SAH	Sawdust only	Composted sawdust
Calabar + IBA	51.5	31.3	49.3	50.0	37.5	48.3	50.0	37.5	48.3
Calabar + Coconut water	50.8	36.4	48.1	51.6	40.0	50	51.6	40	50
Yoruba + IBA	44.5	36.5	43.4	0	0	0	0	0	0
Yoruba + Coconut water	46.7	42.8	47.6	0	0	0	0	0	0

Table 2: Mean square analysis of variance of Ugu growth as influenced by growth hormone treatments and substrates.

Sources of variation	DF	Vine length		Number of nodes			Number of leaves		
		2 WAP	4 WAP	2 WAP	4 WAP	6 WAP	2 WAP	4 WAP	6 WAP
Substrate (S)	2	8.72**	90.09**	2.92**	1.52**	2.07**	26.25**	13.65**	18.60**
Treatment (T)	3	0.89*	7.15*	0.98**	0.77**	34.77**	8.80**	6.95**	312.75**
S × T Interaction	6	1.26**	7.93**	0.63**	0.34*	0.69**	5.65**	3.05*	6.20**
Error	48	0.26	1.85	0.05	0.12	0.13	0.45	1.05	1.20
Total	59								

EVALUATION OF GROWTH MEDIA ON MORPHOLOGICAL CHARACTERISTICS OF *Aschersonia aleyroides*: AN ENTOMOPATHOGENIC FUNGUS

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ABSTRACT
The fungus, Aschersonia aleyroides (Deuteromycotina: Hyphomycetes) is an entomopathogenic fungus reportedly to be host specific to white fly and probably the earliest known entomopathogenic fungus reported on scale insects. In a bid to search for appropriate medium of growth for cultivation and mass production of A. aleyroides as biocontrol agent to curtail the menace of white fly in citrus orchards, leaf samples with Aschersonia growth were obtained from NIHORT, Ibadan farming system orchard and isolation was carried out on Malt extract Agar, Potato dextrose agar and Saboraud dextrose agar. Identification was done based on cultural and morphological observations. PDA gave the best (45.33mm) mycelial growth 21 days post inoculation. Conidia of the fungus were spindle shaped, and hyaline. Based on the ability of A. aleyroides to produce large quantities of conidia on PDA, it was considered as the most suitable medium for the growth of the isolated A. aleyroides.
Keywords: *Aschersonia, agar, citrus, conidia control, entomopathogen*

INTRODUCTION

The utilization of the insect pathogenic fungal genus *Aschersonia* for control of pest has been studied extensively in different countries (Fransen *et al*., 1987, Chanley and Collins, 2007). *Aschersonia aleyrodes* (Webber) was the first fungal species applied to control insect in North America with the potential control of citrus whiteflies in Florida (USA) being attained in the early 1900s (Liu *et al*., 2006). *Aschersonia* spp. are not hazardous to mammals and some species have been reported to be effective bio-control agents against insects (Qiu *et at*., 2013). Consequences of the hazardous effect of the indiscriminate use of pesticides to manage insect pest (white fly) on citrus has necessitated the search for alternatives such as biocontrol agents as part of integrated pest management options to control insect population on the field. Entomopathogenic fungi are able to infect phloem-feeding insects naturally by penetration of the insect cuticle, which make them suitable pathogens of whitefly (Fransen 1990). *Aschersonia aleyrodids* causes epizootics in whitefly populations in the tropics and subtropics (Stefan, 2023). Fransen et al. (1987) found that conidia of *A. aleyrodis* could survive on leaf surfaces of cucumber for at least 3 weeks and will still be able to infect nymphs of greenhouse whitefly. Mass production of entomopathogenous fungi is an important step in successful utilization of entomopathogenic fungi as biocontrol agents. According to Dokgluaymai, *et al*., (2016), the production of conidia is dependent upon the culture medium and its nutritional source plays important role in determining the quantity of conidia in terms of spore germination. Few attempts have been made to multiply mycopathogen using synthetic media. The objective of this study is to investigate the most suitable synthetic medium that will accelerate the growth and sporulation of the *A. aleyroides* for laboratory cultivation.

MATERIALS AND METHODS

Isolation of Entomopathogen; *Aschersonia aleyroides*

Three different synthetic culture media; Malt Extract agar (MEA), Sabouraud Dextrose Agar (SDA) and Potato Dextrose Agar (PDA),) were used to assay the mycelial growth of the pathogen based on the method of Fovo *et al*. (2017). Citrus leaf samples with growth of *Aschersonia* specie were obtained from National Horticultural Research Institute (NIHORT), (Farming system programme orchard) and brought to the pathology laboratory of the institute for isolation. The samples were cut into small pieces and sterilization was done using (5%) NaOCl solution for 1 minute and rinsed in 3 changes of sterilized distilled water. These samples were placed on autoclaved sterilized agar; Potato dextrose agar (PDA), Malt extract agar (MEA) and Sabouraud dextrose agar (SDA), incubation was done at 26 ± 2°C for 21 days. Mycelial growth of the fungus single colony was transferred to fresh media plates to obtain pure culture. Cultural and morphological identification was done as described by Liu *et al.,* (2006) and Wang *et al*., (2013).

Cultural and morphological identification

Fig.1a

Fig.1b

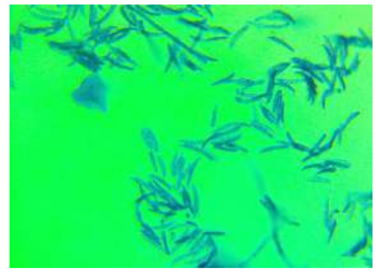

Fig.1c

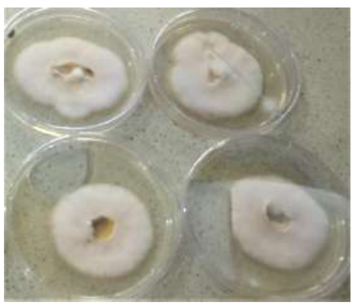

Fig. 1d

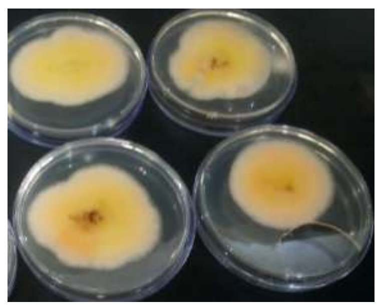

Fig. 1e

Fig 1a: Culture of *Aschersonia* specie on Malt extract (front view)
Fig 1b: Culture of *Aschersonia* specie on Malt extract (reverse of plate)
Fig 1c: Photomicrograph of *Aschersonia aleyroides.*
Fig 1d: Mycelial growth of *Aschersonia aleyoides* at 21 days after inoculation (front view)
Fig 1e: Mycelial growth of *Aschersonia aleyoides* at 21 days after inoculation (reverse)

Table 1: Effect of three growth media on mycelial growth of *Aschersonia aleyroides*

Medium of growth	**Mycelial diameter (mm)**	**mycelial raised edge (cm)**
Malt extract agar	38.33	0.57
Sabouraud dextrose agar	32.67	0.23
Potato dextrose agar	43.33	0.13
LSD ($P \leq 0.05$)	4.00	0.16

The colony of *A. aleyroides* obtained in this study had a characteristically slow growth on the three media used until after 21 days of incubation. The growth culture on MEA was observed to be raised and woolly with uneven edges while that of PDA was slightly flat with even edges, however, SDA culture had slightly raised growth with rough edges. The mycelial growth was also observed to be significantly ($P \leq 0.05$) influenced by culture media. The colony on the culture media was whitish light pink in colour with pink white spore mass and light pink to brown on the reverse of the culture plates. Mycelial growth ranges from 32.67, 38.33, and 45.33mm on SDA, MEA, and PDA while the measurement of the raised culture edge was however found to be 5.70, 2.33 and 1.33cm on MEA, SDA and PDA respectively. The conidial shape was fusoid, spindle shaped pointed towards both ends, hyaline and germinate by producing one or two germ tube

DISCUSSION

The entomopathogenic fungus *A. aleyroides* in this study was identified based on colony morphology and morphological characteristic of conidia and this corroborate the identification reported by Wang *et al*., (2005), Liu (2006), and Wang et al (2013). The production of conidia had been reported to be dependent upon the culture medium and its nutritional source plays important role in determining the quantity of conidia in terms of spore germination (Sikder, 2019). Also, Zhu *et al*., (2008) and Qiu *et al*. (2013) concluded that basic nutritional requirements have significant effect on culture growth, sporulation and morphology in entomopathogenic fungi. Since mass production of entomopathogenic fungi is important step to successful utilization of entomopathogenic fungi as biocontrol agents. In search of suitable synthetic media for the cultivation of *A. aleyroides* among the three media were compared, based on the radial growth of the fungal colony, PDA extract agar gave the best result in term of mycelial growth followed by SDA. However, based on the ability of the fungus to produce conidia, PDA was considered the most suitable medium for *A. aleyroides* mass cultivation, this is in line with the report of Rabbani et al. (2011) and Westphal et al. (2021) that among different culture medium, Potato dextrose agar produced good growth (9.0 cm) and abundant sporulation (2.31 x 10^6) of *A. aleyrodis* and that the main constituent of Potato dextrose agar medium is dextrose and potato which might have been utilized as source of carbon which resulted in profuse growth.

CONCLUSION

Potato dextrose agar is recommended for mycelial growth cultivation and mass production of *Aschersonia* conidia. However, there is need to further investigate the pathogenic ability of the isolated *A. aleyroides in vitro* with citrus white fly.

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GROWTH RESPONSE OF CASHEW SEEDLINGS IN THE NURSERY USING PLANT SOURCE WASTES AS ORGANIC FERTILIZER

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ABSTRACT
Given the contemporary promotion of organic fertilizers over their inorganic counterparts, it is essential to assess organic nutrient sources for their suitability in supplying plant nutrients for crop use. The 3 month experiment was established within a nursery environment. The organic materials used in this study are Brewery Spent Grain (B), Palm Kernel Cake (P), and the combination of both (BP) applied at 4t/ha (1) and 2t/ha (2). The treatments include NF as no fertilizer treatment, B1 (BSG at 4t/ha), B2 (BSG at 2t/ha), P1 (PKC at 4t/ha), P2 (PKC at 2t/ha), BP1 (BSG+PKC at 4t/ha) and BP2 (BSG+PKC at 2t/ha). The nutrient composition of the organic materials was determined in the lab. Percentage emergence was recorded at 2, 3 and 4 weeks after sowing and morphological data were collected at 1, 2 and 3 months after sowing. 100% emergence was observed among the treatments except PB2 at 2 weeks after sowing. The result showed a significant difference in plant height, number of leaves and leaf area. NF had the highest seedling height (53.30 cm), stem diameter (7.59 mm) and leaf area (90.71 cm^2). BSG, PKC and the combination of both at the rates applied did not influence cashew seedling emergence and growth.
Keywords: *Cashew, Seedling, Waste, Organic Fertilizer and Nursery*

INTRODUCTION
The cashew tree, scientifically known as *Anacardium Occidentale* L., is a prominent species of the *Anacardiaceae* family (Subbarao *et al*., 2011). It is an economic important crop in the global market due to its high demand, with Nigeria being one of the top producers. Cashew is primarily cultivated for its valuable wood, cashew apple, and, most importantly, its nut (Adeigbe *et al*., 2015). This tree plays a crucial role in generating substantial income for both farmers and local buyers (Taiwo, 2015) or individuals or bodies engaging in any of its value chains such as seedling production. Cashew is mostly propagated by seed and usually by raising them in the nursery before transplanting to the field. The general vigour of cashew seedlings raised in the nursery plays a significant role in their establishment on the field after transplanting (Brown, 1984). Cashew seedlings are usually transplanted 2 to 3 months after raising in the nursery (Adenikinju *et al*. 1989). Fertilizer application is common in the nursery and it has been observed that cashew responds well to fertilizer application (Gawankar *et al*., 2020).
Plant source wastes from industries and agro-allied factories are known to be a major source of environmental pollution however, there are recent studies on some of these wastes as fertilizers for use in raising both arable and cash crops. Brewery Spent Grain (BSG) is a type of waste produced in large volumes in brewery factories (Aliyu and Bala 2011). It is rich in nutrients (Mussatto *et al*., 2014) which makes it a prospective organic fertilizer source. Palm Kernel Cake (PKC) is another common waste generated in oil processing factories that can be used as livestock feed. Recent research on it has also revealed its potential as an organic fertilizer in raising crops (Olowoake, A. A. 2017; Chidi *et al*., 2022).
With the current advocacy for the use of organic fertilizers as against the use of inorganic fertilizers, it is important to evaluate organic sources for the supply of plant nutrients for crop use. It is important to study the response of cashew seedlings to these two organic fertilizer sources. Therefore, the objective of this study is to evaluate the growth response of cashew seedlings to BSG, PKC and the combination of both before transplanting to the field.

MATERIALS AND METHOD

The 3-month experiment was carried out in the nursery at Cocoa Research Institute of Nigeria (CRIN) Headquarters, Ibadan. The experiment was a Complete Randomized Design (CRD) which consisted of 2 factors which are fertilizer types and application rates. The fertilizers used are Palm Kernel Cake (PKC), Brewery Spent Grain (BSG) and the combination of PKC and BSG while the application rates are 4t/ha and 2t/ha. The total number of fertilizer treatments is 6 which are B1 (BSG at 4t/ha), B2 (BSG at 2t/ha), P1 (PKC at 4t/ha), P2 (PKC at 2t/ha), BP1 (BSG+PKC at 4t/ha) and BP2 (BSG+PKC at 2t/ha). A control treatment with no fertilizer applied (NF) was included as a check making a total number of 7 treatments. The treatments were replicated three times. The cashew nuts used were medium nut size. Topsoil was sourced within the institute and sieved with a 2mm sieve to remove debris. The fertilizers were thoroughly mixed with the soil before potting in 2.5kg capacity polythene bags which were used in raising the seedlings. Watering was done twice a week. Data on % emergence of seedlings were recorded at 2, 3 and 4 weeks after sowing (WAS) while morphological data such as plant height (cm), number of leaves, stem diameter (mm) and leaf area (cm^2) were recorded at a monthly interval from 4 WAS to 12 WAS. Data collected were subjected to Analysis of Variance (ANOVA) using GenStat statistical software and treatment means were separated using Tukey at 0.05% probability level.

RESULT AND DISCUSSION

Analysis of soil amendment materials is important (Mora *et al*., 2019) as it reveals the nutrient composition of the material before use as a fertilizer source. The BSG used in this experiment was air dried before use as fertilizer as it has a slurry form in its natural state. The air dried BSG was analyzed in the lab and it was observed to contain 0.31% N, 0.10% P and 0.40%K as revealed in Table 1. The analysis result of PKC as also shown in Table 1 include 1.63% N, 0.70% P and 0.06% K. This result indicates that basic macronutrient needed by plants are present in both fertilizer source but are low in quantity when compared with other commonly used organic fertilizers such as groundnut cake, neem cake, castor cake, coconut cake, cotton seed cake, poultry manure and farm yard manure (Ganeshamurthy *et al*., 2015). However, PKC is richer in N and P than BSG.

Table 1: Nutrient composition of BSG and PKC waste.

Parameters (%)	Plant Source Wastes	
	BSG	PKC
Nitrogen (N)	0.31	1.63
Phosphorous (P)	0.1	0.7
Potassium (K)	0.4	0.06

BSG = Brewery Spent Grain, PKC = Palm Kernel Cake

Figure 1 shows the % seedling emergence of cashew seedlings as influenced by the fertilizer treatments applied. At 2 weeks after sowing (WAS), NF, B1 and P1 attained maximum seedling emergence (100%), followed by B2 (66.67%), P2 and BP both having (33.33%) while emergence was not observed to have occurred in BP1. From this result, the fertilizer treatments might not play a major role in cashew seedling emergence as the control treatment NF had 100% emergence at 2 WAS. At 4 WAS, 100% seedling emergence was observed across all the treatments. It has been observed that the emergence of cashew seedlings depends greatly on the genetic makeup or cashew nut type sown (Hammed *et al*., 2014).

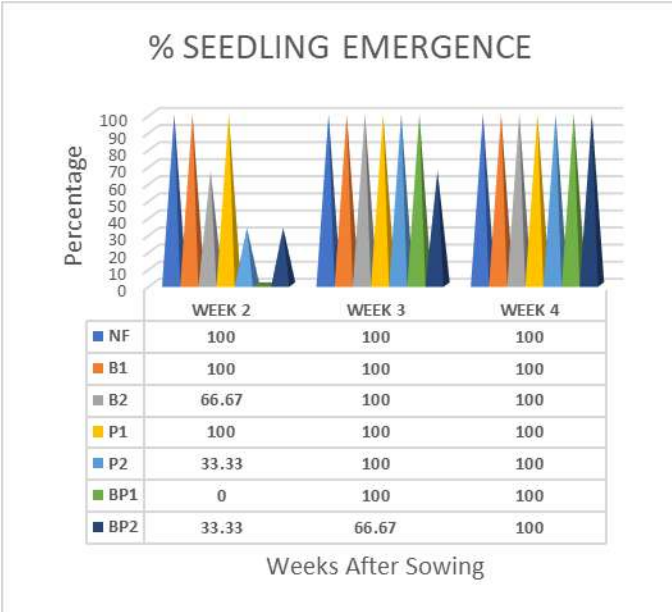

Fig. 1: Cashew seedling emergence as influenced by organic fertilizer treatments.

Table 2 shows the growth response of cashew seedlings to the organic fertilizers used at 3 WAS which was the terminating period of this study. Cashew seedlings responded significantly to the fertilizer treatments in plant height, number of leaves and leaf area while no notable response was observed in stem diameter. The control treatment NF (53.30cm) had a significantly taller plant height than the fertilizer treatments except for BP1 (44.60cm) which had a statistically similar height. B1 (26.60cm) performed least in seedling height and was not comparable with BP2 (30.40cm), B2 (33.33cm), P1 (35.00cm) and P2 (37.20cm). This result implies that the application of the fertilizers did not improve cashew seedling height. Organic manure such as cow dung was observed not to improve cashew seedling height (Opoku-Ameyaw & Appiah, 2000), likewise cocoa pod husk (Agele & Agbona, 2008). PKC1 (29) had the highest number of leaves but was not comparable with PKC2 (20). B1 (11) had the least number of leaves but was not significantly different from BP2 (12), B2 (14), NF (16) and BP1 (18). Only PKC1 (29) gave a statistically higher number of leaves than NF (16). A similar result was also observed by Olowoake, (2017). NF (7.59mm) had the thickest stem diameter however, no comparable difference was observed when compared with other treatments. No improvement in leaf area was also observed among the fertilizer treatments as NF had the largest leaf area (90.1cm^2) followed by BP1 (77.88cm^2), P2 (75.47cm^2), BP2 (73.20cm^2), P1 (72.93cm^2), B2 (62.13cm^2) and B1 (46.80cm^2).

Generally, both fertilizer sources and combinations at both levels did not give an impressive result as expected as NF performed best in plant height, stem diameter and leaf area. This result could be a result of the rates of application used which might not be sufficient enough to make any significant improvement in cashew seedling growth. Organic fertilizers have been observed to be needed in high quantities (Roba, 2018) to make significant improvements in the growth of crops.

Table 2: Growth response of cashew seedlings to plant source wastes.

Treat	*Plant Height (cm)*	*Number of Leaves*	*Stem Diameter (mm)*	*Leaf Area (cm^2)*
NF	53.30[a]	16bc	7.59a	90.71a
B1	26.60c	11c	6.62a	46.80c

B2	33.33bc	14bc	6.96a	62.13bc
P1	35.00bc	29a	6.65a	72.93ab
P2	37.20bc	20ab	6.52a	75.47ab
BP1	44.60ab	18bc	5.87a	77.88ab
BP2	30.40c	12bc	6.46a	73.20ab

CONCLUSION

BSG, PKC and the combination of both as used in this experiment had no influence on cashew seedling emergence as the non-fertilizer treatment attained 100% emergence at 2 weeks after sowing. Cashew seedling growth was not improved by the application of BSG and PKC in this study. However, a higher rate of application is recommended as a trial to further check for the effectiveness of both fertilizer sources in raising cashew seedlings.

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EFFECTS OF DIFERENT TYPES OF ORGANIC MANURE ON THE VEGETATIVE, LEAF YIELD AND COST BENEFIT OF JUTE MALLOW

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ABSTRACT
A field experiment was carried out on the farm centre of the Kwara State College of Education, Ilorin Agricultural Science Department in 2022 planting season to determine the effect of different types of organic manure on vegetative, leaf yield and cost benefit of using the two types of fertilizer on jute mallow. The experimental design was randomized complete block design (RCBD) with three replicates. The treatments were control, manufactured organic manure and produced organic manure. The experimental land was prepared by manual cultivation. The sizes of the experimental plots were 2m by 2m consisting of nine beds with 1m gap. Plant was done by using broadcasting method and the beds were watered thoroughly after planting. Performance indices were plant height, number of leaves /plant, shoot yield, leaf yield, total cost, total return and profit. Data collected from different treatments were subjected to analysis of variance (ANOVA) and the mean separated using DMRT (Duncan Multiple Range Test). The result shows that different types of organic manure had the higher vegetative yield while the non fertilized jute mallow. However the formulated organic manure had the more vegetative growth than the manufacture organic manure. The result also shows that produced organic manure had the highest yield, return and profit. It was concluded that different types of organic manure had significant effect on the vegetative and leaf yield in jute mallow. However, the produced organic manure had more vegetative and leaf yield than manufactured organic manure. It can also be concluded that different types of organic manure had effect on the total cost, total return and profit in jute mallow production. However the produced organic manure had more yield, total return and more profit than the manufactured organic manure.
Keywords: *Jute mallow, manufactured organic manure, produced organic manure, vegetative, leaf yield, profit.*

INTRODUCTIONS

Jute Mallow (*Corchorus olitorius)* is a popular and leafy vegetable of great importance in Nigeria (Dansi *et al*., 2008, 2009). It is an erect annual herb that varies from 60 cm to approximately 150 cm in height depending on the cultivar. It grows in fields next to the houses, on the market garden sites and home gardens around the world. Jute mallow plays an important role in nutrition and household food security. The leaves contain an average of 15% dry matter, 4.8 g of protein, 259 mg of calcium, 4.5 mg of iron, 4.7 mg of vitamin A, 92 µg of folates, 1.5 mg of nicotinamide and 105 mg of ascorbic acid per 100 g of leaves (Grubben and Denton, 2014; Harborne *et al.*, 2019). Despite its nutritional and economic importance, it has been neglected by scientific research and development in Nigeria.

However, there is also a growing international recognition that Neglected and Underutilized Species (NUS) play a role in providing food and nutrition security and income opportunities among smallholder farmers. These NUS crops, trees and animals can help in adapting agriculture and food systems to climate change. Many farmers, especially in marginal areas, rely on NUS for their livelihoods. Consequently, cultivated varieties run the risk of genetic erosion and their cultivation is in serious decline due to low fertility soil, poor yield, pest and diseases. In traditional farming systems, low quantity of fertilizer is applied (Ayodele *et al.*, 2016). In addition, these systems benefit from only the natural soil fertility and possibly small amounts of fertilizer applied to increase the production of other associated crops. This residual fertility is insufficient to meet the crop nutrient supply. Therefore, adequate fertilization is essential to maximize their yields. Indeed, jute mallow requires nutrients such as N, P, K, Mg, Ca, Na and S for a good yielding. These nutrients are specific in function and must be supplied to the plant at the right time and in the right quantity.

Jute mallow responds well to fertilization, particularly nitrogen (Ogunrindé and Fasinmirin, 2011). Moreover, this crop is mostly carried out by marginalized producers of whom access to mineral fertilizers is prohibitive because of their low income (Gensch et al., 2011). Besides, excessive and indiscriminate use of chemical fertilizers leads to soil degradation and imposes a serious threat to human health (Fujimoto, 2018). Also, jute mallow is cultivated on a small scale by women only, so that the production cannot pay back the cost of purchase and transportation of mineral fertilizers. All the above reasons underscore the acute need of alternative sources of fertilizer for sustainable crop production. Organic waste could be a viable alternative to chemical fertilizers. The use of organic manure, e.g. poultry manure and cow dung has improved agricultural productivity in West African countries. Organic farming has enough positive impacts: the long-term productivity in soil conservation and improvement of soil fertility involves the sustainability of production for future generations, stability and food security in diversity cultures and environmental impact using manure. Indeed, organic manures enhance soil moisture, increased soil organic matter, nitrogen, pH, phosphorus, and cation exchange capacity (CEC), and reduced soil exchangeable acidity (Adeniyan and Ojeniyi, 2013; Mbah, 2016)

In Nigeria, various types of organic manure exist for plant nutrition. This can be divided into two that is farmer manufacture type and readymade manufactured type from Fertilizer Company. Hence there is a need to carry out a comparative study to determine the effect of the two types of organic fertilizer on vegetative, leaf yield and cost benefit of using the two types of fertilizer on jute mallow production.

MATERIALS AND METHODS

A field experiment was carried out on the farm centre of the Kwara State College of Education, Ilorin Agricultural Science Department in 2022 planting season between February to May 2022 to determine the effect of different types of organic manure on vegetative, leaf yield and cost benefit of using the two types of fertilizer on jute mallow. The experimental design was randomized complete block design (RCBD) with three replicates. Jute mallow seed used for the experiment was obtained from an Grtet seed in Ilorin, Kwara State Nigeria. So also is the organic manure. The other materials used were weighing scale and poultry manure produced in the department of agricultural science Kwara State College of Education, Ilorin. The treatments were control, manufactured organic manure and produced organic manure. The experimental land was prepared by manual cultivation. The sizes of the experimental plots were 2m by 2m consisting of nine beds with 1m gap. The organic manures were apply at the rate of 1kg/plot for manufacture type and 5kg/plot for produced type two weeks before planting. Plant was done by using broadcasting method and the beds were watered thoroughly after planting. Hand hoeing was done as at when required to control weeds. Watering was done every day using watering can.

Data Collections

The data collected were:

I. Plant height: Determine by using ruler to measure the tip of the plant to the soil level in cm every two weeks.
II. Number of leaves /plant: It was determined by counting the number of leaves /plant every two weeks.
III. Shoot yield: It was determined by using a digital scale to measure the fresh weight of the shoot/plot
IV. Leaf yield: It was determined by using a digital scale to measure the fresh weight of the leaf /plot
V. Total cost: It was determined by adding all the money spent the production of the jute mallow using different organic manure
VI. Total return: It was determined by adding all the money realized after the sales of of the jute mallow using different organic manure

VII. Profit: It was determined by subtracting total return from total cost

Data Analysis

The data collected from different treatment were subjected to analysis of variance (ANOVA) and the mean separated using DMRT (Duncan Multiple Range Test).

RESULTS

Table 1 shows the effect of different types of organic manure on plant height of jute mallow. The effect was significant with throughout the experiment. The formulated organic manure had the tallest plant which was followed manufactured typed. The control had the least plant height. Table 2 shows the effect of different types of organic manure on number of leaves/plant of okra. The effect was significant with throughout the experiment. The formulated organic manure had the highest number of leaves/plant which was followed manufactured typed. The control had the least number of leaves/plant. Table 3 shows the effect of different types of organic manure on the shoot yield of jute mallow. The effect was significant with the produced organic manure having the highest shoot yield was followed by manufactured organic manure. The control had the least shoot yield.

Table 3 shows the effect Different types of organic manure on the leaf yield of jute mallow. The effect was significant and follow similar trend as shoot yield. The effect was significant with the produced organic manure having the highest leaf yield which was followed by manufactured organic manure. The control had the least leaf yield. Table 4 shows the total cost of using different types of organic manure in the production of jute mallow. The effect was significant with the produced organic manure and control having the same total cost. However, the manufactured total was cost higher due to the cost of buying the manufactured organic manure.

Table 5 shows the total return of using different types of organic manure in the production of jute mallow. The effect was significant with the produced organic manure having both the highest yield and return, this was followed by the manufactured organic manure. The least yield and return was recorded in the control. Table 6 shows the profit from using different types of organic manure in the production of jute mallow. The effect was significant with the produced organic manure having profit (N580) this was followed by the manufactured organic manure (N480). The least yield and return was recorded in the control (N390)

DISCUSSION

The result shows that different types of organic manure had the higher vegetative yield while the non fertilized jute mallow. However, the formulated organic manure had the more vegetative growth than the manufacture organic manure. The organic manure had N for vegetative growth. The result is in line with the works of Akanbi *et al* (2018) and collaborate the work of Olaniyi *et al.,* (2018). The result shows that produced organic manure had the highest shoot and leaf yield. The result is expected as organic manures had influenced both the shoot and leaf yield. However, the effect was higher in produced organic manure because the produced organic manure had more organic N than the manufacture organic manure. The result is in line with the works of Akanbi *et. al.,* (2018) and collaborate the work of Olaniyi *et al.,* (2018) The result shows that produced organic manure had the highest yield, return and profit. The result is expected as organic manures had influenced both the shoot and leaf yield. However, the effect was higher in produced organic manure this is because the produced organic manure had more organic N than the manufacture organic manure. This resulted in the jute mallow having more yield, return and profit than the manufactured organic manure. The result is in line with the earlier works of Olawepo *et al.,* (2018) and collaborate the work of Olaniyi, e*t al.,* (2018)

CONCLUSION

It can be concluded that different types of organic manure had significant effect on the vegetative and leaf yield in jute mallow. However, the produced organic manure had more vegetative yield than the manufactured organic manure. It can also be concluded that different types of organic manure had effect on the total cost, total return and profit in jute mallow production. However, the produced organic manure had more yield, total return and more profit than the manufactured organic manure.

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Table 1: Effect of different types of organic manure on the plant height (cm) of jute mallow

	2WAP	4WAP	6WAP
Control	4.2^c	10.2^c	14.8^c
Formulated organic manure	7.3^a	16.3^a	22.1^a
Manufactured organic manure	6.3^b	13.2^b	19.4^b

Mean with the same superscripts are not significantly different.

Table 2: Effect of different types of organic manure number of leaves/plant of jute mallow

	2WAP	4WAP	6WAP
Control	4.2^c	10.2^c	14.8^c
Formulated organic	7.3^a	16.3^a	22.1^a

manure			
Manufactured organic manure	6.3^{b}	13.2^{b}	19.4^{b}

Mean with the same letters are not significantly different.

Table 3: Effect of Different types of organic manure on the Shoot yield (g/plot) of Jute mallow

	Shoot yield	Leaf yield
Control	350^{c}	110^{c}
Manufactured organic manure	420^{b}	140^{b}
Produced organic manure	490^{a}	220^{a}

Mean with the same letters are not significantly different at P ≤0.05

Table 4: Total cost of production of jute mallow(N) per plot using different types of organic manure

	Control	Manufactured organic manure	Produced organic manure
Land preparation	100	100	100
Planting	10	10	10
Maintenance	200	200	200
Manure	0	50	0
Total	310	360	310

Table 5: Total cost of return from the jute mallow (N) per plot using different types of organic manure

	Control	Manufactured organic manure	Produced organic manure
Yield	350	420	490
Sale	700	840	980

Table 6: Profit from the jute mallow (N) per plot using different types of organic manure

	Control	Manufactured organic manure	Produced organic manure
Total return	700	840	980
Total cost	310	360	310
Profit	390	480	580

EVALUATION OF THE EFFECT OF TRAINING ON PLANTAIN/BANANA RAPID MULTIPLICATION TECHNIQUES ON FARMERS PRODUCTIVITY AND WELFARE IN OYO STATE

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ABSTRACT
This study was conducted to evaluate the effect of training on plantain/banana rapid multiplication techniques carried out at the National Horticultural Research Institute, Ibadan on stakeholders' productivity and welfare in Oyo state. Data were collected on types of technologies adopted, effects of technologies on welfare of trainees as well as constraints in application of technologiesusing structured questionnaire from 28 out of 58 trained participants and analyzed using descriptive statistics. Results revealed that most (85.7%) of the participants were males, married (89.3%), with tertiary education (77.6%), average age (52 years), years of experience in plantain/banana farming (10 years) and farm size (5.6±7.6acres). The result further showed that 82.1% adopted the technologies and 46.4% adopted technology related to sucker production. More than three-quarters of the trainees (85.7%) have applied the knowledge gained on types of suckers to use for rapid multiplication, while 57.1% have applied micropropagation techniques and specifically decapitation. Also, the result showed that 85.7% of the respondents agreed that the application of the technologies has increased the income, acquisition of household assets (82.1%), and financial contribution to children's fund (75.0%) with about 60-100%. Access to funds, irrigation and land are constraints to application of the technologies as opined by 46.4% of the trainees. The study recommends that training programmes be evaluated when the participants are expected to have been practicing and not only at the start or the end of the training.
***Keywords**: Applied technologies, Evaluation, Rapid multiplication techniques, Plantain/Banana*

INTRODUCTION

Training programmes are conducted with the aim of ensuring improved skills, knowledge and attitude as well as change in behaviour or performance of the trainees (Osei et al, 2005). Training evaluation is a means of obtaining relevant information from trainees on the effects of a training programme previously organized. An effective way of evaluating a training programme is to assess participants (trainees) when they are already on-the-job using what they were taught (Osei et al, 2005). Evaluating participants at the time of training is used to determine whether or not the objective of the training has been achieved (Neendoor, 2003). This provides an immediate evaluation of the training. However, having a follow-up study to determine how effective a training programme has been able to change participants' performance on-the-job offers adequate insight into how useful the training is to participants' work environment or situation (Osei et al, 2005).

Plantain is an important staple food crop, the fourth worldwide; which contributes to food security, decreased rural poverty and poverty alleviation. It is a raw material for many delicacies and snacks. Nigeria is a major producing country of plantains in the world (Ayanwale et al, 2016). There are different techniques for the propagation of this all-important staple plantain (including bananas), some of which are mother plant stripping, decapitation, corm technique, tissue and cell culture (Tumuhimbise and Talengera, 2018).

Rapid production of clean planting materials is important to ensure increased productivity and welfare of plantain farmers. It is also important, considering the contribution of the crop to food security, as well as reduced poverty alleviation. This study was therefore carried out to evaluate the effect of a training on rapid multiplication techniques for plantain/banana carried out at National Horticultural Research Institute, Ibadan on farmers (trainees) welfare.

Specifically, this study profiled:

- Personal characteristics of the trainees (participants)
- Training modules which the participants have applied to the plantain/banana production
- Technologies adopted by the trainees
- Perceived effect of application of the training on trainees' welfare
- Constraints to application of technologies by the trainees

METHODOLOGY

The study was carried out at NIHORT. Plantain producers were trained on rapid multiplication of plantain to produce clean and disease-free planting materials. The producers trained were part of NIHORT stakeholders in plantain value chain. A total number of 58 stakeholders were exposed to practical demonstration on the processes of rapid multiplication technology of plantain. After 2 years, a total number of 28 trainees were randomly selected and data were collected on the extent of adoption of the technology and effect on welfare as well as constraints in the application of technologies.

Data collected were analyzed using descriptive statistics.

RESULTS AND DISCUSSION

Personal characteristics of trainees

The results revealed that most of the trainees were males (85.7%), married (89.3%), with tertiary education (77.6%), only 28.6% had farming as primary occupation (Table 1). Furthermore, the average age of trainees was 52 years (51.6±14.3), with household members being on the average of 5 (5.3±2.7) and 10 years' (10.0±11.5) experience in plantain/banana production while their average farm size was5.6±7.6 acres.This implies that the trainees have the educational ability to apply the knowledge disseminated during the training as observed in their educational qualification. Most of the participants are not new to the plantain/banana enterprise; they have spent an average of 10 years in the enterprise and have sizeable farmwith an average of 5.6 acres where they produce.

Training modules which participants' have applied to their plantain enterprise

The results further revealed that most of the trainees have applied the knowledge gained from the training as regard the types of suckers (85.7%) suitable for plantain production (Table 2). Thus, they are able to select the best type of sucker available in their locality for rapid multiplication of plantain. More than half of them have also applied the knowledge transferred on macro propagation techniques and decapitation (57.1% respectively) while 46.4% have applied corm techniques as well as the use of macro chamber/propagator. This implies that useful knowledge which could be easily applied by the trainees was passed across to them during the training session. Moreover, application of the knowledge transferred during the training implies that there will be an improvement in the participants' plantain enterprises.

Adoption of technologies after training

Furthermore, the results showed that 82.1% of the trainees have adopted different aspects of the technology after their capacity was built (Table 3). They adopted technologies pertaining to sucker production (46.4%), decapitation methods (14.3%) as well as corm techniques (10.7%). The results have shown that not only were some training aspects applied by the trainees they have also adopted these technologies for use in their plantain enterprises.

Adoption of the training modules (aspects) taught is expected to increase the productivity and welfare of the plantain farmers (producers).

Effect of technologies on welfare of trainees

Trainees were asked to rate their opinion on how the training has impacted their lives (welfare). Table 5 showed that most of the trainees opined that there was up to 60-100% increase in their welfare considering increased income (85.7%), acquisition of household assets (82.1%), increased financial contribution to household and to children's education (75.0% respectively). Only 35.7% opined that the training has enhanced their decision-making power up to 60-100%.

Constraints in application of technologies

Despite the application of knowledge gained, 46.4% of the trainees opined that there were constraints to the application of technologies they were taught (Table 5). Some of the constraints include fund and access to irrigation (10.7%) as well as access to land (7.1%). This implies that knowledge gain is not the only factor required for participants to apply the technologies taught.

CONCLUSION

Most of the trainees have applied the knowledge gained from the training and were able to select the best types of suckers in their respective locality for rapid multiplication of plantain. Furthermore, the stakeholders have adopted technologies pertaining to rapid multiplication techniques of plantain multiplication. The study recommends that training programmes be evaluated when the participants are expected to have been practicing and not only at the start or the end of the training. This is to give an insight as to whether or not the training is achieving its ultimate aim of improved welfare for the trainees.

Table 1: Personal characteristics of participants

Characteristics	Frequency (Percentage)	Mean (Standard deviation)
Sex		
Male	24(85.7)	
Female	4(14.3)	
Marital status		
Single	3(10.7)	
Married	25(89.3)	
Educational qualification		
Primary	3(10.7)	
Secondary	3(10.7)	
Tertiary	22(77.6)	
Age		51.6(14.2)
Household size		5.3(2.7)
Years of cultivating Plantain		10.0(11.5)
Farm size(acres)		5.6(7.6)
Years of experience in plantain/banana production		10.0(11.5)
Primary occupation		
Farming	8(28.6)	
Trading	1(3.6)	
Public service	6(21.4)	
Private business	3(10.7)	
Others	10(35.7)	
Secondary occupation		
Farming	24(85.7)	
Trading	-	
Public service	-	
Private business	1(3.6)	
Others	3(10.7)	

Table 2: Training modules which participants' have applied to their plantain enterprise

Training modules applied	Frequency	Percentage
Types of suckers	24	85.7
Macro propagation techniques	16	57.1
Decapitation	16	57.1
Corm Techniques	13	46.4
Macro chamber/propagator use	13	46.4
Shade house nursery construction	6	21.4
Management measures	7	25.0
Economics of production	8	28.6
Marketing of Plantain	9	32.1

Table 3: Adoption of technologies after training

Variable	Frequency	Percentage
Adopted technology after training		
Yes	23	82.1
No	5	17.9
Technologies adopted		
Sucker production	13	46.4
Corm techniques	3	10.7
Decapitation	4	14.3
Macro propagation	1	3.6
Management measures	1	3.6
No response	1	3.6

Table 4: Effect of technologies on welfare of trainees

Variable	Frequency	Percentage
Increase in income		
No increase	1	3.6
10-50% increase	3	10.7
60-100%	24	85.7
Acquisition of properties/household items		
No increase	2	7.1
10-50%	3	10.7
60-100%	23	82.1
Increase financial contribution to household		
No increase	3	7.1
10-50%	4	14.3
60-100%	21	75.0
Increase financial contribution to children's education		
No increase	4	14.3
10-50%	3	10.7

60-100%	21	75.0
Enhanced decision-making power		
No increase	17	60.7
10-50%	1	3.6
60-100%	10	35.7

Table 5: Constraints in application of technologies

Variable	Frequency	Percentage
Are there any constraints in applying the technologies taught?		
Yes	13	46.4
No	15	53.6
Constraints		
Fund	3	10.7
Access to Irrigation	3	10.7
Pest infestation	1	3.6
Inadequate labour	1	3.6
Access to land	2	7.1
Lack of monitoring	1	3.6
Marketing issues	1	3.6
No response	1	3.6

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HOUSEHOLD PERCEPTION OF THE HEALTH BENEFITS OF FRUITS AND VEGETABLES IN SOUTH-WESTERN NIGERIA

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ABSTRACT
Despite an increasing focus on the health benefits of fruits and vegetables in human diet, their consumption is still far below the World Health Organization's recommended intake of at least 400g per day per capita in Nigeria. The study therefore assessed the perception of the health benefits of fruits and vegetables among households in southwestern Nigeria. A total of 450 households were randomly selected from the study area using a multistage sampling technique. Information was obtained from household heads with the aid of personal interviews and semi-structured questionnaire. Data were analysed using descriptive and inferential statistics. The perceived benefits of fruits and vegetables were assessed using a Likert 5 points rating scale of "Strongly Agreed", "Agreed", Undecided", "Disagreed" and "Strongly Disagreed". Results revealed that only 50.0% of the respondents had favourable perception of the health-related benefits of fruits and vegetables, while 45.0% and 42.8% of the household heads had unfavourable perception on the health-related benefits of fruits and vegetables, respectively. These findings implied that about half (50.0%) of the sampled respondents do not have positive perception of the importance of fruits and vegetables in human health. Hence the need for more enlightenment programmes and comprehensive nutrition education strategies on the health benefits of fruits and vegetables among household in south-western Nigeria.
Keywords: *Perception, fruit and vegetable intake, health benefits, Likert scale*

IINTRODUCTION

Low fruits and vegetable consumption are associated with the most important causes of premature mortality globally, this is the reason many people in most countries have some form of malnutrition due to the inadequate unbalanced or excessive consumption of macro nutrients and micronutrients (Daniel et al., 2019). This has led to the spread of many of the non-communicable diseases that are the main cause of premature mortality globally. However, economic growth has been considered as one of the factors that can determine the consumption rate of fruit and vegetable According to Silva et al., (2017), consumption of fruits and vegetables is important for the provision of micronutrients to the body, as these food items are a rich source of vitamins and minerals required for the growth, development, and normal functioning of the human body. The micronutrients supplied by fruits and vegetables are also vital for the optimal functioning of the gastro-intestinal tract as they also enable the body to use other nutrients required for its normal function like energy from fats and carbohydrate (Ibe et. al., 2020).
Various reviews have associated low intake of fruits and vegetables with chronic diseases such as cardiovascular diseases, blood pressure, hypercholesterolemia, osteoporosis, many cancers, chronic obstructive pulmonary diseases, respiratory problems as well as mental health (Park et al., 2011; Payne et al., 2012; Habauzit et al 2014; Pem and Jeewon, 2015). Despite an increasing focus on the health benefits of fruits and vegetables, their consumption is below the recommended intake among adults in both developed and developing countries (Ruel et al., 2005; Morbidity and Mortality Weekly Report, 2010; Banwat et al., 2012; Ogundari and Arifalo, 2013). Price of vegetables, price of fruits, level of education and age are the factors greatly influencing demand for fruits and vegetables (Aturamu et al., 2021). Although, a considerable number of research has been done in Nigeria (Ogundari and Arifalo, 2013; Layade and Adeoye, 2014; Ibe et al., 2018; Adenegan et al., 2018; Obayelu et al., 2018) to ascertain the

factors influencing fruit and vegetable consumption/demand however, there is a dearth of information on consumers' perception of the health benefits and barriers of fruits and vegetables as well as the factors influencing their perception in Nigeria. Thus, this study was conducted to examine households' perceived benefits and barriers of fruits and vegetables and also analyze the relationship between their socio-demographic factors and perception in southwestern Nigeria.

MATERIALS AND METHODS

Description of the study area

This study was carried out in southwestern Nigeria which falls on latitude 6^0 to the north and latitude 4^0 to the south. It is marked by longitude 4^0 to the west and 6^0 to the east. It is bounded in the north by Kogi and Kwara States, in the east by Edo and Delta States, in the south by Atlantic Ocean and in the west by Republic of Benin. The zone is characterized by a tropical climate with distinct dry season between November and March and a wet season between April and October. The mean annual rainfall is 1480mm with a mean monthly temperature range of 18^0C – 24^0C during the rainy season and 30^0C – 35^0C during the dry season.

Method of data collection

A multistage sampling technique was used to select the respondents. The first stage was the random selection of two states (Ogun and Osun states) out of the six states which makes up the southwestern zone. The second stage involved the random selection of ten Local Government Areas (LGAs) from the selected states proportionate to the size of LGAs in the two states. In the third stage, one city and one village were randomly selected per each of the selected LGAs, while in the last stage 411 households were randomly selected from the selected communities proportionate to size.

Data were collected from household heads or their spouse using personal interviews and semi-structured questionnaire. Information was sourced on the socio-economic and demographic characteristics of household heads such as age, gender, household size, level of education, income level, occupational status as well as response to some statements on the perceived health benefits of fruits and vegetables.

Method of data analysis

Data obtained were analysed using descriptive statistics, inferential statistics and the Likert scale 5-point scale. In the scale, statement like "Strongly Agreed" (SA) was given a rating of 5 points, "Agreed" (A) 4 points, "Undecided" (U) 3 points, "Disagreed" (D) 2 points and "Strongly Disagreed" (SD) 1 point. The mean score (MS) was calculated as follows:

$$MS = (\Sigma\ (RP \times O) / \Sigma f)$$

Where RP is the rating points, O is the number of observations and f is the total number of sampled respondents.

RESULTS AND DISCUSSION

Socioeconomic characteristics of respondents

As shown in Table 1, about 86 percent of households sampled in the study area were male-headed with only 14.1% headed by female. The mean age of household heads was 45.09±13.54 years. This indicated that a larger proportion of the sampled household heads were in active and productive age. Furthermore, more than 40 percent of the respondents were within the age range of 20-40 years, married, educated, had between 1 and 5 household size, engaged in other occupation other than agriculture and earned less than N50,000 monthly. The fact that most of the household heads were educated implied that they are likely to aware of the health benefit of fruit and vegetable in human diet.

Households' perception on health benefits of fruits and vegetables

The results of analysis of households' response to certain statements on perceived health related benefits of fruits and vegetables using Likert 5-point scale rating are presented in Tables 2 and 3. The result showed that most of the respondents in the study area had positive perception on the health-related benefits of fruits and vegetables. This result is in line with the findings of Wolf *et al.,* (2008), where nearly all the respondents sampled in their study reported that there were health benefits related to eating fruits and vegetables. Respondents did not perceive time taken to prepare fruits and vegetables as a barrier. They perceived fruits and vegetables to be cheap, readily available, provide essential nutrients, help to maintain body weights and also lower the chances of illnesses such as cancer, high blood pressure, stroke and so on.

CONCLUSION

This study examined the perception of household heads in south-western Nigeria on the health benefits of fruits and vegetables in human health using primary data which were obtained with the aid of personal interviews and semi-structured questionnaire. Data were analyzed using descriptive and inferential statistics. Findings from the study revealed that about half of the sampled household heads sampled do not have positive perception of the importance of fruits and vegetables in human health. The positive perception of health benefits of fruits and vegetables among respondents would likely indicate their readiness in the purchase and consumption. Hence the need for more awareness and nutrition education programmes education (such as health talks, seminars, workshops and jingles) for households in south-western Nigeria on the nutritional value and major health benefits of fruits and vegetable when consumed in adequate proportion.

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Table 1: Socio-demographic characteristics of household heads

Variables		**Percentage**
Sex	Male	85.9
	Female	14.1
Age (years)	20-40	45.7
	41-60	40.9
	61-80	12.2
	>80	1.2
	Mean	45.09
	Standard deviation	13.54
	t-value	0.84
Marital status	Married	84.2
	Single	4.6
	Widowed	8.8
	Divorced/separated	2.4
Household size	1-5	60.3
	6-10	35.8
	>10	3.9
	Mean	5.39
	Standard deviation	3.02
	t-value	4.12^{***}
Educational level	No formal education	10.5
	Primary school education	23.3
	Secondary school education	34.3
	Tertiary education	31.9
Main occupation	Agriculture	15.1
	Non-agriculture	84.0
Secondary occupation	Farming	15.1
	Civil service	22.1
	Trading	21.9

	Professional/private worker	13.1
	Artisan	26.3
	Others	1.5
Monthly income (in Naira)	<10,000	8.3
	10,000-50,000	6.2
	51,000-100,000	21.0
	>100,000	8.7
	Mean	47,941.51
	Standard deviation	48,810.62

Source: Estimated by author from survey data
*** indicate significance at 1% level.

Table 2: Distribution of respondents according to their perception on the health-related benefits of fruits

Perception statement	**SD %**	**D %**	**UD %**	**A %**	**SA %**	**MS %**	**Remarks %**
Fruits are inconvenient to eat	16.8	80.8	0.7	1.0	0.7	1.9	D
Fruits provide essential vitamins and nutrients	1.5	1.2	1.5	23.1	72.7	4.7	SA
Fruits take a lot of time to prepare	14.4	82.0	1.5	1.7	0.4	1.9	D
Fruits lower chances of heart disease	0.2	1.5	11.2	31.9	55.2	4.4	A
Fruits are not readily available	14.6	79.6	2.2	2.9	0.7	2.0	D
Fruits help to maintain weight	0.5	4.1	9.7	32.8	52.8	4.3	A
Fruits are very expensive	11.2	66.4	2.9	13.6	5.8	2.4	D
Fruits lower chances of stroke	0.5	2.4	11.2	29.9	56.0	4.4	A
I do not like fruits	23.8	68.6	0.2	5.4	2.0	1.8	D
Fruits lower chances of high blood pressure	0.5	1.9	9.0	32.4	56.2	4.4	A
Most of my household members does not like fruits	23.1	75.2	0.5	0.5	0.7	1.8	D
Fruits lower chances of cancer	0.5	2.9	12.2	30.9	53.5	4.3	A

Source: computed by author from field survey
SD=Strongly Disagreed (1); D=Disagreed (2); UD=Undecided (3); A=Agreed (4); SA=Strongly Agreed (5); MS=Mean Score

Table 3: Distribution of respondents according to their perception on the health-related benefits of vegetables

Perception statement	**SD %**	**D %**	**UD %**	**A %**	**SA %**	**MS %**	**Remarks %**
Vegetables are inconvenient to eat	18.2	79.8	0.2	1.0	0.7	1.9	D
Vegetables provide essential vitamins and nutrients	0.5	0.5	1.5	26.8	70.8	4.7	SA
Vegetables take a lot of time to prepare	16.5	78.6	1.0	2.9	1.0	1.9	D
Vegetables lower chances of heart disease	0.2	1.7	10.2	31.9	56.0	4.4	A
Vegetables are not readily available	17.0	75.2	0.7	5.4	1.7	1.9	D
Vegetables help to maintain weight	0.7	3.4	9.5	33.1	53.3	4.4	A
Vegetables are very expensive	11.7	74.0	1.9	7.8	4.6	2.2	D
Vegetables lower chances of stroke	0.2	2.4	10.5	31.6	55.2	4.4	A
I do not like vegetables	21.9	75.4	0.2	1.5	1.0	1.8	D
Vegetables lower chances of high blood pressure	0.2	2.4	8.5	31.9	56.9	4.4	A
Most of my household members does not like vegetables	20.9	73.7	0.5	1.5	3.4	1.9	D
Vegetables lower chances of cancer	0.2	2.9	11.4	30.9	54.5	4.4	A

Source: computed by author from field survey
SD=Strongly Disagreed (1); D=Disagreed (2); UD=Undecided (3); A=Agreed (4); SA=Strongly Agreed (5); MS=Mean Score

FUNGI TOXIC EFFECT OF *MORINGA OLEIFERA* LEAVES AND *ALLIUM SATIVUM* (GARLIC BULBS) EXTRACTS AGAINST ROT CAUSING FUNGI PATHOGENS OF CUCUMBER (*Cucumis sativus* L.)

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ABSTRACT
The Cucurbitaceous plant family is affected by several diseases caused by different formae of fungus Fusarium oxysporum. Two economically important fungi species F. oxysporum and F. verticillioides have been identified as a causative pathogens causing rot in Cucumis sativus L.(Cucumber). Samples were collected from symptomatic cucumber fruits expressing rot and were surface sterilized, cultured on solidified Potato dextrose agar and incubated at 28±2°C for 5 days. Sub culturing was done to obtain pure cultures of the isolates. Isolates were identified using cultural, microscopic and molecular characterization. The culture was viewed under the microscope and identified morphologically as Fusarium spp. The pathogenicity of F. oxysporum and F. verticillioides confirmed on healthy cucumber fruits revealed its capability to cause infection on healthy fruits. The growth inhibition of all the isolated fungi by extracts of Allium sativum (Garlic) and Moringa oleifera (Moringa) at different days of incubation. There was significant growth inhibition of the two isolated organisms but F. oxysporum had the highest inhibition occurrence followed by F. verticillioides. There was no significant ($p \leq 0.05$) difference in the growth inhibition between F. oxysporum and F. verticillioides all through the seven days of observation. The aqueous extracts gave better growth inhibition compared to the ethanol extracts. Growth inhibition of F. oxysporum was better than that of F. verticillioides
***Keywords**: Moringa oleifera, Allium sativum, Cucumis sativus, fungitoxicity.*

INTRODUCTION

Cucumber (*Cucumis sativus* L.), an important vegetable crop belonging to the family Cucurbitaceous. It is an annual monoecious creeping vine that bears large leaves that form canopy over its cylindrical fruits (Adetula and Denton, 2003). Cucumber, a popularly cultivated fruit in the gourd family has its origin traced back to ancient India and has been ranked the fourth most widely cultivated vegetable in the world after tomato, cabbage and onion (Wehner, 2007). In Nigeria, the cucumber plant will thrive well at any time of the year even though it has little or no tolerance to frost. During the raining season, the crop is grown under rainfed conditions and during the dry season using irrigation year (Eifediyi and Remison, 2009). It prefers conditions of high light, high humidity, high soil moisture, temperature and fertilizers in green-houses (El-Aidy et al., 2007).

Fruits generally, due to their high moisture content and nutrient composition are prone to pathogenic fungal attack which in addition to causing rots may also make them unfit for human consumption by producing mycotoxins. Gatto *et al.,* (2011) reported that fungal infections are the main cause of postharvest rots of fresh fruits and vegetables during storage and transport which cause significant economic losses in the commercialization phase. Infections caused during postharvest conditions lower shelf life of fruits and adversely affect the market value of fruits thereby having a negative impact on the economy. The contamination of fruits with mycotoxins has not only caused health hazards but also resulted in economic losses, especially for exporting countries. Presently, use of chemical fungicides serves as the primary means for controlling postharvest fungal decay of fruits and vegetables. Continuous use of fungicides is been frowned at as there is increasing public concern regarding contamination of fruits and vegetables with fungicidal residues and proliferation of resistance in the pathogen populations.

MATERIALS AND METHODS

Sample Collection

The experiment was conducted at the Plant Pathology Laboratory of the National Horticultural Research Institute, Ibadan, Nigeria. Cucumber fruits with signs of rot were obtained from a local fruit market in Ibadan. The diseased samples were packaged in a paper bag and taken to the laboratory for further research. The leaves of *Moringa oleifera* leaves were collected from a residential building at Oluyole Estate Ibadan, Oyo State while *Allium sativum* cloves were bought at Oje market in Ibadan.

Isolation and Identification of Fungi

The pathogenic organisms from the rotten cucumbers were isolated using a direct plating method. The cucumber fruit was washed under running water and surface sterilized with 70% ethanol for about three minutes and thereafter rinsing in three changes of sterile distilled water before blotting it dry on filter paper. A sterile scalpel was used to cut a section of tissue from the cucumber fruit moving from the healthy to the diseased portion where the fungus is likely to be more active. The cut portion is aseptically placed on a Petri dish containing 15ml of potato dextrose agar (PDA) and incubated at room temperature of 27^0C ± 2^0C in a laminar flow for seven days. The growth on the Petri dishes was observed and sub-culturing was done to get pure cultures.

Identification of Fungal Isolates

This was done based on the description of the morphological appearance of fungal colonies on Potato Dextrose Agar culture medium and the slide culture technique for microscopic evaluation according to method by Wantanabe (2002).

Pathogenicity Test

Healthy cucumber fruits were surface sterilized with 70% ethanol. Cylindrical plugs were cut from each cucumber fruit using a sterile 5mm cork borer. Pure culture of each isolated fungus was introduced into the holes in three replicates. The cylindrical plugs were placed back in the holes and sealed with sterile petroleum jelly. The fruits were incubated at room temperature (28±2oC) for7–10days while the control has no fungus. The cucumber fruits were examined after 7days to access and record the extent of rot and the pathogens were re-isolated from the inoculated cucumber fruits. The experiment was done in three replicates under sterile conditions.

Preparation f Plant Extracts

The leaves of *M. oleifera* and clove of *A. sativum* were washed under running water, air dried for weeks at room temperature and grounded into powdered form. The powdered samples were added to different conical flasks containing the extraction solvent (sterile distilled water and ethanol). For the aqueous plant extraction, dried plant materials were soaked in water for 24hours, stirred every 2 hours, sieved with muslin cloth and further filtered using Whatman filter paper. The aqueous filtrate was concentrated using a rotator evaporator at 50^0C. While for the ethanol extraction, dried plant materials were soaked in ethanol for 72hours with constant stirring every two hours after which solvent was collected using muslin bag. It was further filtered using Whatman filter paper and filtrate was evaporated to dryness using a rotatory evaporator set at 40^0C. After getting the crude extracts of each botanical, 0.25g of each extract was dissolved in 250ml of sterilized distilled water and it served as the stock solution. Further dilutions were made to get the 25, 50, 75 and 100%, a modified method of Akanmu *et al.,* (2013a).

Growth Parameter Measured

Data collected were limited to the length of the mycelia growth extension of the two fungal organisms. Radial growth was measured at 24 hours interval for seven days as the mean growth along the two axes on two pre-drawn perpendicular lines on the reverse side of the plate.

Fungi toxicity was expressed as percentage inhibition of mycelia growth using formula adopted from Onuh *et al.,* (2005);

$$F_P = \frac{F_1 - F_2}{F_1} \times 100$$

Where F_P = percentage inhibition of mycelia growth, F1 = mycelia growth in control plate

F_2 = mycelia growth in plate containing plant extracts.

Statistical Design and Analysis

The experiment set up was laid out in a Completely Randomized Design (CRD). The data collected were subjected to analysis of variance (ANOVA) using Generalized Linear Model (GLM) procedure of Statistical Analysis Software (version 9.1). The differences between means were separated using Duncan's Multiple Range Test (DMRT) at $p \leq 0.05$.

RESULTS

Fungi isolated from rotting cucumber

The fungi isolated and found pathogenic from the rotting cucumber fruits are *F. verticillioides* and *F. oxysporum* (Plate 1),

Growth inhibitions of the isolated fungi by *Moringa oleifera* and *Allium sativum* extracts

Table 1 shows the growth inhibition of all the isolated fungi by extracts of *A. sativum* (Garlic) and *M. oleifera* (Moringa) at different days of incubation. There was significant growth inhibition of the two isolated organisms but *F. oxysporum* had the highest inhibition occurrence followed by *F. verticillioides* . There was no significant ($p \leq 0.05$) difference in the growth inhibition between *F. oxysporum* and *F. verticillioides* all through the seven days of observation.

Table 1: Radial growth inhibition of the isolated fungi by *Moringa oleifera* and *Allium sativum* extracts (cm)

Organism	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Control	2.45^{a}	4.22^{a}	5.51^{a}	6.58^{a}	7.31^{a}	7.68^{a}	8.14^{a}
Fusarium verticillioides	0.53^{b}	0.78^{b}	1.03^{b}	1.29^{b}	1.48^{b}	1.66^{b}	1.83^{b}
Fusarium oxysporum	0.44^{b}	0.72^{b}	0.90^{b}	1.14^{b}	1.31^{b}	1.44^{b}	1.56^{b}

Means with different letters in a column are significantly different at $p \leq 0.05$

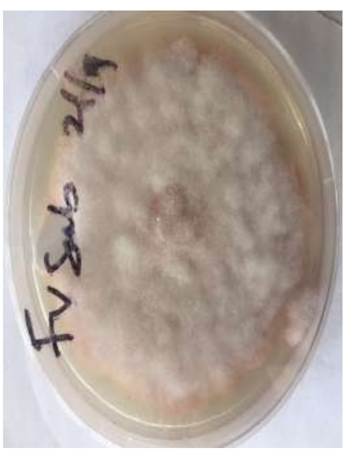

Plate 1: Pure culture of *Fusarium verticillioides*. Pure culture of *Fusarium oxysporum*

(A) (B)

Plate 2: Pathogenicity test for (A) *F. oxysporum* *and* *(B) F. verticillioides*

DISCUSSION

This research showed that cucumber fruits are prone to postharvest rot caused by fungal pathogens and that *F. verticillioides* and *F. oxysporum* were the fungal pathogens isolated from the rotting cucumber fruits as proved by pathogenicity tests. Onaebi and Chiejina (2013) suggested that these pathogens could have gained entry into the fruits through wounds or bruises created during harvesting and packaging of the fruits for delivery to the markets.

Results obtained from the *in vitro* study of the effects of *M. oleifera* and *A. sativum* at different concentration levels on *F. verticillioides*, and *F. oxysporum* showed that both extracts have antimicrobial potentials and this supports several reports on the fungicidal effects of plant extracts on different pathogens of crops (Amadioha and Obi, 1999; Olufolaji, 1999; Onifade, 2000; Okigbo and Ogbonna, 2006; Nwachukwu, E. O. and Osuji**,** 2008).

The significantly better result obtained with ethanol extract and *M. oleifera* in the individual assay supports the work of Chiejina and Onaebi (2016) who reported that ethanol plant extracts of *Chromolaena odorata* and *M. oleifera* significantly reduced the mycelial growth of the isolates *in vitro*.

CONCLUSION

The experiment shows that *M. oleifera* and cloves of *A. sativum* have fungi toxic potentials against fungi associated with rot of cucumber caused by *F. oxysporum*, *F. verticillioides* individually. Further work to evaluate the synergetic effectsof *M. oleifera* leaves and cloves of *A. sativum* for fungitoxic potentials against fungi associated with rot of cucumber will still be needed before credible assertions can be made on the phytotoxicity of the two extracts on the isolated fungi.

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BEYOND THE CUP: EXPLORING THE ANTI-HYPERTENSIVE PROPERTIES OF *Camellia sinensis*

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ABSTRACT
Hypertension, a major global health concern, affects millions of individuals and is a leading cause of cardiovascular diseases. In recent years, Camellia sinensis, commonly known as tea, has garnered attention for its potential anti-hypertensive properties. This review delves into the growing body of scientific evidence regarding the effects of tea consumption on blood pressure regulation. The chemical composition of Camellia sinensis is dissected, highlighting its diverse bioactive compounds, including polyphenols, caffeine, theanine, theaflavins and thearubigins among others. The mechanisms underlying the antihypertensive effects of Camellia sinensis are elucidated, encompassing actions such as vasodilation, antioxidant activity, and lipid profile modulation. Additionally, the review highlights the need for personalized recommendations and future directions for research in this field.
Keywords*: Hypertension, Camellia sinensis, blood pressure, vasodilation, antioxidant*

INTRODUCTION

Hypertension, often dubbed the "silent killer," is a widespread and potentially life-threatening medical condition characterized by elevated blood pressure (Bromfield and Muntner, 2013). Hypertension is a complex and widespread health issue with far-reaching consequences. It is crucial for individuals to be proactive in monitoring their blood pressure and adopting a heart-healthy lifestyle (Ettehad *et al.,* 2016). While conventional medications and lifestyle modifications play a vital role in managing hypertension, there is a growing interest in exploring natural remedies, particularly medicinal plants, as potential alternatives to pharmaceutical interventions (Ahmad *et al.,* 2015).

Plants have been used for medicinal purposes for thousands of years across different cultures and civilizations (Chukwuma *et al*., 2019). Medicinal plants owe their therapeutic properties to a vast array of phytochemicals, including alkaloids, flavonoids, terpenoids, polyphenols, and essential oils. These bioactive compounds exhibit a range of activities, from anti-hypertensive and antioxidant to antimicrobial and anticancer effects. The chemical diversity of these constituents contributes to the broad spectrum of medicinal plant applications in modern medicine (Mgbeahuruike *et al.,* 2017).

Camellia sinensis is a versatile and culturally significant plant that has shaped the world of beverages. Beyond its delicious flavors, *Camellia sinensis* continues to be a subject of scientific research for its potential health-promoting properties (Mazur *et al., 2021*). The antioxidant properties of tea polyphenols, particularly epigallocatechin gallate (EGCG), have been associated with reduced oxidative stress, inflammation, and the prevention of chronic diseases, including cardiovascular diseases, cancer, and neurodegenerative disorders. Additionally, the presence of theanine, caffeine and volatile compounds like terpenes in tea has been linked to improved cognitive function and alertness (*Izzreen and Fadzelly, 2013)*

Understanding Hypertension

Hypertension is a chronic medical condition characterized by consistently elevated blood pressure levels (Fagard *et al*., 2009). Blood pressure is the force exerted by blood against the walls of the arteries as the heart pumps it throughout the body. It is typically measured in millimeters of mercury (mm Hg) and is expressed as two values: systolic and diastolic blood pressure. Systolic blood pressure, represents the pressure in the arteries when the heart beats or contracts to pump blood, while diastolic blood pressure, represents the pressure in the arteries when the heart is at rest between beats. Normal blood pressure is typically defined as around 120/80 mm Hg. Hypertension is diagnosed when blood pressure consistently exceeds 130/80 mm Hg (Kjeldsen, 2018). Several factors contribute to the development hypertension. These include genetics, sedentary lifestyle, diet high in salt, alcohol consumption, smoking and underlying medical conditions (Ettehad *et al.,* 2016).

Bioactive Compounds of *Camellia sinensis*

The composition of tea's bioactive compounds can vary depending on factors such as the type of tea (green, black, white, oolong), growing conditions and processing methods. Tea is reported to contain the following compounds;

Polyphenols: Catechins are the most abundant polyphenols present in tea. The main catechins are epicatechin (EC), epicatechin gallate (ECG), epigallocatechin (EGC), and epigallocatechin gallate (EGCG). EGCG, in particular, is reported for its potential health-promoting properties. Besides catechins, tea contains other polyphenols such as quercetin, kaempferol, and myricetin (Samanta, 2022).

Caffeine: Caffeine, a natural stimulant, can improve alertness and cognitive function when consumed in moderation. The caffeine content varies depending on the type of tea and the brewing method (dePaula and Farah, 2019)

Theanine: Theanine is an amino acid that is found almost exclusively in tea leaves. It has a calming effect on the nervous system and can help reduce stress and anxiety (Li *et al.*, 2022).

Theaflavins and Thearubigins: These compounds are primarily found in black tea and are the result of the oxidation process that black tea leaves undergo. Theaflavins and thearubigins contribute to the colour, flavor, and aroma of black tea (Teshome, 2019).

Essential Oils: Tea leaves contain essential oils that give tea its characteristic aroma and flavour. These oils can vary in composition and contribute to the distinct profiles of different tea varieties (Chen *et al.*, 2014).

Antihypertensive Mechanisms

Several mechanisms have been postulated to explicate the mode of action of *Camellia sinensis* in blood pressure-lowering. *Epigallocatechin gallate* was reported to help prevent cardiac hypertrophy and hypertension by suppressing angiotensin II and pressure overload, reactive oxygen species generation and NADPH oxidase over-expressions (Li *et al*., 2006). Tea catechins, according to some research data, can stimulate the production of nitric oxide (NO) in the endothelium, leading to vasodilation, which helps lower blood pressure by reducing vascular resistance. For instance, in a study conducted by Ramirez-Sanchez *et al*., (2011), epicatechin contributes to blood pressure regulation via stimulation of NO production by endothelial NO synthase (eNOS) in endothelial cells.

Tea is renowned for its potential role as an antioxidant in the management of hypertension. One of the primary mechanisms by which tea exerts its antioxidant effects is by reducing oxidative stress. Hypertension is often associated with an imbalance between the production of reactive oxygen species (ROS) and the body's ability to neutralize them with antioxidants. Tea, rich in flavonoids such as catechins, acts as a scavenger of ROS. These compounds can donate electrons to unstable ROS, neutralizing their damaging effect (Nakagawa and Yokozawa, 2002).

Hypertension is often associated with unfavorable changes in blood lipid levels, such as elevated LDL cholesterol (Jia *et al*., 2010). Tea consumption has been linked to improvements in lipid profiles, including reductions in LDL cholesterol levels. This may contribute to reduced cardiovascular risk in hypertensive individuals. A possible mechanism for the aforementioned could be that, tea catechins increase micellar cholesterol solubilisation and thus inhibit the absorption of cholesterol from the intestinal contents (Koo and Noh, 2007).

Future Recommendation

There is a need for research that would investigate the potential interactions between *Camellia sinensis* and commonly prescribed anti-hypertensive medications to ensure their safe co-administration. In addition, awareness on the benefits of *Camellia sinensis* as a complementary approach to hypertension management within public health initiatives is needed. This would encourage individuals to incorporate tea consumption into their daily routines, alongside other lifestyle modifications.

CONCLUSION

The mounting scientific evidence discussed here underscores the multifaceted role that tea can play in regulating blood pressure and promoting cardiovascular health. However, research that would evaluate safe co-administration with other anti-hypertensive agents and effective awareness on tea consumption must accompany this review to ensure widespread access to the potential benefits of tea consumption.

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COMPARATIVE EFFECT OF DIFFERENT CEREAL GRAINS AS SPAWN SUBSTRATE ON MYCELIAL GROWTH PERFORMANCE OF SOME OYSTER MUSHROOMS

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ABSTRACT

Oyster mushrooms are widely grown owing to their simple and low production technology with high biological efficiency. Spawn is the planting material in mushroom cultivation, its quality is very key for a successful crop of any edible and medicinal mushrooms. The main objective of the study was to determine the best grain spawn for getting early colonization and high yield crop of oyster mushrooms. Different cereal grains namely, wheat (Triticum aestivum), Sorghum (Sorghum bicolor) and Millet (Pennisetum glaucum) were evaluated for spawn production of the following oyster mushrooms, Pleurotus ostreatus var columbinus (blue oyster), P. djamor (pink oyster), P.citrinopileatu (Yellow oyster), and P. pulmonarius (Indian phoenix mushroom). The results revealed that blue oyster mycelium showed preference for all the grain substrates evaluated with no significant difference in its vertical mycelia extension (8.55, 8.33 and 8.17cm) on Sorghum, wheat and millet respectively at p<0.05 while Indian oyster showed preference for wheat grains and recorded its longest mycelium, 9.22cm on wheat and least (8.17cm) on millet. Millet grains appeared to be the least preferred grain as all the mushrooms recorded their least growth on it. The study concludes that sorghum and wheat are the best spawn substrates for effective mycelia growth.

Keyword: *Oyster mushroom, mycelia extension, cereal grains, comparative, mycelial density*

INTRODUCTION

Mushrooms are macro-fungi, unlike micro-fungi, they produce visible reproductive structure from which their spores are released into the atmosphere. These spores are microscopic, usually suspended in the air and beaten down during the rains, if they fall on a suitable substrate, they germinate into thread-like mycelium which may eventually develop into a mushroom primodium which matures into visible fruiting bodies (Stamets, 2000). Mushrooms are known for their organoleptic and medicinal values and are highly priced for this, they are also rich in high quality protein which contains all the essential amino acids as found in animals and are sources of vitamins and minerals (Chang and Miles, 2008).

A medium through which the mycelium of a fruiting culture has grown, and which serves as the inoculum or "seed" for the substrate in mushroom cultivation, is called the mushroom spawn. Failure to achieve a satisfactory harvest may often be traced to unsatisfactory spawn quality. Consideration must also be given to the nature of the spawn material, since this influences the rapidity of growth in the spawn medium, as well as the rate of mycelial growth, and the filling of the beds following (spawn running) inoculation (Ragunathan *et ai.,* 1996).

The success of mushroom cultivation is largely dependent on the quality of its planting material, a vigorous mushroom spawn will results in healthy fruiting bodies and high yield. In a situation where the spawn substrate is not preferred, the mushroom mycelia's growth is retarded or no growth results (Mahadavan and Shanmugasundaram, 2018). This study therefore evaluated the mycelia growth of six different mushrooms on three cereal seeds for preference by the various mushrooms.

MATERIALS AND METHODS

Cultures of *Pleurotus ostreatus var columbinus* (blue oyster), *P.djamor* (pink oyster), *P.citrinopileatus* (Yellow oyster), *Calocybe indica* (milky white), *Ganoderma lucidium* (reishi mushroom) and *P.*

*pulmonarius (*Indian phoenix mushroom*)* were prepared on potato dextrose agar and slants were maintained at 4^0C in a refrigerator until needed.

Seeds of wheat (*Triticum aestivum*), guinea corn (*Sorghum bicolor*) and millet (*Panicum miliaceum*) were purchased from Bodija market, a local food market in Ibadan. The seeds were rid of empty kernels and were separately soaked for eight hours and drained to about 60% moisture content. The soaked and drained seeds were separately filled into 200ml capacity glass bottles (3/4 way filled) The bottles were then plugged with cotton wool wrapped in aluminum foil and sterilized in an autoclave for 30minutes at 121^0C (Zadrazil, 1978). After cooling to room temperature, the bottles were seeded with mycelia-agar discs of the different mushrooms being evaluated. The bottles were then kept in a dark room within the laboratory for two weeks to allow for the mycelia to ramify the seeds. Mycelial growth was measured every other day from the day of inoculation (Fasidi and Ekuere, 1993) and mycelia density was visually done on a scale of +1 to +3 where +1 is moderate mycelial density, +2 is abundant mycelial density and +3 is very abundant mycelial density according to the method of Mahadevan and Shanmugasundaram (2018).

The experiment was a completely randomized design with four replications.

RESULTS

All the mushrooms grew on all the grain substrates tested, blue oyster mycelia showed preference for all the grain substrates evaluated with no significant difference in its vertical mycelia extension at $p<0.05$ while Indian oyster showed preference for wheat grains and recorded its longest mycelium, 9.22 on wheat and least on others. Millet grains appeared to be the least preferred grain as all mushrooms recorded their least growth on it. It was also observed that *S. bicolor* recorded the longest total mycelia growth of all the grain substrates evaluated. (Table1).

Figure 1 shows average daily growth rate of the mushroom mycelia, this result agrees with the report of Mahadavan and Shanmugasundaram (2018), who reported that *Sorghum bicolor* seeds as grain substrate, supported prolific growth of the mycelia of some oyster mushrooms above barley followed by wheat where millet ranked least in all the parameters considered. Therefore, this study concludes that sorghum and wheat are the best spawn substrates for effective mycelia growth.

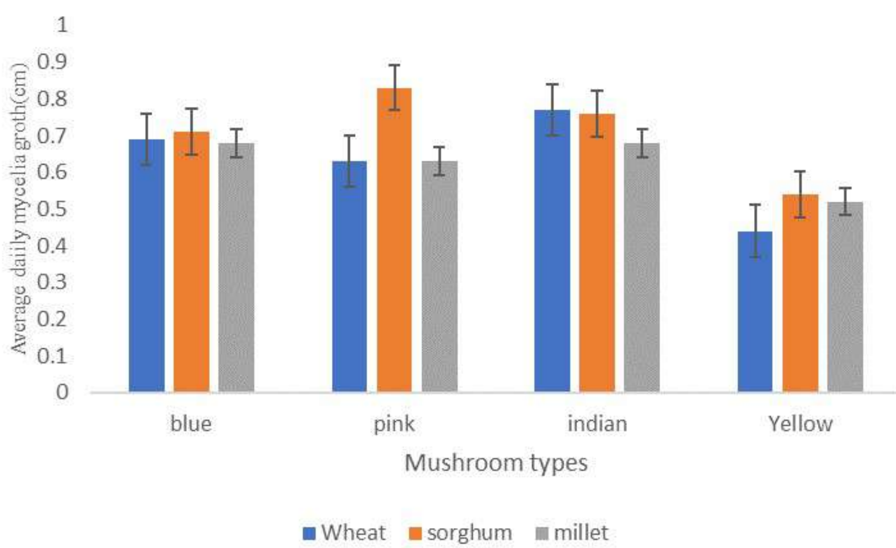

Fig 1: Mycelia growth of various mushrooms on three different spawn substrate types

Table 1: Mycelia growth and mycelia density of four oyster some selected on difrent grain substrates

Mushroom type	Blue oyster		Pink oyster		Indian oyster		Yellow oyster		Total mycelia growth (cm)
	Mycelia growth rate and mycelia density								
	Mycelia extension (cm)	Mycelia density	Mycelia extension (cm)	Mycelia density	Mycelia extension (cm)	Mycelia density	Mycelia extension (cm)	Mycelia density	Cumulative mycelia extension (cm)
Wheat	8.33^{a}	+3	7.50^{b}	+2	9.22^{a}	+3	5.33^{b}	+1	30.38^{b}
Sorghum	8.55^{a}	+3	10.00^{a}	+3	9.11^{a}	+3	6.42^{a}	+1	34.08^{a}
Millet	8.17^{a}	+3	7.52^{b}	+2	9.17^{a}	+3	6.25^{a}	+1	31.11^{c}

+1 moderate mycelial density, +2 is abundant mycelial density and +3 is very abundant mycelial density. Means followed by the same superscript letter(s) in each column are not significantly different (P>0.05) by Duncan's multiple range test.

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DIGITIZATION OF HORTICULTURAL NEWS IN NATIONAL HORTICULTURAL RESEARCH INSTITUTE LIBRARY, IBADAN, OYO STATE

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ABSTRACT
The study investigated digitised horticultural news using the National Institute for Horticultural Research (NIHORT), Ibadan, as a case study. It employed the case study and descriptive research design. The data used for this article were obtained from the collection of all digitised news between the year 2007 and 2014. Using the descriptive statistics to present the data, the study revealed that a total number of 231 digitised horticultural news with The Guardian having the highest number of horticultural news that have been digitised. The study also shows that 88 news have been digitised under the ornamental news, 32 under the spices category, 59 under the fruits category, 35 under the vegetable category, 20 under the food security and health category and 7 under other crops. The article concludes that although digitisation of horticultural news has been ongoing, the number of digitised news are few therefore recommends that libraries should priotise digitising every news in every newspaper as a daily routine.
Keywords: *Research Institutes, Icts, Print media. Horticulture, Preservation*

INTRODUCTION

Libraries and librarians have been tasked with the duty of adopting and ingraining the usage of technologies in library services and operations in view of the current breakthroughs in Information and Communication Technologies (ICTs) and the quickening rate of information explosion. Due to this, its current print materials now need to be converted into forms and/or mediums usable with various information and communication technologies. Digitisation refers to a wide variety of steps involved in the process of conversions and making of historical and other materials globally accessible through the application of digital processes (Otubelu and Ume, 2015). Libraries all over the world are quickly adopting digitisation procedures for their resources as a means of survival in order to strengthen their mechanisms and raise their relevance in this era of massive information explosion and accessibility mediums. Mohammed (2009) pointed out that libraries and the degree of service delivery to the community are more affected by the growth of ICTs and its subsequent integration in library and information services. In order to conserve the original item from destruction and to provide public access to resources that could otherwise be prohibited due to geographic differences, tangible information items must be transferred to digital format. This process is known as digitisation (Yaya and Adeeko, 2016).
Development, sustainable production, marketing, and use of high-value, intensively cultivated food and ornamental plants are all aspects of horticulture. It is both a science and an art. The Latin words hortus (garden plant) and culture (tilling the soil) are the source of the word. In horticulture, food and ornamental plants are produced with meticulous attention to detail, frequently in a small area as opposed to a large field (Michaels *et al*., 2022). As horticultural practices continue to evolve, access to historical horticultural news becomes invaluable for understanding the industry's evolution, the challenges it has faced, and the innovations that have propelled it forward. Digitisation offers a promising avenue to unlock this treasure trove of knowledge. As stewards of knowledge in the field of horticulture, National Horticultural Research Institute (NIHORT) library, nestled in the heart of Nigeria recognizes the critical need to preserve and disseminate its rich collection of horticultural news, ensuring that it remains accessible to future generations of scholars, researchers, and practitioners. This study explores the journey undertaken by NIHORT library to digitise its extensive collection of horticultural news.

Research Objectives

The major aim of the research is to assess the digitisation of horticultural news in NIHORT Library. The specific objectives are to:

i. Determine the number of horticultural news that have been digitised in the various newspapers subscribed to at NIHORT Library.
ii. Ascertain the number of horticultural news that have been digitised under various category of horticulture at NIHORT Library.

Research Questions

i. How many horticultural news has been digitised in the various newspapers subscribed to at NIHORT Library?
ii. What is the number of horticultural news that has been digitised under the various category of horticulture at NIHORT Library?

METHODOLOGY

The case study research design was employed for this study while a descriptive research design was used to gather broad quantitative data about the number of digitised news. The data was obtained from three newspapers that are subscribed to by the institute namely Nigerian Tribune, The Punch and The Guardian newspapers. The obtained data was analysed using descriptive statistics. The article relied on digitised news in the three newspapers obtained from the library between the year 2007 to 2014.

DISCUSSION

This study examined horticultural news that have been digitised using The Nigerian Tribune, The Punch and The Guardian Newspapers between 2007 and 2014. It was revealed that between the year 2007 and 2014, 46 digitised news were recorded in The Nigerian Tribune, 45 in The Punch Newspaper and 140 in The Guardian Newspaper which has the highest number (Table1). These statistics shows that 231 horticultural news have been digitised between 2007 and 2014. This reveals availability of digitised horticultural news in NIHORT library for use by researchers/users.

The study further delineates the digitised news under various category. The findings revealed that under Ornamental News, Nigerian tribune had the least number of digitised news with a total number of 3, The Punch had 4 while The Guardian being the highest number of digitised news (81) (Table 2). In the spices category with a total of 32 digitised news, The Punch had 3, the Nigerian Tribune had 13, while The Guardian had 16 digitised news. (Table 3) In the Fruits category with a total number of 59 digitised news, The Guardian has more digitised news with a total number of 24, The Punch had 23 digitised news followed by Nigerian Tribune which has the least with a total number of 12. (Table 4) Table 5 shows that The Guardian had a total number of 14 digitised news in the vegetable category, The Nigerian Tribune has 12 and The Punch with the least 9. While in the category of food, security and health news (Table 7) , the study found that few newspapers have been digitised with Nigerian Tribune having 4 digitised news, The Punch having 4 and The Guardian with 2 digitised news. A total of 10 horticultural news has been digitised under the food, security and health. In the category of other crops, the study found a total number of 7 digitised news with The Guardian having the highest number of 3 digitised new, The Punch had 2 and Nigerian Tribune had 2 (Table 6)

CONCLUSION

The digitisation of library materials has been discovered to be a crucial aspect in the growth of modern libraries. The delivery of library services has continued to change as a result of the current development. It is necessary for special libraries especially in horticultural institute, to step up their efforts to digitise their local content for preservation and simple access if they are to coexist with the rapidly expanding information technologies. The study was able to reveal that there is a need for horticultural libraries to digitise horticultural news by taking it as a daily routine to search for relevant information in newspapers and digitise them, thereby providing a robust resource base of the institutes and rendering better services to the researchers. When horticultural news are digitised, the information is preserved and researchers can make quick references to them regardless of their location.

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Table 1: Digitised News in Various Subscribed Newspapers at NIHORT Library

YEAR	NIG. TRIBUNE	THE PUNCH	THE GUARDIAN
2007	2	1	4
2008	8	1	29
2009	9	4	16
2010	10	7	25
2011	2	2	3
2012	10	13	28
2 013	4	6	23
2014	1	11	12
TOTAL	46	45	140

Table 2: Digitised Horticultural News - Ornamental at NIHORT Library

YEAR	NIG. TRIBUNE	THE PUNCH	THE GUARDIAN
2007	-	1	4
2008	2	1	19
2009	-	-	5
2010	1	2	14
2011	-	-	2
2012	-	-	20
2013	-	-	10
2014	-	-	7
TOTAL	3	4	81

Table 3: Digitised Horticultural News - Spices at NIHORT Library

YEAR	NIG. TRIBUNE	THE PUNCH	THE GUARDIAN
2007	-	-	-
2008	3	-	-
2009	3	-	-
2010	1	1	6
2011	-	-	-

2012	3	1	2
2013	2	1	2
2014	1	-	2
TOTAL	13	3	16

Table 4: Digitised Horticultural News - Fruits

YEAR	NIG. TRIBUNE	THE PUNCH	THE GUARDIAN
2007	1	-	-
2008	1	-	1
2009	3	4	7
2010	3	7	3
2011	1	2	6
2012	3	7	3
2013	1	2	6
2014	-	7	1
TOTAL	12	23	24

Table 5: Digitised Horticultural News - Vegetables

YEAR	NIG. TRIBUNE	THE PUNCH	THE GUARDIAN
2007	1	-	-
2008	2	-	2
2009	3	-	4
2010	1	2	-
2011	1	-	-
2012	3	3	2
2013	1	3	5
2014	-	1	1
TOTAL	12	9	14

Table 6: Digitised Horticultural News - Other crops

YEAR	NIG. TRIBUNE	THE PUNCH	THE GUARDIAN
2007	-	-	-
2008	-	-	2
2009	-	-	-
2010	1	-	-
2011	1	1	-
2012	-	1	1
2013	-	-	-
2014	-	-	-
TOTAL	2	2	3

Table 7: Digitised Horticultural News - Food Security and Health

YEAR	NIG. TRIBUNE	THE PUNCH	THE GUARDIAN
2007	-	-	-
2008	-	-	1
2009	-	-	-
2010	3	-	-
2011	-	-	-
2012	1	1	-
2013	-	-	-
2014	-	3	1
TOTAL	4	4	2

RESPONSE OF PINEAPPLE (*Ananas comosus Var*.) TO SELECTED HERBICIDES

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ABSTRACT
Pineapple plants show delayed maturation mainly because their superficial root system exposes them to intense competition with weeds for nutrients. This attribute contributes to delays in crop development and thereby reduces their overall yield and quality. For this reason, it becomes necessary to apply herbicides to control weeds. The objective of this study was to determine the response of different varieties of pineapple (Smooth cayenne, MD2, and Sugar loof) to various herbicides at their vegetative stage. The experimental setup consisted of four treatment categories, which includes the control and three herbicide treatments with each having five replicates. The control was hand-weeded, while the herbicide treatments were administered with tolerable levels of Atrazine, Glyphosate, and Paraquat. The physiological evaluations of pineapple leaves were used to assess potential adverse effects due to the applied herbicides. Based on these assays, we did not observe any substantial difference on the Atrazine treatment plots when compared to the control treated population within the exposure period of 70 days. However, paraquat-treated pineapples showed considerable physiological responses at a week or 7 days of treatment application. Further anatomical analysis of the Pineapples may reveal unexpected variations from the control population.
Keywords: *Atrazine, glyphosate, paraquat, pineapple, treatment.*

INTRODUCTION

Pineapple (*Ananas comosus*) belongs to the family Bromeliaceae, consisting of 50 genera and about 2500 known species. It has dagger-like leaves making it to be classified to the monocotiledonae family. In Nigeria, the most popular species of pineapple grown are Smooth Cayenne, Sugar loof, and MD2, a new strain from Costa Rica that is sweeter than the regular varieties, and always growing to a uniform size and ripening evenly. The MD2 is also referred to as golden yellow (FAO, 2010). Pineapple has a slow growth with a superficial rooting system, these are major factors that exposes it to intense competition with weeds, contribute to its delay of development, reduce its yield and quality (Reinhardt, 2002). It is recommended to keep the fields clean from weeds during the first five to six months of field establishment. It is pertinent to know that in pineapple fields, weed competition is exacerbated by the fact that the crop is small and grows very slowly, favoring water and nutrient uptake by weeds (Catunda, *et. al*., 2005). One of the alternatives to control competition is the use of herbicides, which allows less reliance on manpower. During the crop cycle, ten to twelve weeding may be needed, which leads to burdening the production cost considerably. Weed control with herbicides is a good alternative, especially in large fields and rainy periods when the grass grows quickly and hand-hoe weeding is not feasible.

In a report given by Leonardo, *et. al.,* (2012) on the growth, production, and quality of pineapple in response to herbicide use, the results obtained on the vegetative phase were that the use of herbicide on the treatment had no effect when compared to manual hoe weeding on the number of leaves. Considering the natural flowering, the same number of leaves was observed after the tenth month (July) in all treatments, being the peak during the fourteenth month (November). Catunda *et al*. (2005), evaluated the effect of herbicide semicarbazone on pineapple growth, cultivar 'Pérola', also did not obtain difference in the D-leaf growth, despite showing phytotoxicity symptoms at the beginning of the crop development, indicating that the damages caused in the first few days by the herbicides did not disturb the final growth of the crop. However, these authors compared the effects of the herbicide mixture diuron + paraquat on the crops; they reported severe damage to the pineapple plants, which caused their death 30 days after treatment (Catunda *et al*., 2005).

The application of these herbicides is where the issue arises since herbicides in recent days are termed lesser-known toxicants (US, EPA) that is, toxicants in our environment that attention is not paid to. Agrochemicals, such as herbicides, insecticides, pesticides, and may others. had been said to be lesser-known toxicants in our environments today. The effects of these toxicants in our environment cannot be over-emphasized since they do not only affect targeted organisms but also the non-targeted. Agrochemicals such as herbicides are generally used to control weeds (target organisms) in farmlands generally. The project will be focused on the effects of these herbicides, on pineapple plants (non-target organisms) during their vegetative phase. Also, to know the type of varieties that had high susceptibility or resistance to particular herbicide in Nigeria. Moreover, herbicides are toxicants that have negative effects on humans and their environments, it is important to know if these herbicides can have a negative effect on these pineapple varieties. The objectives of the study were:to know the effects of herbicides on pineapple plants during their vegetative phase based on their physical changes and to determine how the herbicides can affect pineapple plants in their vegetative phase.

MATERIALS AND METHODS

Description of the site

The experiment was conducted at an experimental site located at Federal University, Oye-Ekiti, Faculty of Science, behind the second makeshift lecture hall. The experimental site had the following geographic coordinates: N 07º46.616', E 005º18.916', Average temperature of 21-25 ^{O}C, average rainfall of;1000-1500 mm per annum relative humidity; 50-80 %. The topography of the area was an almost flat one. Physical characterization was done on the soil and it was discovered to be loamy soil. There was no specific type of land preparation (no heap or bed made) the pineapples were planted directly on the field And there was no fertilizer applicatio to the plants, while and the period of plant exposure to herbicides was carried out every thirty days (30). There was no need for wetting during the first few months of planting which fell in the rainy season.

Description of the plant materials

The pineapple suckers were gotten from National Horticultural Research Institute, Idi-Ishin Jericho Ibadan. The suckers were transported down to Oye-Ekiti by public transport on the 19th of May 2019 after which the site clearing was done and they were planted at exactly 1 week and 5 days of collection. The suckers were planted in the evening and the physical characteristics of the suckers were taken note of which includes the drying of the leaves that was obvious in the MD2 variety and weathering of leaves noticed in the Smooth Cayenne while the Sugar loof variety looks good (without any withering or drying of leaves). The period of acclimatization was for 3 months before treatment applications. The pineapples were expected to mature after 1 and a half years of planting.

Experimental design

1. The experiment had 4 weed control treatments which included the control (hand-hoe weeding = T_O) and 3 herbicide types (T_{1-3}), 3 varieties of pinneapples (MD2, Sugar loof, Smooth cayenne = V_{1-3}), each at 5 replicates per weeding treatment to give a total of 20 suckers for each variety, for a total of 60 suckers for the whole plot. Plant spacing of 60cm x 75cm was used with a space of 75cm in between the blocks. The concentration of herbicides used was such that it will not harm the plant since the study is a long-term exposure (chronic exposure) according to the United States Environmental Protection Agency. The blocks of treatment were labeled based on the herbicides used which include T_O (conruol) T_1 (Herbicide Atrazine), T_2 (Herbicide Glyphosate), and T_3 (Herbicide Paraquat dichloride) as the active ingredient and they were prepared at a concentration of 2.5g/L, 2.5ml/L, and 2.5ml/L respectively and dissolved in 1litre of water using a magnetic stirrer to ensure a homogenous mixture of the solvent and then transferred into bottles. The herbicides were sprayed on the field at an equal volume of 100ml in a 200ml herbicide dispenser (pushp). This hand sprayer was used to control dispersal by wind as well as the volume,

and hand weeding was used for the control. The application of the herbicides was performed on a weekly basis. The herbicides were applied for a period of 10 weeks and physical observations were taken note of at the different times they were applied.

RESULTS

Physical observation

Table 1 showed the records of observations taken and indicated that after the first week of treatmrnt applications, all plots were in good condition as there was no physical changes observed on the planted suckers. However, after the second application, the pineapples with Paraquat plot (T3) treatment began to dry up along with the weeds. After this was observed, the plot was left to recover from the shock which did not happen until the end of the treatment period. In contrast, , the pineapples treated with Atrazine (T1) showed no significant physical changes while the weeds started to dry up.With this trend, application of the treatment continued till the end of the experiment. Plot treated with Glyphosate (T2) recorded no casualty due to the treatment applied, hence, the application was continued., However, a yellowish coloration was observed on the weeds by the 3rd week of application. This similar observation made in T2 got changed by the 7th application. . There was increase in growth observed in both treatments T1 and T2, while the control plots were weekly hand-weeded and watered.

DISCUSSION

When comparing the physical response observed on the control pineapples plot with the pineapple varieties on the treatment plots, the treatments showed that after the first application of Atrazine (T1), the pineapples and even the weeds around were not affected, until the second application where the weeds responded to the herbicide treatment, revealing that the effect of atrazine concentration used can be seen on the weeds after two consecutive application of the herbicide but not on the pineapple varieties, as there was no evident effect of Atrazine on their physical appearance till the end of the experiment (Figure 1). The pineapple varieties with Glyphospahte treatment (T2) did not respond immediately to the herbicide treatment unlike the weeds, which began to give a yellowish coloration just after the second application which was later seen on the pineapple plants after the seventh application of the herbicide showing that the persistent application of Glyphosate at a concentration of 2.5 ml L^{-1} will elicit a response in the pineapple plants. In other words, when the pineapples on T2 were physically compared to the control, they were totally different from the control (Figure 2). Lastly, the pineapples treated with Paraquat (T3) responded to the treatment immediately after the first application, with all the pineapples on that plot responding to it equally and this is seen in the dry leaves they possessed. This indicates that pineapples will respond to Paraquat application at a concentration of 2.5ml L^{-1} of water. Since this was noticed the pineapple plants were left to recover and it was after the tenth application they all recovered (Figure 3). Also, this indicates that there is a big gap between the control and the treatment groups. This was in trend with reporsby Catunda, *et. al.* *2005) in which Paraquat and Diuron were mixed and this caused severe damage to the crops after which all the plants died 30 days after the treatment.

CONCLUSION AND RECOMMENDATION

The study showed that the vegetative production of the pineapple varieties upon the usage of atrazine was not disturbed as the pineapples did not respond to the herbicide treatment effect. This can also be said of the treatment with the use of Glyphosate, that with a wide interval of application, there will be no effect on the vegetative growth of the pineapple plants. In contrast to the above, the consecutive application of paraquat even at a very low concentration causes severe damage to the vegetative production and growth of the three pineapple varieties. However, the performing of an anatomical analysis of the pineapples will help to reveal the effects of the herbicides on the plant tissues, for a better insight into whether there was an effect that couldn't be seen on the physical appearance of the pineapples.

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Table 1: Date of applications and rate of application

S/N	DATE OF APPLICATION	ATRAZINE T1	GLYPHOSATE T2	PARAQUAT T3
1.	9th October 2019	Applied	Applied	Applied
2.	16th October 2019	applied	applied	Not applied
3.	23rd October 2019	applied	applied	Not applied
4.	30th October 2019	applied	applied	Not applied
5.	6th November 2019	applied	applied	Not applied
6.	13th November 2019	Applied	Applied	Not applied
7.	20th November 2019	Applied	Applied	Not applied
8.	27th November 2019	Applied	Applied	Not applied
9.	4th December 2019	Applied	Applied	Not applied
10.	11th December 2019	Applied	Applied	Not applied

T1: Treatment 1, T2: Treatment 2 and T3: Treatment 3 where is T_O?

Figure 1: showing treatment Atrazine plot before and after application of herbicide

Figure 2: showing treatment Glyphosate before and after application of herbicide.

Figure 3: showing treatment Paraquat plot before and after application of herbicide

PREFERENCE OF ORGANIC AND INORGANIC FERTILIZERS APPLICATION AMONG ARABLE CROP FARMERS IN OGBOMOSO AGRICULTURAL ZONE OF OYO STATE

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ABSTRACT
*The crop output or plant performance of any cultivated farmland is determined by its level of soil fertility. Hence, productivity of any farmer is directly proportion to the quantity of harvested crops from a given size of farmland. This study therefore assessed the preference of organic and inorganic fertilizers application among arable crop farmers in Ogbomoso Agricultural zone of Oyo State, Nigeria. Specifically, the study described the socio-economic characteristics of the respondents, examined the crop enterprise combinations, identified the sources of fertilizers available to the respondents and determined the level of preference of both organic and inorganic fertilizers among the respondents. Multistage sampling procedure was employed to select 158 arable crop farmers, while interview schedule was used to collect relevant information from the respondents. The data collected were analyzed with frequency counts, percentage and mean as the main descriptive tools, while Pearson Product Moment Correlation was used as inferential statistical tool. The results revealed that 77.2% and 22.8% sampled farmers were male and female, with mean age of 46.63 years, mean farm size of 2.40ha and mean of 7.99 years of farming experience respectively. Inorganic and organic fertilizers have weighted mean score of 1.5 and 0.74 and were ranked 1st and 2nd. The educational status (r=0.370**; p<0.000), farm size (r=0.250**; p<0.002) and years of farming experience (r=0.299**; p<0.000) exhibited significant relationship with the preference of fertilizers application among the arable crop farmers.*
Keywords: *Organic, Inorganic, Fertilizer, Application*

INTRODUCTION

It is no doubt that soil fertility level of any agricultural farmland would determine the crop yield and its harvest during a specific cropping season. As a result of declining soil fertility, farmers tend to remain productive by making necessary amendments in order to improve the soil fertility level through the application of either organic or inorganic fertilizers. A prominent constraint to higher productivity among farmers in the Sub-Saharan region, including Nigeria is "soil infertility" related mainly to low nutrient status of the soils and continuous cultivation without planned replenishment of depleted soil nutrients (Wanyama et al., 2009). The fact that, agriculture is important in the economy of Nigeria with crops of cocoa, oil palm, maize, rubber, yam and cassava produced for food and foreign exchange earnings, and providing employment for over 66% of the population (IFAD, 2014), it is also imperative that crop yield is encouraged and sustained through the application of amendment materials (fertilizers).

A contributing factor to insufficient food production is the low soil organic matter content, and consequently, the inherent infertility of soils in Nigeria and in sub-Saharan Africa (Shiyam & Binang, 2013). As a result, small scale farmers, who produce the bulk of food in Nigeria, have to embrace fertilizer application – organic and inorganic – in order to increase yield (FAO, 2013). According to IFPRI (2011), the production efficiency of farmers for most crops is low. Druilhe & Barreiro-Hurlé (2012) asserted that among the problems hampering arable crop yield is availability and affordability of inorganic fertilizers. However, Shiyam & Binang (2013) argued that inorganic fertilizer may increase yield in the short term but may be both uneconomical and environmentally unsound. They stated that organic fertilizer, unlike the inorganic options, is environmentally sustainable and able to achieve increased agricultural productivity.

In lieu of the above premise, this study therefore focused on the preference for organic and inorganic fertilizer application among arable crop farmers in Ogbomoso agricultural zone of Oyo State, Nigeria. Hence, the study described the socio-economic characteristics of the respondents, examined the crop enterprise combinations, identified the sources of fertilizers available to the respondents and determined the level of preference of both organic and inorganic fertilizers among the respondents. The study tested the significant relationship between the socio-economic characteristics of arable crop farmers and their preference of organic and inorganic fertilizer application.

Previous research has identified a few factors that affected the fertilizer usage by arable crop farmers in developing nations. In Nigeria, Amanze et al. (2010) shown that whereas gender, age, and household size had no effect on farmers' usage of fertilizer in the production of arable crops, crop output, education level, farm size, and fertilizer price did. In Kenya, Wanyama et al. (2009) demonstrated that the likelihood of farmers adopting fertilizer in maize production was significantly influenced by the presence of change agents (extension) visits, the percentage of land under maize production, the sex of the household head, and agricultural training. Conversely, the intensity of fertilizer application was significantly influenced by the employment type of the household head, the price of fertilizer, and the proportion of area allocated for maize cultivation. In Nigeria, Chianu and Tsujii (2004) discovered that farmers from the Guinea savanna zone, younger farmers, farmers with higher levels of education, and farmers who cultivate a variety of crops have a higher likelihood of using fertilizer.

Kelly (2006) investigated the factors influencing fertilizer demand in sub-Saharan Africa and found that the cost of fertilizer, crop output prices, and the cost of other inputs that can be used in place of fertilizer are the main drivers of fertilizer demand in the area. In Nigeria, research by Akpan and Aya (2009) revealed that factors such as family size, consumption spending, the number of chicken birds kept by farmers, the number of goats owned, and the perceived price of fertilizer all had a negative impact on the demand for fertilizer. Fertilizer demand is positively impacted by farmer education, farm size, income, extension agent contact, ability to forecast rainfall, availability of contemporary communication tools, and yield of maize and mixed crops planted with it. According to research conducted in Nigeria by Olayide et al. (2009), the amount of fertilizer used intensively rises with family labor and physical access to the fertilizer, but decreases with farm size and distance from homestead.

Minot et al. (2000) reported that fertilizer demand from farmers in Malawi and the Benin Republic. In the Benin Republic, it was found that the number of cattle owned, the size of the farm, the expenditures of the household head, the education level of the head of the household, and the size of the farm all significantly impacted the need for fertilizer. They deduced that the following factors influence fertilizer demand in Malawi: farm size, number of pigs owned, education of the household head, ethnicity, price of maize, expenditure of the household head, club membership, and vegetable plot. According to Staal et al. (2003), some of the key factors influencing farmers' decisions to use fertilizer in Kenya include population density, soil textures (clay, loamy, and sand), cash crop plots, pasture plots, extension services, education, and the number of adults per acre.

Fufu et al. (2006) discovered that age, farmers' perceptions of price changes, and expectations for rainfall are important factors that influence fertilizer usage among maize farmers in their empirical investigation on the drivers of fertilizer use on maize fields in eastern Ethiopia. The utilization of fertilizer by smallholder farmers was found to be highly influenced by various factors, including age, education, credit, presence of a cash crop, distance to fertilizer market, and agro-ecological potential, as confirmed by Olwande et al. (2009) in Kenya.

METHODOLOGY

This study was carried out in Ogbomoso Agricultural Zone of Oyo State. The zone is one of the four Agricultural zones in Oyo State. Ogbomoso Agricultural Zone comprises of five (LGAs). Multistage sampling procedure was adopted for this study. Firstly, purposive sampling technique was employed in the selection of three LGAs which includes Surulere, Ogo-Oluwa, and Oriire LGAs respectively due to their rurality in nature. During the second stage, one percent (1%) number of villages was considered from the list of registered villages in the selected LGAs. Thereafter, the use of random number table was employed in the selection of five (5) villages from Oriire LGA, three (3) villages from Surulere LGA, and two (2) villages from Ogo-Oluwa LGA respectively, which amounted to a total of ten (10) villages and thirty percent (30% = 158) of the registered arable crop farmers were randomly selected accordingly. Both descriptive (frequency counts, percentages, mean, rank) and inferential (Pearson Product Moment Correlation) tools were employed to analyzed the data and tested the formulated hypothesis of the study.

RESULTS AND DISCUSSION

Socio-economic characteristics

Table 1 revealed the mean age of the respondents to be 46.63 years which suggests that the respondents are adults. Their adulthood is expected to differentiate between organic and inorganic fertilizers and their relevance to crop production. Both male (77.2%) and female (22.8%) arable crop farmers were sampled for this study. This implies that males are more involves in farming compared to their female counterpart. It is also an indication that both genders are involved in arable crop production. It was also observed that majority (94.3%) of the respondent were married with only 5.7% single. The variation in the marital status may be due to differences in their age. The result on educational background showed that 79.1%, 11.4% and 7.0% were secondary, primary and tertiary school leavers. This implies that almost all the arable crop farmers are literate. The means farm size and years of farming experience were 2.40ha and 7.99. The result on farm size suggests that the arable crop farmers cultivate sizeable farmland and with a specific years of farming experience. The variation in the farm size cultivated may be due to difference the farmland ownership status and access to required production input such as capital, fertilizers, etc. The farm size is may also determine the fertilizer requirements of the respondents. Most (95.6%) of the respondents received extension contact. The respondents contact with extension services is expected to influence their arable crop production knowledge and preference for fertilizer application.

Table 1: Distribution of respondents by socio-economic characteristics

Variables	Frequency (Percentage)
Age (years	
≤30	27(17.1)
31-40	53(33.5)
41-50	59(37.3)
>50	19(12.0)
Mean=46.63	
Sex	
Male	122(77.2)
Female	36(22.8)
Marital status	
Married	149(94.3)
Unmarried	9(5.7)
Educational status	
No formal	4(2.5)
Primary	18(11.4)
Secondary	125(79.1)
Tertiary	11(7.0)
Farm size (ha)	
≤1	12(7.6)
1-2	8(5.1)
>	138(87.3)
Mean=2.40	
Extension contact	
Yes	151(95.6)
No	7(4.4)

Years of farming experience	
≤10	8(5.1)
11-20	21(13.3)
21-30	32(20.3)
31-40	21(13.3)
>40	76(48.1)
Total	**158(100.0)**

Source: Field Survey, 2023

Crop enterprise combinations

Table 2 revealed the different combinations of crop types grown by the respondents which include sole maize (70.3%), sole cassava (61.4%), maize and cassava (100.0%), maize, yam and cassava (79.9%), maize, cassava and okra (100.0%), maize, cassava and tomatoes (62.0%), maize and okra (86.1%), maize and tomatoes (44.9%) respectively. This results implies that most respondents combines two or more arable crops at a time on the same farmland probably with the intention to maximize the use of available farmland, rainfall season, labour usage, food availability for household consumption (food security) and profit maximization.

Table 2: Distribution of respondents by crop enterprise combination

Crops	*Frequency (Percentage)
Sole Maize	111(70.3)
Sole Cassava	97(61.4)
Maize + Cassava	158(100.0)
Maize + Yam + Cassava	126(79.7)
Maize + Cassava +Okra	158(100.0)
Maize + Cassava + Tomatoes	98(62.0)
Maize + Okra	136(86.1)
Maize + Tomatoes	71(44.9)
Yam + Okra	142(89.9)
Leafy vegetable + Pepper + Tomatoes	69(43.7)

Source: Field Survey, 2023; *: Multiple Responses

Sources of fertilizers

Table 3 revealed the sources of both organic and inorganic fertilizers available to the sampled respondents and 93.7% each indicated Agricultural Development Programme (ADP)/Government and market/poultry farm, only market (76.6%) and only poultry farm (17.1%), while only 35.4% indicated input dealers. The result implies that, the respondents' source for the fertilizers from different sources. The choice of source may be due to availability, nature of relationship between the source and the arable crop farmers, etc.

Table 3: Distribution of respondents by source of fertilizers

Sources	*Frequency (Percentage)
ADP/Government	148(93.7)
Market	121(76.6)
Poultry farm	27(17.1)
Market + Poultry farm	148(93.7)
Input dealer	56(35.4)

Source: Field Survey, 2023; *: Multiple Responses

Preference of organic and inorganic fertilizers

For this objective, 3-point rating scale of mostly preferred, preferred and not preferred was employed. Thereafter, weighted mean was computed and ranked accordingly (Table 4). Inorganic fertilizer had the highest weighted mean score (WMS) of 1.5 and was ranked first (1st), while organic fertilizer was ranked second (2nd) with WMS of 0.74. This result is in conformity with Olaleye et al. (2008), that 40.5% and 59.5% of the farmers preferred the use of organic and inorganic fertilizers. This result implies that most farmers preferred and applied inorganic fertilizer compared to organic fertilizer. Their preference for each fertilizer may be due to difference in their knowledge of advantage/purpose, convenience and availability of the two types of fertilizers.

Table 4: Distribution of respondents by preference of organic and inorganic fertilizers

Types of fertilizer	**Frequency (Percentage)**				
	Level of preference				
	Mostly preferred	**Preferred**	**Not preferred**	**WMS**	**Rank**
Organic	32(20.3)	54(34.2)	72(45.6)	0.74	2nd
Inorganic	97(61.4)	43(27.2)	18(11.4)	1.5	1st

Source: Field Survey, 2023; WMS: Weighted Mean Score

Test of hypothesis

The result of Pearson's product moment correlation (PPMC) revealed that educational status (0.370**; p<000), farm size (0.250*; p<002) and years of framing experience (0.299**; p<000) recorded a significant relationship with the level of preference of fertilizers among the respondents. This result implies that, the identified socio-economic variables have decisive influence on the preference of fertilizer application among the arable crop farmers. The results therefore reject the null hypothesis. This result corroborate Minot et al. (2000) and Amanze et al. (2010), reported that size of farm plot, household head expenditure, farm size, educational level, maize plot, rice plot, and number of cattle owned has significant effect on fertilizer application.

Table 5: Test of significant relationship between the socio-economic characteristics of respondents and their level of preference of fertilizers using PPMC analysis

Socio-economic variable	**Pearson correlation (r-value)**	**P-value**	**Result**	**Remark**
Age	0.094	0.240	NS	Accept H_0
Educational status	0.370**	0.000	S	Reject H_0
Farm size	0.0250**	0.002	S	Reject H_0
Years of farming experience	0.299**	0.000	S	Reject H_0
Extension contact	0.007	0.935	NS	Accept H_0

Source: Data Analysis, 2023; **: Correlation is significant at 0.01 level; S: Significant; NS: Not Significant; H_0: Null hypothesis

CONCLUSION AND RECOMMENDATIONS

Conclusively, the study revealed that farmers of different socio-economic background such as age groups, genders, educational status, etc. are involved in arable crop production in the study area. The farmers cultivate numbers of arable crops both as sole and multi-cropping with majority having preference for inorganic fertilizer. It was observed that socio-economic variables influence the level of preference of arable crop farmers in the study area. The study therefore recommend the need to educate the arable crop farmers on the relevance of both types of fertilizers in relation to their side effects to both farmland and human health, it is also important to encourage arable crop production through extension service/training and timely provision of required production inputs especially fertilizers.

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PROFILE DISTRIBUTION OF ORGANIC AND AMORPHOUS SESQUIOXIDES ALONG A TOPOSEQUENCE OF SOILS IN KWARA STATE, NIGERIA

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ABSTRACT

The study was carried out in Kwara State to evaluate soil profile distribution of organic and amorphous sesquioxides (iron and manganese) along a toposequence. Three profile pits were established along the toposequence which were delineated into three topographic units, upper slope, middle slope and lower slope. The amorphous Fe and Mn had a total mean value of 0.02 and 0.05mg/kg^{-1} in the upper slope, 0.05 and 0.16mg/kg^{-1} respectively in the lower slope. Organic Fe and Mn in the upper slope showed a mean value of 0.02 and 0.01mg/kg^{-1}, while the lower slope showed a higher value of 0.03 and 0.02mg/kg^{-1} of Fe and Mn as compared to the upper slope. The result showed that amorphous sesquioxides are more available in the lower slope while it was negligible in the medium slope. Topography, soil chemical properties such as organic carbon play a significant role in the distribution forms of sesquioxides.

***Keywords**: Soils, toposequence, sesquioxides, Kwara State.*

INTRODUCTION

Iron (Fe) and manganese (Mn) found in soils are released during soil weathering and soil development. They are re-precipitated as amorphous or crystalline oxides, hydroxides or oxyhydroxides (Obi *et al.,*2009). Oxides, hydroxides and oxy-hydroxides of iron (Fe), manganese (Mn), are referred to as sesquioxides. They occur in soils mainly as amorphous and crystalline inorganic compound; however, a small fraction may be present in the organic complexes (Hassan *et al* 2015). The form and content of the oxides influence soil physicochemical properties such as phosphate retention, charge surface, specific surface area, aggregate formation and stabilization making it unavailable in highly weathered tropical soils, *(*Duiker *et al.,* 2003).

Hot climates areas are known to experience a lot of weathering processes, and weathering is a major factor that contribute to the distribution of sesquioxides. Weathering of primary minerals is more powerful in the tropics than in a temperate climate and it occurs to a greater depth. Consequentially, sesquioxides are formed during weathering of soils. Topography is a factor of soil weathering and soil formation processes; therefore, topography is a major factor contributing to the distribution of sesquioxides soils. Subardja and Buurman (1980*)* confirmed that elevation influenced soil properties, development and degree of weathering. The objectives of this research were to access some physical and chemical properties of the soils; investigate the forms, content and distribution of iron and manganese oxides along the soils; and compare the distribution of iron and manganese sesquoxides with other physical and chemical properties of the soils on the toposequence.

MATERIALS AND METHODS

Location of Study

The study was carried out at the University of Ilorin, in Ilorin South local government area of Kwara State, Nigeria. Ilorin South falls within latitude 8°26′29.8″N and longitude 4°405′48.7″E. The toposequence has an elevation ranging from 308 to 334m above sea level. The climate of the area is characterized with an average temperature of 29^{0}C, an average humidity level of 52%, with an average wind speed of 10km/h. The rainy season is between March and November with a brief break in August and the annual rainfall varies from 1200 mm to 1500 mm. Ilorin falls within the Guinea savannah belt.

Analytical Procedure

Soil samples were collected from profile pits in each of the topographic units. Three profile pits were dug and the toposequence was delineated into three topographic units: upper slope (UPS), middle slope (MS) and lower slope (LS). The samples collected were air-dried, sieved through a 2mm sieve. The samples for Fe and Al determination were further passed through 1mm sieve. Particle size analysis was performed by the hydrometer method and organic matter by the Walkey-Black method. Soil pH was determined both in water and KCl following (Mclean 1965) procedure. Total Nitrogen was determined by Kjelhdal distillation method (AOAC 1999) while the cation exchange capacity was by the summation method. Available phosphorus was by the Bray and Kurtz No 1 (1954) method. Amorphous oxides were extracted by ammonium oxalate extraction (McKeague and Day 1966). The organic oxides were extracted by tetra sodium pyrophosphate ($Na_4P_2O_7$) solution, (Mckeague, 1967). The oxides of Fe and Al were correlated with some soil properties using GenStat.statistical tool.

RESULTS AND DISCUSSION

Physical properties of the soils

The physical properties of the soil are shown in (Table 1). The three pedons UPS, MS, LS were deep; the profiles were 160cm, 170cm and 200cm deep respectively. Idoga *et al.,* (2006) reported that soil depth, increased with decreasing altitude or down slope, soils on the UPS and MS were weakly structured, while those at the LS were well developed. The soils were classified as Ultisols and they have relatively high percentage of sand. The MS profile was poorly drained, this could result to why the sesquioxides in the medium slope were very negligible as opposed to other profiles. The sand content decreased with soil depth except MS which showed an increase and a further decrease with soil depth. Udo (1980), noted that in poorly drained soils, iron reduction to a divalent state usually occur, inducing high solubility and the resultant loss of the element by leaching.

Table 1: Physical properties of the soil

Pedon	Depth(cm)	Sand (%)	Silt (%)	Clay (%)	Bulk density (g/cm)	Textural Class
UPS	0-43	88.40	4.40	7.2	1.61	Sand
	43-72	84.40	8.40	7.2	1.77	Sand
	72-95	82.40	6.40	11.20	1.68	Loamy sand
	95-160	82.40	6.40	11.20	1.65	Loamy sand
MS	0-20	92.40	0.40	7.20	1.59	Sand
	20-125	78.80	12.88	8.32	1.64	Sandy loam
	125-170	88.80	6.88	4.32	1.58	Sand
LS	0-33	84.80	10.88	4.32	1.56	Loamy sand
	33-110	82.80	12.88	4.32	1.49	Loamy sand
	110-200	80.80	14.88	4.32	1.54	Loamy sand

Chemical properties of the soils

Some of the chemical properties of the soil are shown in (Table 2). All the profiles had a soil pH < 6.8, this shows that the soils are acidic. The value of organic carbon at UPS ranged from 0.44 to 2.79%, 0.26 to 2.87%, 0.82 to 2.72% and in the upper, middle and lower slope respectively. The value shows that organic carbon decreased with increase in depth. The values of the available phosphorus (AP) at the upper, middle and lower slopes ranged from 0.75 to 1.02 mg kg-1; 0.83 to 2.06 mg kg-1 and 0.88 to 5.41mg kg-1 respectively. Available phosphorous exceeded 4 mg kg-1 in the lower slope profile, this shows that the lower slope profile is not a weathered soil like the upper and middle slope profiles. Duiker *et al.,* (2003) proves that phosphate is usually not available in highly weathered soils. This result proved that the Upper and the middle slope soil profiles are weathered soils.

The data on the forms of Fe and Al are shown in (Table 3). The amorphous Fe (ox) had a mean value of 0.06, 0.01 and 0.05 mg kg^{-1} in the profiles. Thus, it is deduced that the amorphous oxide of Fe is higher in the UPS. The organic Fe (p) has a mean value of 0.03, 0.05, and 0.03 mg kg^{-1} in the three profiles, the middle slope has the highest value, this could be as a result of weathering of the organic material. Amorphous Mn (ox) had mean values of 0.05, null, and 0.6 mg kg^{-1} across the three soil profiles. While the organic Mn (p) showed mean values of 0.01, null, 0.02 mg kg^{-1} across the three profiles. Manganese had an insignificant value in the middle slope for both the amorphous and organic forms.

Table 2: Chemical properties of the soils.

Depth	H_2O	KCl	Ca	Mg	K	Na	EA	CEC	OC	AP	TN	OM	BS
			Cmol/kg-1 →								% →		
0-43	6.67	5.07	2.06	13.19	1.02	5.78	1.8	23.85	2.79	0.97	1.12	4.81	92.45
43-72	6.55	4.81	0.88	9.06	1.28	5.2	2.2	18.62	1.12	0.89	0.32	1.93	88.45
72-95	6.51	4.49	0.89	9.34	1.18	5.48	1.6	18.49	0.86	0.75	1.28	1.48	91.35
95-160	6.03	4.17	1.75	9.1	1.02	5.29	2.2	19.36	0.44	1.02	2.08	0.76	88.64
0-20	6.21	5.12	1.08	8.92	1.01	6.24	2.6	19.85	2.87	0.83	2.4	4.95	86.9
20-125	6.3	4.43	0.9	11.46	1.05	5.05	2.6	21.06	1.44	0.54	0.8	2.48	87.65
125-170	6.11	4.31	1	9.55	0.79	5.2	2.6	19.14	0.26	2.06	1.44	0.45	86.64
0-33	6.5	5.6	1	10.59	0.99	6.14	2.4	21.12	2.73	5.41	3.6	4.71	88.64
33-110	5.71	4.43	0.94	10.94	0.76	5.1	2.6	20.34	1.14	0.88	1.6	1.97	87.22
110-200	5.8	4.84	0.88	10.42	0.92	5.39	2.8	20.41	0.82	1.03	1.36	1.36	86.28

KCL= Potassium chloride, EA= Exchangeable Acid (cmol/kg), CEC= Cation Exchange Capacity (cmol/kg), OC= Organic Carbon (cmol/kg), AP= Available Phosphorus (cmol/kg), TN (100%)= Total Nitrogen, OM (100%)= Organic Matter, BS (100%)= Base saturation, UPS= Upper slope, MS= Medium slope, LS= Lower slope.

Table 3: Values of the forms of Iron and Managanese (Organic and amorphous sesquioxides)

PEDON	DEPTH	$FE_{(ox)}$	$MN_{(ox)}$	$FE_{(p)}$	$MN_{(p)}$	$FE_{(t)}$	$MN_{(t)}$
UPS	0-43	0.15	0.11	0.02	NIL	0.79	0.69
	43-72	0.03	0.02	0.03	0.01	0.49	0.42
	72-95	0.01	0.03	0.02	NIL	2.13	0.27
	95-160	NIL	0.04	0.03	0.01	1.48	0.98
Mean		0.06	0.05	0.05	0.01	1.22	0.59
MS	0-20	NIL	NIL	0.10	NIL	3.08	1.18
	20-125	0.01	NIL	0.02	NIL	1.22	0.23
	125-170	NIL	NIL	0.02	NIL	2.98	0.64
Mean		0.01	NIL	0.04	NIL	2.43	0.68
LS	0-33	0.07	0.28	0.01	0.03	1.59	0.63
	33-110	0.03	0.03	0.03	0.01	0.44	0.08
	110-200	NIL	NIL	0.04	0.01	0.92	0.11
Mean		0.05	0.16	0.08	0.02	0.98	0.27

NB: Amorphous Fe and Mn (ox), Organic Fe and Mn (p), Total Fe and Mn (t)

Table 4: Correlation between Amorphous and Organic Fe and Mn

Soil Properties	Fe (ox)	Fe(p)	Mn (ox)	Mn (p)
OC	0.629*	-0.120	0.345	0.177
OM	0.913***	-0.684**	0.770	0.236
EA	-0.482*	0.039	-0.682	0.190
AP	0.013	-0.196	0.301	0.026
TN	-0.245	0.089	0.251	0.074
Na	0.063	0.029	0.337	0.243
K	0.199	-0.124	0.101	0.128
Ca	0.447*	-0.150	0.429	0.140
Mg	0.598*	-0.539*	0.276	0.223
CEC	0.417	-0.247	0.282	0.171
pH (water)	0.641*	-0.488*	0.345	0.107
pH (KCL)	-0.245	-0.016	0.208	0.164
BS	0.063	-0.540*	0.812	0.236

The distribution of amorphous iron (Fe) had significant strong positive correlation with organic matter of the soil ($p<0.001$); significant moderate positive correlation with organic carbon, magnesium, CEC, pH (water), and base saturation ($p<0.05$); weak positive relation with pH (KCl); very weak positive correlation with potassium; and very weak negative correlation with available phosphorus and total nitrogen (Table 4). The distribution of amorphous manganese (Mn) showed significant strong positive correlation with base saturation ($p<0.001$); significant moderate positive correlation with organic matter ($p<0.01$); weak positive correlation with organic carbon; available phosphorus, total nitrogen, CEC, and pH (water); and very weak relation with potassium and pH (KCl). The distribution of organic iron along the toposequence had weak positive correlation with exchangeable acidity; and very weak positive correlation with total nitrogen, but significant strong negative correlation with organic matter ($p<0.01$); significant moderate negative correlation with pH (water), and base saturation ($p<0.05$); weak negative correlation with CEC; and very weak negative relation with organic carbon, available phosphorus, potassium, pH (KCl). Whereas, the distribution of organic manganese had
significant moderate positive correlation with available phosphorus ($p<0.05$); weak positive relation with total nitrogen; very weak positive relation with organic matter, CEC, and pH (KCl) but weak negative correlation with pH (water); very weak negative with organic carbon, potassium, and base saturation.
Seal *et al.* (2006) observed positive correlation of organic carbon with amorphous organic iron and negative correlation with amorphous iron. Ammari and Mengel (2006) inferred that soil organic matter played an important role in availability and solubility of iron. Juo *et al*., (1974) concluded that Nigeria has a relatively small amount of amorphous iron oxides in most Alfisols and Ultisols derived from acidic parent rocks. Maniyunda *et, al* (2015) confirmed that pedogenetic development and sesquioxides crystallization were significantly higher in the subsoil compared to surface horizons.

CONCLUSION

Based on the results, this study showed that the upper and the middle slope profiles have aged and weathered due to the high sesquioxides content present. The Clay and organic matter also had a strong influence on the movement and the distribution of the forms of organic and amorphous sesquioxides of Iron and Manganese in the soils.

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MUSHROOM/ GINGER VALUE CHAIN CAPACITY BUILDING: A CASE OF FEDERAL GOVERNMENT CONSTITUENCY PROJECT IN NDOKWA WEST LGA, DELTA STATE, NIGERIA

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ABSTRACT
Mushroom and ginger are high valued crops of immense health benefits and income potential. Mushroom is a prized delicacy with notable health benefits, a good protein substitute especially where other protein sources are not affordable. Ginger too is a health based crop used as accompaniment in the treatment of various health related issues. Although an increased awareness is being generated among the populace on the health and income benefits, it becomes necessary to have capacity of interested stakeholders developed for sustained production and utilization of the crops. Thus, a program was organized to train youths on mushroom and ginger production and utilization. Based on needs assessment in the community of focus, 80 respondents were selected as part of a Federal Government sponsored constituency project facilitating training for youths. Data was obtained through use of structured questionnaires and analyzed through frequency counts, percentages and t-test. Findings revealed that majority (80%) of the respondents were aged between 19 and 48 years. A sizeable proportion (58.8%) were males, married (75%), while 78.8% had education from primary to tertiary. Major occupation by 51.2% of respondents was farming. There was significant difference between the total post evaluation mean score and pre evaluation mean score (t=16.692, p=.000). In order to achieve a nationwide spread cultivation of mushroom and ginger processing both for local consumption and export,while also reducing youth unemployment, it becomes imperative to strengthen capacity of unemployed youths and other prospective stakeholders to maximally benefit from the potentials in the selected value chains for income generation and livelihood enhancement.
Keywords: *Farming, horticulture, mushroom, ginger, empowerment*

INTRODUCTION

Capacity building is the process of equipping individuals with the understanding, skills and access to information, knowledge and training that enables them to perform effectively in an informed society. Capacity building is necessary to equip both citizens and stakeholders with skills and competencies necessary in horticultural value chains to ensure sustainable agricultural development, improved income and economic empowerment (NIHORT,2020 and Berg,2016). Mushrooms are exotic functional foods with health benefits such as anti-viral, cholesterol-lowering, immune boosting anti-oxidant and anti-ageing properties (Bamigboye *et al*,2022). They can be converted to various forms of products such as mushroom biscuits, soup premix as health based food products. (Ogbo *et al*,2023). Nutritionally, mushrooms are rich sources of protein, fibre, vitamins and carbohydrates. Mushrooms help to prevent cancer and other life threatening diseases. Also environmental pollution can be reduced by mushrooms which convert and utilize organic wastes (Ayodele,2023). They also promote healthy skin complexion and hair, energy level, brain function, bone strength and overall low weight. (Oyetayo,2011). Different studies carried out on mushroom include perception and consumption of wild and cultivated mushroom in Port Harcourt, Nigeria. The survey revealed that 53.3% were conversant with wild mushrooms, and 27.8% with cultivated mushrooms. Although 58.9% indicated interest in mushroom consumption, and the relatively low consumption was attributed to its unavailability by 68% of the respondents (Adedokun and Okomadu,2017).

Ginger is an important cash crop in Nigeria, a flowering plant whose rhizome is frequently consumed as a spice, either fresh or dry, or used for a number of therapeutic purposes (US NCCIH, 2016). Ginger is available in different forms such as raw ginger, dry ginger, bleached dry ginger, ginger powder, ginger oil, ginger oleoresin and ginger candy. It is an important spice used for pickles and preservatives (Emmanuel, 2022). Ginger is one of the most widely used spices and herbs around the world, with a significant presence in the global food market and a substantial postharvest loss ((Malik *et al*, 2023) with storage loss estimated as high as 50 % (Rema and Rajeev, 2002). This underscores the need for processing into more stable forms for longer shelf life. Bamigboye,*et al* (2022), Adejo and Ademu (2018), Ndem and Martha (2016) advocated for training on mushroom production to facilitate its cultivation and consumption. Similarly, Omorefosa (2016) and Ayodele (2023) recommended massive cultivation of mushrooms and development of the mushroom value chain in Nigeria as a panacea to food scarcity, weapon for youth and women empowerment. This could provide 30 million skilled, semi-skilled and unskilled jobs for unemployed graduates, vulnerable youths and women, and contribute significantly to rural development and the country's GDP. It is against this background that a Federal Government sponsored constituency training program was conceived with the aim of reducing unemployment among the Nigerian youths, promote sustainable livelihood and economic empowerment by building their capacity in mushroom production and mushroom/ginger value addition. Specific objectives were to assess the knowledge uptake of the respondents and also profile their socio-economic characteristics.

METHODOLOGY

The study area was in Delta State, South-South part of Nigeria. The State is bordered on the north by Edo State, the east by Anambra and Rivers States, the south by Bayelsa State, and to the west by Bight of Benin. It has a projected population of 5,636,100 in 2022 with a land area of 16,986km^2 and lies at latitude 5^0 30'N and longitude 6^0 00'E (Delta State Government,2023). Delta State is blessed with a favourable natural environment (riverine and upland) and climatic conditions that warrant all year round farming activities. Wide variety of crops such as rice,yams, cassava, mangoes, pawpaw, rubber and oil palm are grown. There is availability of fertile land and water resources creating opportunities in vegetable and fish farming (Obekpa and Tasie, 2022). Agriculture comprised 13.2% of the State's GDP in 2020.

Needs assessment was carried out in Ndokwa/Ukwani Federal Constituency of Ndokwa West Local Government Area of Delta State. to determine preference of training programme and the commodity crops of focus. Population for the study were youths in Ndokwa West Local Government Area. A total of 80 male and female respondents randomly selected from 15 communities were trained under the Batch 2 segment of the training. Participants were exposed to theoretical and practical hands on experience training sessions in four training modules comprising: Mushroom production: Mushroom and ginger value addition: Economics, marketing and record keeping of mushroom production, and Economics, marketing and record keeping of ginger value addition. Data were collected through the use of structured questionnaires. Descriptive statistics such as frequency, percentages and means were used to describe the socio-economic characteristics of the respondents while t-test was used to compare the pre-evaluation and post-evaluation knowledge mean scores of the respondents.

RESULTS AND DISCUSSION

Findings from Table 1 revealed that majority (58.8%) of the trainees were males, married (75%) and involved in farming activities (51.2%). Eze, *et al* (2017) affirmed that males are the bread winners who have to engage in productive activities to provide for their family needs. A sizeable proportion (80%) of the trainees was within the age bracket of 19 and 48 years which is the active age while 45% had tertiary education. However, most (62.5%) of the trainees did not belong to any association. Asfaw and Admassie (2004) posited that education enhances the capacity of farmers to obtain and analyze information which may result to increased production. The results on Table 2 revealed that post training scores increased for each of the modules taught. Knowledge of participants before and after the training for each of the modules taught was assessed with paired sample t-test. Differences observed in the mean values were statistically significant at 1% level of significance as shown in the t-values (Table 3). These includes: Mushroom production (t= 12.377, p=.000), mushroom marketing and record keeping (t=9.032, p=.000), ginger processing (t= 15.999, p=.000), ginger processing and record keeping (t=8.364, p=.000). Overall, significant difference existed between total post knowledge score and total pre-knowledge score of participants (t= 8.364, p=.000). This implies that the participants' knowledge increased for each of the modules they were taught which were above the knowledge that they had before they participated in the training program, thus suggesting that exposure to the training improved the knowledge level of the participants.

CONCLUSION AND RECOMMENDATIONS

The study concludes that knowledge level of trainees improved after exposure to the trainings. Although majority of the trained youths did not belong to any agricultural association. The study recommends fully funded training by the Federal Government for unemployed youths to be domiciled in each senatorial district in Nigeria, with empowerment to facilitate integration into specific value chains, with formation of youth groups to explore both local and export market options.

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Table 1: Socio-economic characteristics of the respondents (n=80)

Variables	Frequency	Percentage
Sex		
Male	47	58.8
Female	33	41.2
Age (in years)		
19-28	24	30.0
29-38	25	31.2
39-48	15	18.8
49-58	10	12.5
> 58	4	5.0
No response	2	2.5
Marital status		
Single	16	20.0
Married	60	75.0
Widowed	4	5.0
Educational qualification		
Primary	5	6.3
Secondary	22	27.5
Tertiary	36	45.0
Others	10	12.5
No response	7	8.7
Major occupation		
Farming	41	51.2
Trading	13	16.3
Student	13	16.3
Unemployed youths	8	10.0
No response	5	6.2
Membership of association		
Yes	17	21.3
No	50	62.5
No response	13	16.2

Source: Field survey, 2019

Table 2: Pre and post knowledge scores of participants

Variables	Pre knowledge mean score	Post knowledge mean score
Mushroom production	0.16	3.03
Mushroom marketing and record keeping	0.63	2.54
Ginger processing	0.97	7.03
Ginger marketing and record keeping	0.25	0.99
Total Score	1.93	13.29

Source: Field survey, 2019

Table 3: Test of difference between pre and post knowledge scores of participants

Variable	Mean	Standard Deviation	Standard Error Mean	T value	Df	Sig
Post score of mushroom production - pre score of mushroom production	2.870	2.035	0.232	12.377	76	.000
Post score of mushroom marketing and record keeping - Pre score of mushroom marketing and record keeping	1.908	1.842	0.211	9.032	75	.000
Post score of ginger processing - Pre score of ginger processing	6.053	3.298	0.378	15.999	75	.000
Post score of ginger marketing and record keeping - Pre score of ginger marketing and record keeping	0.733	0.759	0.088	8.364	74	.000
Post evaluation total score - Pre evaluation total score	11.362	6.088	0.681	16.692	79	.000

Source: Field survey, 2019

TECHNICAL EFFICIENCY OF TOMATO PRODUCTION IN YAMALTU-DEBA LOCAL GOVERNMENT AREA OF GOMBE STATE

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ABSTRACT
The study investigated the level of technical efficiency of tomato farmers in Yamaltu-Deba Local Government Area of Gombe State. A multistage sampling technique was used to select eighty tomato farmers from the study area. Information was obtained from the sampled farmers through the use of a structured questionnaire. Stochastic Production Frontier Analysis (SPFA) with Cobb-Douglas functional form was used to analyze the technical efficiency of the farmers. The result revealed the tomato farmers in the study area were fairly efficient with mean technical efficiency level of 0.87. Fertilizer use, organic manure, pesticide and farm size enhanced tomato output and technical efficiency of the farmer at 1% and 10% alpha level. Return-to-scale of 0.32 was estimated, implying the farmers operate in the stage two of production where doubling the input lead to less than double in the output. Farmers should therefore pay attention to their input combination to avoid diminishing returns.
Keywords: *Production function, tomato, stochastic frontier, inefficiency*

INTRODUCTION

Tomato (*Lycopersion esculentum* mill) is one of the leading vegetable crops in Nigeria. The crop is high in nutritional values and it is rich in vitamins, mineral and fibre. It is widely used in varieties of dishes as raw, cooked or processed products in Nigeria. The production of tomato started experiencing increase from 1.79MT in 2010 until 2015 when it hit the production volume of 4.22 MT. However, the country could not sustain the increase as the production value declined to 3.57 in 2021 (FAOSTAT, 2021). The decline in production volume has raised an important policy question such as what factors are responsible for the dwindling production figure of tomato in the country. The answer perhaps could be in the technical efficiency of the farm or the farmers which is referred to as the ability of a farm to produce as much as output with the level of inputs, given the existing technology (Erena *et al*, 2021). The study therefore seeks to support literatures in production efficiency by analyzing the technical efficiency of tomato farmers in Yamaltu-Deba Local Government Area of Gombe State. Specifically, the study described the socio-economic characteristics of tomato farmers; estimated the determinants and levels of technical efficiency of tomato farmers in Yamaltu-Deba Local Government Area of Gombe State.

MATERIALS AND METHODS

Study Area

The study was carried out in Yamaltu-Deba Local Government Area (LGA), Gombe State. Yamaltu-Deba is one of the eleven Local Government Areas in the State with its headquarters in Deba. According to NBS (2009), the result of 2006 census indicated a population of 255,726 for Yamaltu-Deba LGA. The LGA covers an area of about 1,981 square kilometers and lies at latitude $11^0 31'$ N and longitude 11˚24' E with the temperature ranges from 20^0C to 31^0C and mean annual rainfall of 750mm. The soil is rich clay-loam, making it ideal for agricultural activities (Saleh *et al*., 2021). The LGA is known for cultivation of a wide range of vegetables, fruits and cereals. It hosts parts of the lake Dadinkowa and shares boundaries with parts of Borno State to the North, Balanga LGA to the South, Gombe and Akko LGAs to the East (Erie *et al*, 2019). The target population was tomato producers.

Sampling technique

A multistage sampling technique was used in the choice of individual respondent. The first stage was purposive selection of Yamaltu-Deba LGA from eleven LGA in Gombe state. Yamaltu/Deba was selected because it is known for production of tomato. The second stage was random selection of two belts within the LGA based on size of tomato production- Dadinkowa and Kwandon. The third stage involved random selection of forty tomato producers from each belt, making a total of eighty. However, data from seventy-seven respondents were found useful for analysis.

Data source and analysis

Primary data were used for this study. Data were collected by the use of well-structured questionnare. Respondents were asked to indicate socio-economic characteristics and production variables (quantities of inputs used and output).

Data analysis involved the use of descriptive and Stochastic Production Frontier Analysis (SPFA). The descriptive analysis was used to analyze socio-economic characteristics of farmers while SPFA with Cobb-Douglas functional form was used for estimating the determinants and levels of technical efficiency.

$$Y_i = f(X_i, \beta)e^{v_i - u_i} \text{...}(1)$$

$$\ln Y_i = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + \beta_7 \ln X_7 + v_i - u_i \text{........}(2)$$

where,

Y_i= Observed individual *ith* farm output of tomato (Kg)

X_1=Farm size (ha)

X_2= Quantity of seeds (Kg)

X_3= Fertilizer (Kg)

X_4= Organic manure (Kg)

X_5= Herbicides (litres)

X_6= Pesticides (litres)

X_7= Labour (man days)

$\beta_{i's}$ =Technology parameters to be estimated

ln=Natural log

The v_{is} are random error variable that are assumed to have normal distribution $iid\, N(0, \delta_{vi}{}^2)$. The u_{is} are non-negative random variable having half of normal distribution $iid\, N^+(0, \delta_{ui}{}^2)$ which measures technical inefficiency effects.

Accordingly, Technical efficiency (TE) of individual tomato farmer is defined as the ratio of observed output (Y_i) to the corresponding frontier output (Y_i^*), conditioned on the level of input used by farm. Technical inefficiency is therefore defined as the amount by which the level of production is less than the frontier output. The model for TE will be expressed as:

$$TE = \frac{Y_i}{Y_i^*} = \frac{f(x_i;\beta).\exp(-u_i)}{f(x_i;\beta)} = \exp(-u_i) \text{...}(3)$$

where, Y_i is the observed and Y_i^* is the frontier output. Technical efficiency takes value between 0 and 1 i.e $0 \leq \text{TE} \leq 1$.

In addition, the study measured technical inefficiency, u_i , of the tomato farmers. The technical inefficiency effects are as follows:

$$\ln Y_i = f(\alpha + \beta) + e_i \text{...}(4)$$

$$u_i = \alpha_0 + \alpha_1 Z_1 + \alpha_1 Z_1 + \alpha_1 Z_1 + \alpha_1 Z_1 + \alpha_1 Z_1 + \alpha_1 Z_1 + \alpha_1 Z_1 + \alpha_1 Z_1 + v_i + u_i \text{..................}(5)$$

Where,

ui=technical inefficiency of equations 4 and 5 respectively

α_i=Vector of parameters
Z_1=Age of tomato farmers (years)
Z_2= Marital status
Z_3=Education (years)
Z_4=Household size of the farmer
Z_5=Membership of association: 1 if farmer belongs to association, 0 otherwise
Z_6=Extension visit
Z_7=Training
Z_8=Record keeping: 1 if farmer keeps record of farming activity, 0 otherwise
e=Random error
The u_i is non-negative random variable having half of normal distribution $iid\,N^+(0,\delta_{ui}^{\ 2})$.

RESULTS AND DISCUSSION

Socio-economic characteristics distribution of respondents

The distribution of socio-economic in table 1 revealed that most of the producers were within the age range of 20-39years with mean age of 37years. This is an indication that the farmers in the study area enjoys involvement of young persons in farming activities. About eighty-one percent of the respondents were male, indicating that men engage more in the tomato production in the study area. This is in conformity with finding of Saleh *et al,* 2021 (2021) and Usman and Bakari (2013) who reported the mean age of approximately 40years in their study areas. Over 68% of those engaged in tomato production were married with the mean household size of 11 persons, implying that most of the respondents have advantage of supply of family labour. The result is in line with Pius *et al*, 2006 who opined that farmers with sizeable family could engage them to their farm business. Eighty-three percent of the respondents had formal education, indicating that majority of respondents were literate and this could assist them in effective communication in doing their business (Asogwa and Okwoche, 2012). In term of experience, 54.6% had spent between 6 and 15 years the tomato farming, indicating a relatively high knowledge in tomato production. The greater the year of farming experience, the more knowledgeable the farmer is in minimizing costs and maximizing the profits.

Table 1: Socio-economic characteristics of the tomato farmers in the study area

	Frequency	Percentage
Sex		
Male	62	80.5
Female	15	19.5
Age (years)		
<20	4	5.2
20-29	19	24.7
30-39	23	29.9
40-49	15	19.5
50-59	14	18.2
>59	2	2.6
Mean	**37**	
Marital status		
Single	24	31.2
Married	53	68.8
Educational level		
None	13	16.9
Primary	12	15.6
Secondary	18	23.4
Tertiary	34	44.2

Mean	**11**	
Household size		
1- 5	17	22.1
6-10	30	39.0
11-15	16	20.8
16-20	8	10.4
21-25	2	2.6
25-30	4	5.2
Mean	**11**	
Years of experience		
1-5	28	36.4
5-10	31	40.3
11-15	11	14.3
16-20	6	7.8
21-25	1	1.3
Mean	**9**	

Source: Field survey, 2021

Summary of quantity of input used by tomato farmers

A tomato farmer in the study area harvested an average output of 5,758.78kg from 1.08ha of land and about 5.63kg tomato seeds. The farmer applied an average of 130.24kg of fertilizer, 21.94litres of herbicides, 43. 37litres of insecticides and utilized average of 481.94mandays per hectare (Table2).

Table 2: Summary of quantity of input used by tomato farmers

Variables	Mean quantity
Average farm size for tomato (ha)	1.08
Seed (kg)	5.363
Fertilizer (kg)	130.24
Herbicides (litres)	21.94
Insecticides (litres)	43.37
Labour (manday)	481.94
Output (kg)	5,758.78

Maximum Likelihood Estimate for the Stochastic frontier

The result of stochastic frontier analysis and the inefficiency model are presented in table 3. The variance parameters for sigma squared (σ^2) and gamma (Υ) are 0.0304 and 0.978 respectively for tomato farmers and are significant. The sigma squared is an indication of goodness of fit and correctness of the distributional form assumed for composite error term while the gamma shows that about 97.8% of total variation is due to technical inefficiency and 2.2% accounts for random shocks.

The result further shows that the coefficient of the parameter estimates of farm size was positive and significant to output at 10%, use of organic and inorganic fertilizer was positive and significant at 1% and insecticide have positive significant influence on tomato output at 1%. While the coefficient of the parameter estimates of herbicide had negative and significantly effect on output at 10%. This implies that one unit increase in farm size, organic and inorganic fertilizer, and insecticide will increase tomato output by 0.016, 0.058, 0.072 and 0.162 respectively. However, a unit increase in quantity of herbicide will reduce the output by 0.119. The estimated elasticity of all the inputs are less than one, indicating decreasing returns to scale. This implies that the farmers operate in the stage two of production, and should be careful to know when to stop increasing input because increase in input combination by 1% will result to less than 1% increase in total output.

The lower panel of table 3, presents the estimated parameters of the inefficiency model in the stochastic frontier production function of tomato farmers. The signs of inefficiency model of the stochastic frontier production function had important implications on technical efficiency. The result revealed that only the coefficient of the parameter estimate of membership of association was positive and statistically significant to technical inefficiency which implies that membership of professional association reduces efficiency of the farmer. This is against the *apriori* expectation and may be due to the fact that some decisions being taken by the executives are having negative influence on the activities of the members. Although record keeping, training, household size and marital status were not statistically significant but had negative signs. The negative signs indicate parameters that reduce technical inefficiency of the farmer, and thus increase their efficiency.

Table 3: Maximum Likelihood Estimate for the Stochastic frontier

Variables		**Coefficient**	**SE**	**T-value**
Constant		0.151	0.056	2.69
Farm size	X1	0.016	0.102	1.65*
Seed	X2	0.013	0.011	1.26
Fertilizer	X3	0.058	0.014	3.93***
Organic manure	X4	0.072	0.013	5.36***
Herbicide	X5	-0.119	0.063	-1.89*
pesticide	X6	0.162	0.062	2.60***
Labour	X7	0.118	0.008	1.47
Inefficiency variables				
Age	Z1	0.186	0.018	1.03
Marital status	Z2	-0.566	0.541	-1.05
Year of education	Z3	0.001	0.035	0.04
Household size	Z4	-0.043	0.029	-1.49
Membership of association	Z5	0.897	0.483	1.89*
Extension visit	Z6	0.240	0.689	0.35
Training	Z7	-0.066	0.633	-0.11
Record keeping	Z8	-0.603	0.590	-1.02
Variance parameter				
Sigma-squared (σ^2)		0.0304	0.017	1.733*
Gamma (γ)		0.978	0.024	40.61***
Log-likelihood		93.756		
Wald chi2(34)		463.22		
Sample size		77		
RTS		0.32		

Source: Computed from field survey data, 2021. *** = Significant at 1%, ** = Significant at 5% , * = Significant at 10%, RTS-Returns To Scale.

Distribution of technical efficiency estimates for tomato farmers in the study area

Frequency distribution of technical efficiency of the farmers shows the efficiency of the farmers ranges from minimum value of 0.58 and maximum value of 1 with the mean technical efficiency value of 0.87 (Table 4). This shows that if the farmers with minimum efficiency are able to achieve the maximum level of efficiency, they would be able to save 42% of production resources. Likewise, the efficient farmers will be able to save 13% of their usual production input. The mean technical efficiency value also indicates that tomato farmers in the study area were fairly efficient.

Table 4: Frequency distribution of technical efficiency estimates for tomato farmers in the study area

Efficiency range	Frequency	Percentage
Less than 0.50	-	-
0.51-0.60	1	1.30
0.61-0.70	5	6.49
0.71-0.80	10	12.99
0.81-0.90	25	32.47
0.91-100	36	46.75
Total	77	100.00
Mean TE= 0.87		
Minimum= 0.58		
Maximum= 1		
Standard deviation= 0.10		

Source: Computed from field survey data, 2021

CONCLUSION

Based on the findings, the study concludes that farmers were fairly efficient and could improve their output and efficiency through proper input combination. Fertilizer and pesticide contributed largely to output in the study area, the study therefore recommends policy that will encourage input distribution to farmers in order to boost tomato production. Training of farmers should be encouraged as this could improve their efficiency.

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EVALUATION OF WASTE PAPER AND SAWDUST COMBINATION FOR THE CULTIVATION OF BLUE OYSTER MUSHROOM (*Pleurotus ostreatus var columbinus*); AN EDIBLE MUSHROOM

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ABSTRACT
Mushroom cultivation is an economically feasible bio-technological process for conversion of various lignocellulosic wastes into edible protein. The aim of this study is to evaluate the suitability of waste paper in combination with sawdust for oyster mushroom production. From the National Horticultural Research Institute (NIHORT) Ibadan, the pure culture of blue oyster mushroom (Pleurotus ostreatus var columbinus) was obtained from Mushroom unit while the shredded waste paper was supplied by NIHORT management team. The mushroom was cultivated on paper substrate alone, sawdust substrate alone and in combination ratios of 1:3, 3:1 and 1:1. The experiment was laid out in a complete randomized design (CRD) in five replicates. Substrate ratio combination of 1:3 produced the highest number of fruits (13.00), BE (40.38%), PE (14.48%), days to full mycelial colonization and primordial initiation (26.00 days and 29.69 days respectively) and highest fruit weight (70.67 g). Substrate ratio combination of 3:1 had the largest width of pileus (9.90 cm) compared with others. Paper alone, sawdust alone and ratio 1:1 had comparable length of stipe while the shortest (4.80 cm) was observed on ratio 1:3. This study revealed that paper and sawdust combination (1:3) resulted in high BE and fruit bodies yield. Thus, waste paper is an alternative substrate for mushroom cultivation.
Key words: *Edible mushroom, Paper, Pleurotus ostreatus var columbinus*

INTRODUCTION

Pleurotus species (Oyster mushroom) has been widely cultivated and commercialized after *Agaricus bisporus* (Mshandete, 2011). It is a potential source of dietary fiber, contains approximately 100 bioactive compounds and rich in protein, carbohydrates, lipids, minerals and vitamins but with low fat and calories contents (Deepalakshmi and Mirunalini, 2014). Oyster mushrooms are the least expensive and easiest to grow commercial edible mushrooms as a result of their ability to recycle agricultural or horticultural wastes due to its multilateral enzyme system that can biodegrade a large range of lignocellulosic wastes (Mshandete, 2011), convert crop residues to food protein, serve as source of food production and security, employment opportunities and source of income (Banik and Nandi *et al*., 2004). Various substrates reported in the cultivation of mushrooms include cassava wastes, cottonseed hull, rice and wheat straw, leaves, paddy straw, barley straw, beans straw, corncob, sawdust and sugarcane baggase (Sharma *et al*., 2013; Sonnenberg *et al*., 2015; Otunla *et al*., 2016). Mushroom cultivation can play an important role in ensuring food security, diversifying business and employment opportunities, both in urban and rural areas (Tesfay *et al*., 2020).

Sawdust and waste paper are incinerated, disposed openly in fields and burnt, leading to environmental and or air pollution. Papers composed of primarily cellulose, hemicellulose and lignin (Tesfay *et al*., 2020) and a number of colleges and offices dispose waste papers. If this can support the growth of mushrooms, it may help to transform this waste into an acceptable edible biomass of high market value and serve as a cheap source of substrate for mushroom growers. Therefore, the current study was aimed at evaluating waste paper, in combination with sawdust, for the cultivation of mushroom.

MATERIALS AND METHODS

***Source of higher fungus* (*mushroom spawn*)**

Pleurotus ostreatus var columbinus spawn (seed) used for this research study, was obtained from the pure culture collection from the Mushroom unit mycology laboratory of the National Horticultural Research Institute (NIHORT), Idi-Ishin, Jericho, Ibadan, Oyo State.

Substrates collection and composting

The sawdust used for this experiment was collected at Sanngo sawmill within Ibadan, Oyo State while the shredded waste paper was obtained from NIHORT, Ibadan. They were composted for a month at the mushroom unit substrate composting room as follow; paper alone, sawdust alone and in the combination ratios of 1:3, 3:1 and 1:1.

Mycelia ramification on substrates

Each of the substrate (500 g) was packed into heat-resistant transparent polythene bags, replicated five times and the bags were of the size 35 x 10 cm. The necks of the bags were tucked with a cotton plug and were sterilized in an autoclave at 121ºC for 15 minutes. Aseptically in the inoculating room, the bags were separately inoculated with the mushroom spawn on cooling and later transferred into the vegetative room (temperature and relative humidity of 28-30 ºC and 82-85% respectively) to allow mushroom mycelia ramification.

Cropping and harvesting of mushroom

The cropping or fruiting house was maintained at 24-28 ºC and relative humidity at 84-87%. Inoculated substrate bags fully ramified with mushroom mycelia were moved out of the vegetative room into the cropping house where fructification took place. Mushroom fruit bodies were harvested manually by twisting them from the base without leaving any remnant. The following parameters were observed and recorded; number of fruits, fruit weight, width of pileus, length of stipe, days to full mycelia colonization and primordia initiation while Biological and Production Efficiencies were calculated.

***Research* Design**

In five replicates, the experiment was laid out in a complete randomized design (CRD).

Data Analysis

Data collected was analyzed using ANOVA while significant means were separated using Duncan's multiple range test.

RESULTS AND DISCUSSION

It was observed that the substrates, singly and in combinations, showed remarkable growth and yield of the mushroom species. *Pleurotus* species are known to be able to degrade lignocellulosic agricultural and or horticultural wastes (Mshandete, 2011). The mushroom must have secreted hydrolyzing enzymes to degrade the components of the substrates for easy accessibility of the component nutrients.

***Days to full mycelial colonization*:** The shortest number of days to full mycelial colonization (16.00 days) was recorded on paper substrate alone followed by substrate ratio of 3:1 (18.67 days). Substrate ratio combination of 1:1 was significantly different (22.67 days) while the longest number of days was recorded in substrate combination of ratio 1:3 which was comparable to what was observed in sawdust substrate alone (26.00 days and 25.00 days respectively). This was similar to the work of Girmay *et al*. (2016) that reported 14.00 days, Shah *et al*. (2004) that reported 2-3 weeks and Kumari and Achal (2008) that reported 20.00 days after inoculation. This may be due to the substrate nature, ability to retain moisture and differences in environmental condition. Temperature of 30 ºC is optimal to the growth of *Pleurotus ostreatus* (Marino *et al*., 2003).

***Primordia initiation*:** This was first observed in substrate ratio combination of 3:1 (24.00 days). This was followed by what was recorded on paper alone which however was not significantly different from what was observed on substrate ratio 1:1 (26.33 days and 26.67 days respectively). The longest number of days was recorded on substrate ratio combination of 1:3 which was comparable to sawdust substrate alone (29.69 days and 29.00 days respectively) (Table 1). Various researchers reported different number of days for primordia initiation. This was in consonance with the report of Oei (2003) that materials with high quality lignin and cellulose will have longer number of days for primordia initiation. Substrate with higher amount of waste paper had longer time. This could be attributed to the lignin and cellulose content of waste paper.

***Number of fruits*:** The highest number of fruits (13.00) was recorded in paper and sawdust combination of ratio 1:3. This was followed by ratio combination of 1:1 (8.00) which however, was not significantly different from what was harvested on the sawdust substrate alone. The least (5.67) was observed on paper substrate alone (Table 1).

***Fruitbody weight*:** The heaviest fruit weight of 70.67 g was recorded on paper/ sawdust combination of ratio 1:3. This was followed by 60.00 g fruit weght harvested on paper substrate alone. The least (51.67 g) was observed on paper/ sawdust combination of ratio 1:1 which however, was not significantly different from what were recorded on substrate combination of ratio 3:1 and sawdust substrate alone (Figure 1). The growing season, environmental condition and variation in the nutrient composition are attributable to the variation in the fruit weights. There was availability of carbon from the sawdust while the paper provided cellulose, hemicellulose and lignin and also created crevices within the substrate combination for effective and efficient mycelia remification.

***Width of pileus*:** The widest width of pileus (9.90 cm) was observed in substrate ratio combination of 3:1 followed by ratio combination of 1:3 but this was not significantly different from what was recorded on paper substrate alone and other substrate ratio combinations (8.33 cm, 8.33 cm and 7.23 cm respectively) and sawdust alone (7.53 cm). This was longer than what was reported (3.8-5.2 cm) by Gume *et al*. (2013) but similar to an earlier report by Idowu and Otunla (2021). The size is a function of the amount of light and the aeration of the inoculated substrate bags in the cropping room (Kivaisi *et al*., 2003).

***Length of stipe*:** The longest length of stipe (6.77 cm) was recorded on substrate ratio combination of 1:1 which was comparable to that of paper substrate alone and sawdust substrate alone (6.33 cm and 6.07 cm respectively). This was significantly different from what was observed on substrate ratio of 3:1 which was also comparable to what was observed in ratio 1:3 (Table 1). Width of pileus and length of stipe vary on different substrates due to the structure, compactness and the physical properties of the substrate (Tesfay *et al*., 2020).

***Biological and Production Efficiencies*:** Both followed the same trend; substrate combination of ratio 1:3> paper alone> sawdust alone> 3:1> 1:1 respectively (Figure 2). One part of paper to three parts of sawdust gave the highest biological and production efficiencies, I opined that the sawdust served as a better source of carbon as earlier reported by Shah *et al*. (2004).

CONCLUSION AND RECOMMENDATION

Days to full mycelia colonization on paper substrate was shortest and with the greatest mycelia density. However, the harvested fruit weight was less than that of substrate ratio combination of 1:3 due to low nutrients in the paper. Therefore, paper could be employed to create crevices within the sawdust substrate to enhance mycelia ramification and be optimized for its cellulose, hemicellulose and lignin contents for maximum mushroom fruit bodies yield.

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Table 1: Number of fruits, width of pileus, length of stipe, full mycelia colonization and primordia initiation of *Pleurotus ostreatus var columbinus* on various treatments

Treatments	Number of fruits	Width of pileus (cm)	Length of stipe (cm)	Full mycelia colonization (Days)	Primordia initiation (Days)
Paper alone	5.67	8.33	6.33	16.00	26.33
P:SD (1:3)	13.00	8.33	4.80	26.00	29.69
P:SD (3:1)	6.67	9.90	5.23	18.67	24.00
P:SD (1:1)	8.00	7.23	6.77	22.67	26.67
Sawdust alone	8.00	7.53	6.07	25.00	29.00
LSD	2.23	1.54	0.72	2.53	26.33

P= Paper substrate SD= Sawdust substrate

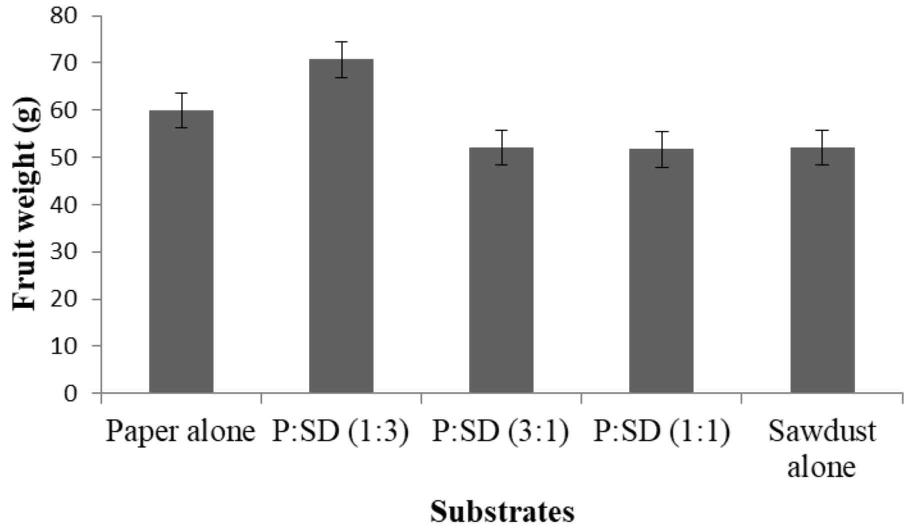
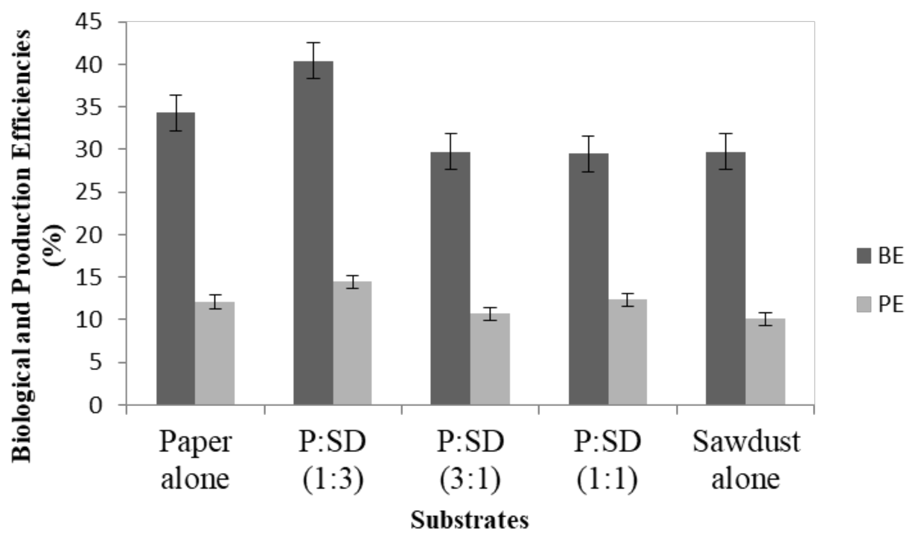


Figure 1: Harvested fruit weights of Blue mushroom (*Pleurotus ostreatus var columbinus*) on various treatments



BE= Biological Efficiency PE= Production Efficiency

Figure 2: Biological and Production Efficiencies of Blue mushroom (*Pleurotus ostreatus var columbinus*) on various treatments

GROWING MEDIA EFFECTS ON SEED GERMINATION AND SEEDLING GROWTH OF *Lycopersicum lycopersicum*

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ABSTRACT
An experiment was carried out in the screen house of the National Horticultural Research Institute, Ibadan Nigeria. The study was carried out to determine the effect of different growth media on the seed germination and seedling growth of tomato (Lycopersicum lycopersicum L.). Viable seed of tomato were planted in different growth media: T1: coco peat, T2: coco peat and topsoil (1:1), T3: spent mushroom compost, T4: spent mushroom compost and topsoil (1:1), T5: sawdust, T6: sawdust and topsoil (1:1), T7: rice husk, T8: rice husk and topsoil (1:1) and T9: sole topsoil (control). Data were obtained on the number of leaves, plant height, stem girth and at the termination of the experiment, data on root length, fresh and dry weight were observed. It was observed that the growth media with sole cocopeat has the highest plant height (7.01 cm) and was significantly different from other treatments while the least plant height of 3.20 cm was observed in rice husk treatment.
Keywords*: Growing media, Lycopersicum lycopersicum L., seed germination, seedling growth*

INTRODUCTION

Tomato *Lycopersicum lycopersicum* L., holds a preeminent position as the most widely consumed vegetable worldwide. Its popularity stems from its ubiquitous presence as a fundamental ingredient in an extensive array of dishes, whether consumed raw, cooked, or processed. Belonging to the Solanaceae family, which encompasses various commercially significant species, the tomato is a staple crop cultivated globally for both local consumption and export purposes. In 2014, the global cultivation of tomatoes encompassed an expansive 5 million hectares of land, yielding a bountiful production of 171 million tonnes. Among the major tomato-producing nations, the People's Republic of China (hereafter referred to as "China") and India played pivotal roles in contributing to this substantial production (FAOSTAT, 2017). The versatility of tomato cultivation is evident in its ability to thrive in diverse geographical zones, whether in open fields or controlled environments such as greenhouses. Harvesting of tomatoes can be achieved through manual labor or mechanized means. While under specific conditions such as rejuvenation pruning, weeding, irrigation, and frost protection, the tomato plant can exhibit perennial or semi-perennial characteristics, it is predominantly regarded as an annual crop in commercial agriculture (Geisenberg and Stewart, 1986).

The concentration of tomatoes fluctuates as the fruit undergoes the maturation process, a feature that significantly contributes to the taxonomy of this species. This aspect proves invaluable in the domain of crop breeding for cultivated tomatoes, as recognized by esteemed bodies such as the Organisation for Economic Co-operation and Development (OECD, 2008), and researchers like Spooner, Anderson, and Jansen (1993). The nutritional profile of tomatoes is enriched with lycopene, a potent antioxidant and carotenoid, renowned for its ability to protect cells against oxidants associated with cancer development. Categorized as a climacteric fruit, the tomato exhibits a unique ripening process characterized by an escalation in both respiration and ethylene production as it matures. Understanding these physiological intricacies is critical for optimizing harvesting and storage practices.

In the context of plant cultivation, the term 'growth medium' pertains to the material employed in containers to nurture plants. It could be a solid, liquid, or semi-solid substrate specifically designed to sustain the growth of a population of microorganisms or cells, including small plants like moss (Physcomitrella patens). Different types of growth media are tailored to suit the needs of diverse plant species. Modern cultivation practices have also embraced "soilless culture," a system where plants are grown without traditional soil in situ (Gruda, 2009). In these systems, solid rooting media, often referred to as "growing media" or "substrates," play a pivotal role. These materials serve as a surrogate for soil, offering essential anchorage for the root system, supplying water and nutrients to the plant, and ensuring adequate aeration in the root zone (Gruda et al., 2006).
The choice of growth medium emerges as a critical factor influencing seedling quality in nursery settings (Baiyeri and Mbah, 2006). It acts as a reservoir for essential nutrients and moisture (Grower, 1987). Effective management of growth media is deemed vital in ensuring the production of high-quality seedlings capable of withstanding seasonal challenges encountered in the field (Khan et al., 2006). While numerous organic materials can be utilized as constituents of growth media, only a limited subset has been thoroughly investigated. This research seeks to evaluate sustainable practices for cultivating selected vegetable crops in nurseries through the utilization of different growth media.

MATERIALS AND METHODS

The experiment was set up during the rainy season between June and August 2023. The experiment was laid out in CRBD with seven (7) treatments replicated twice. The crops were tomato and pepper. The media were cocopeat (CB), cocopeat and topsoil (CBTS), spent mushroom (SM), spent mushroom and topsoil (SMTS), sawdust (SD), sawdust and topsoil (SDTS) and topsoil. The growth media were measured in 2kg for sole media (spent mushroom, cocopeat, and sawdust) properly mixed with water and evenly spread on a planting tray while other combined media were measured in a ratio 2:1 (2kg of the media mixed with 1kg of topsoil) evenly mixed. The seeds were evenly planted in the trays of media. 50 seeds of tomato and pepper were planted in the media. Emergence data were taken on all the crops with respect to the growth medium starting from 4 days after planting, and at 2 weeks after planting (2WAP), agronomy data were taken on all the crops for a period of 3weeks after which destructive samples were also taken for further analysis.

RESULTS AND DISCUSSION

Table 1 shows the vegetative growth parameters of the tomato seedlings with respect to the different sowing media. It is observed that the growth media with sole cocopeat has the highest plant height (7.01 cm) and was significantly different from the height in coco peat and topsoil; spent mushroom compost and topsoil (1:1). The least plant height of 3.20 cm was observed in rice husk treatment. The highest stem girth of 1.7 mm was observed in rice husk and topsoil treatment at ratio 1:1 and it was significantly higher than other treatments. The least stem girth was observed in sawdust treatment.

Table 1: Vegetative growth of *Lycopersicum lycopersicum* (Ibadan local) in response to different growth media at five weeks after sowing

	Tomato (Ibadan Local)	
	Plant Height (cm)	Stem Girth (mm)
Treatments	5 weeks after sowing	
T1	7.01	1.1
T2	6.17	1.2
T3	5.98	1.1
T4	6.05	1.2
T5	3.33	0.6
T6	5.00	0.9
T7	3.20	0.7
T8	5.23	1.7

T9	4.90	0.9
$LSD_{0.05}$	0.64	0.23

T1: coco peat, T2: coco peat and topsoil (1:1), T3: spent mushroom compost, T4: spent mushroom compost and topsoil (1:1), T5: sawdust, T6: sawdust and topsoil (1:1), T7: rice husk, T8: rice husk and topsoil (1:1) and T9: sole topsoil (control)

CONCLUSION

From the results, it can be concluded that cocopeat is a good media for the growth of *Lycopersicum lycopersicum*: however, rice husk and topsoil treatment in 1;1 ratio support healthy stem girth in the seedling growth.

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EFFECT OF DIFFERENT GROWTH MEDIA ON GERMINATION AND GROWTH OF QUEEN PALMS

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ABSTRACT
This study was conducted to determine the effect of different growth media and he germination and growth of queen palm (Syagrus romanzoffiana), the most popular ornamental palm in Nigeria. Different growth media and their combinations were used, which include: Topsoil + Manure (1:3), Topsoil + Manure (2:2), Topsoil + Manure (3:1), Topsoil + Sawdust (1:3), Topsoil + Manure (2:2), Topsoil + Manure (3:1), manure alone, sawdust alone, and topsoil alone as the control. Results obtained showed that Topsoil + sawdust (3:1) produced 100% of germinated seeds while Topsoil + manure (1:3) produced significantly higher palm heights (32.17cm), fresh shoot weight (5.43g), fresh root weight (2.53g) and dry shoot weight (3.11g). Palms grown with manure produced the highest dry root weight.
Keywords: *Queen palms, groth media, seed germination, manure, sawdust*

INTRODUCTION

Queen palm (*Syagrus romanzoffiana*) is a popular ornamental palm tree species popularly used in landscaping and garden designs in Nigeria. Queen palms are known for their graceful, feather-like fronds, which can reach lengths of up to 3 m. They have a slender trunk that can grow up to 12 m tall and is usually topped with a symmetrical crown of fronds. Queen Palms are native to South America but have become popular ornamental trees in various parts of the world, including Nigeria, where they are commonly used in landscaping. **They** are known for their tolerance of a wide range of soil types and their ability to withstand drought conditions once established. They thrive in tropical and subtropical climates. It also has ecological importance due to its sweet fruits and being consumed by parrots and other animals (Laindorf *et al*., 2018; Weirich Neto *et al*., 2020). It is easily adapted to different types of soils and climates.

Growth media play a crucial role in determining the germination and subsequent growth of queen's palm (Salamat *et al*., 2019; Junior *et al*., 2013). Several growth media including soil, peat moss, vermiculite, and their combinations has been reported to impact the germination and growth of queen palms (Al-Khayri and Naik, 2017). These authors reported that choice of growth media significantly influenced the germination rate and subsequent growth of queen palm. Different growth media have varying properties, including water-holding capacity, aeration, and nutrient content, which has some impact on germination rate and subsequent growth, vigour, and sustenance of plants (Nath & Singh, 2012; Mir *et al*., 2021). The objective of this study is to determine the effect of different growth media on the germination and growth of queen palms.

MATERIALS AND METHODS

Ripe, matured, sorted seeds of queen palms were collected from the Floriculture Garden, National Horticultural Research Institute, NIHORT, (7˚25″N and 3˚52″E) Ibadan, Nigeria. The seeds were pregerminated by soaking for two weeks in water. The water was drained every other until two weeks and then, the seeds were de-pulped, washed and soaked in 2% sodium hypochlorite for 1 hour, thereafter, rinsed in running water for 5 minutes. After pre germination treatment, the seeds were selected and used for germination and growth experiment. Growth media used in the study was Topsoil + Manure (1:3), Topsoil + Manure (2:2), Topsoil + Manure (3:1), Topsoil + Sawdust (1:3), Topsoil + Manure (2:2), Topsoil + Manure (3:1), manure alone, sawdust alone, and topsoil alone as the control. Growth media were measured into jute bags (20L each on volume basis) and arranged in a completely randomized design with five replicates.

Queen palm seeds were selected based on good appearance and colour. Twenty seeds were planted in each media and monitored for germination. Agronomic practices were maintained, and the pots watered at least three times every week to field capacity. Data taken include the number seeds, the heights of seedlings, the number of leaves, the shoot fresh shoot and root weights and the dry shoot and root weights. Data were collected from 3 weeks after planting with the emergence of the plumule. Data collection was done every two weeks after emergence. Data collected were analyzed using SAS 2000 software, mean separation was by the least significant difference.

RESULTS AND DISCUSSION

Highest germination percentage (100%) was produced with the use of Topsoil + sawdust (3:1) after 7 weeks (Table 1), which was significantly from the germination percentage obtained with the use of manure (61.25%). Apart from Topsoil alone, Topsoil + sawdust (3:1) had significantly higher germination percentage than the other growth media. Use of this growth media could be explored in palm seedlings nursery. Other authors reported a 1:1 mixture by volume of peat moss and perlite for palm seeds germination (Meerow and Broschat, 2017). Furthermore, Topsoil + manure (1:3) produced the highest heights of palms. This could be adduced to the presence of manure in the media. Shokalu *et al* (2021) also reported that growth attributes of pines were improved with organic soil amendments. The fresh shoot weight (5.43g), fresh root weight (2.53g) and dry shoot weight (3.11g) was also obtained with the use of Topsoil + manure (1:3) while manure grown seeds had the highest dry root weight (1.64g). This could be attributed to the environment being favourable to root initiation of the queen palms.

CONCLUSIONS

The germination and growth queen palms were enhanced with the use of different growth media. Results obtained showed that Topsoil + sawdust (3:1) has great potentials in its use for germination of ornamental palms seedlings, while Topsoil + manure (1:3) and manure has great potentials in the provision of proper growth and establishment of the palms seedlings. It is recommended that further studies be carried out to verify and validate the value results obtained in this study.

Table 1: Effect of different growth media on number of germinated seeds and height of queen palms

	Number of Seeds germinated			Height of Germinated Plants (cm)					
	5	6	7	5	6	7	8	9	10
Growth media	Weeks after planting			Weeks after planting					
Topsoil + manure (1:3)	11.50	16.25	16.75	9.76	14.98	16.81	19.78	24.22	32.17
Topsoil + manure (2:2)	11.50	14.50	14.25	7.49	14.98	15.06	19.94	23.59	30.72
Topsoil + manure (3:1)	13.75	16.00	16.75	8.46	15.06	16.01	19.63	25.81	31.41
Topsoil + sawdust (1:3)	12.00	16.75	17.00	7.73	16.03	16.06	20.16	24.54	30.86
Topsoil + sawdust (2:2)	13.75	14.00	18.75	7.88	14.50	14.50	18.88	19.54	28.73
Topsoil + sawdust (3:1)	18.25	17.50	20.00	6.96	12.65	12.65	16.94	22.33	28.78
Manure	11.50	12.25	11.00	10.08	16.01	16.81	19.09	21.66	31.19
Sawdust	16.00	15.50	18.50	7.16	13.01	13.01	17.23	22.64	31.55
Topsoil	16.50	17.50	19.75	9.42	14.24	14.50	19.22	23.4	30.95
LSD	6.258	5.344	4.23	2.167	2.415	2.415	4.065	3.857	3.387

Table 2: Effect of different growth media on number of fresh and dry shoot and root weights of queen palms (g)

Growth Media	Fresh Shoot weight	Fresh root weight	Dry shoot weight	Dry Root weight

Topsoil + manure (1:3)	5.43	2.53	3.11	1.26
Topsoil + manure (2:2)	3.05	1.15	2.94	1.38
Topsoil + manure (3:1)	3.97	2.46	2.63	1.59
Topsoil + sawdust (1:3)	2.72	1.68	2.31	1.41
Topsoil + sawdust (2:2)	3.13	2.08	2.17	1.49
Topsoil + sawdust (3:1)	4.03	2.41	2.34	1.35
Manure	2.94	1.43	2.77	1.64
Sawdust	2.72	2.19	1.95	1.44
Topsoil	3.23	2.01	2.97	1.15
LSD	1.50	0.99	0.655	0.305

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FIELD EVALUATION OF TEN EGGPLANT (*Solanum gilo*) ACCESSIONS FOR GROWTH, YIELD AND REACTION TO VIRUSES.

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ABSTRACT

Eggplant is a fruit or leafy vegetable crop cultivated for food and medicinal purpose. Viral Diseases impose significant constraints on both yield and quality of eggplant production. A field trial conducted at the research farm of the National Horticultural Research Institute, Ibadan, Nigeria in 2021 cropping season to evaluate the virus disease response, growth and yield of 10 eggplant accessions. The experiment was laid out in a randomized complete block design and replicated three times. Data on virus disease incidence and severity, plant height (cm), were collected bi-weekly, after transplanting (WAT), Data on fruit yield were collected. The data was analyzed using analysis of variance (ANOVA) and means were separated using the Duncan Multiple Range Test (DMRT). The disease incidence at 8 WAT for accession V9 (10.0%) and V1 (23.3%) were significantly lower (p<0.05) than the other varieties, disease severity in accession V1 (2.00), V8 (2.00) and V9 (1.33) at 8 WAT were also significantly lower (p<0.05) than the other varieties. Accession V1, V8 and V9 significantly (p>0.05) had the taller plants (47.10cm, 45.30cm and 44.74cm) while V2 had the least plant height (28.3cm). The highest fruit yield was obtained from accession V1 (55.33 t/ha) followed by V9 (36.900 t/ha) and V8 (32.83 t/ha) respectively which were significantly (p>0.05) higher than accession V2 (13.23 t/ha) that produced the least fruits. The study concluded that since accession V1, V8 and V9 had reduce virus incidence, severity and gave better fruit yield of eggplant, this has given more insight which will be helpful for national breeding for virus resistance in eggplant.

Keyword: *Virus, Disease incidence, Disease severity, Accession.*

INTRODUCTION

Eggplant (*Solanum gilo*) is a very important vegetable crop in Nigeria especially in the eastern part of Nigeria which has developed a high popularity and has become one of the most consumed vegetables. Eggplant is of significant importance to the culture and tradition of the locals in the Eastern part of Nigerian (Onuoha, 2005). The crop is mainly cultivated for food, medicine and represents the main source of income for many rural household in Nigeria. Eggplant are perennial crop but are grown commercially as an annual crop and thrive well in rich, deep, well drained, sandy loamy soils. It is well adapted to the tropical climate (Rao and Subramanian 1994.). Eggplant is a very good source of dietary fibre, potassium, copper, small amounts of protein, vitamins (vitamin B and C), minerals, starch and other nutrients. The leaves are excellent sources of vitamins A and B (particularly riboflavin), calcium, phosphorous, and iron (USDA, 2009). Most small scale farmers are dependent on the production of the fruits and leafy vegetable as means of livelihood and income generation. Eggplant is exposed to many pathogens, including threatening fungi, bacteria and viruses (Beemster and Rozendaal, 1972; Hanˇcinský *et al*., 2020).

Plant viruses are among the principal disease-inducing agents affecting crop as they are transmitted through vegetative propagation, by contact between infected and healthy plants and by different vectors, including insects and nematodes (Banttari *et al*., 1993). Some of these viruses, such as the *Cucumber mosaic virus* CMV, (Bagewadi *et al*., 2015), *Tomato spotted wilt virus* TSWV, (Kamberoglu and

Caliskan, 2009) and *Eggplant mottled dwarf virus* EMDV, (Martelli 1969). Despite its importance, eggplant farmers face several adverse conditions in growing the crop throughout the tropics on a large scale due to its susceptibility to a large number of pathogens. Among the factors responsible for low yield of eggplant, viral diseases are considered to be the most serious, preventing the crop from achieving it genetic potentials (Fajinmi *et al.*, 2012). Studying the impact of *these* viruses on the growth and yield of eggplants will help to determine to what extent the damage done by this virus and also to justify the need to invest on the control measures. Hence the objective of this study was to determine the growth and yield response of 10 accessions of eggplant to viruses.

MATERIALS AND METHODS

The trial was conducted at the experimental field of National Horticultural Research Institute, Ibadan, Nigeria during the planting seasons (June to September) of 2021. The genetic materials comprised of 10 eggplant variety was obtained from the seed unit of National Horticultural Research Institute. These varieties are new purified lines developed from two cycles of selfing and selection from eggplant germplasm collected from farmers` field in South Western Nigeria. Seeds used in this study were derived from seeds harvested from selected individual segregants from earlier generations having farmers preferred traits such as high number of fruits per plant, intermediate plant height with appropriate fruit size and shape.

The experimental design was randomized complete block design and replicated three times. The eggplant seeds were sown in bowls filled with sterilized top soil, kept in an insect-free and insect screened cages in the nursery for 6 weeks. The seedlings were transplanted to the field.

Data Collected

Disease evaluation

The disease incidence (DI) was calculated as the number of plants showing virus symptoms expressed as a percentage of the total number of plants in the plot using the formula below,

Where;

$$\text{Disease incidence (\%)} = \frac{\text{Number of infected plants}}{\text{Total no of plant sampled}} \times 100$$

Virus Severity

This was determined from the 2nd to 8th week after transplanting. The disease severity of the virus was determined using a disease severity scale based developed by Arogundade *et al.*, (2012) and Ayo-John *et al.*, (2012): where; 1= no visible symptoms, 2= mild symptoms (less than 10% of total leaves) such as mosaic, mottling, yellowing, vein banding or necrosis, 3= moderate symptoms greater than 10% but less than 50%, 4= severe symptoms greater than 50% but less than 75% accompanied with reduced leaf lamina or distortion, 5= severe symptoms greater than 75% plus leaf distortion and general stunting of the plant.

Growth parameters measured

Data on growth parameters was taken bi-weekly from 2 to 8 weeks. The collected data were on (i) Plant height, by measure plant height from soil level to the apex (ii) the yield data.

Statistical analysis

All data collected were subjected to analysis of variance (ANOVA) and means were separated using the Duncan Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Virus disease incidence of 10 eggplant accessions

The performances of ten accessions of the eggplant to viruses on the disease incidence showed that, at 2 WAT there was no significant difference ($P \geq 0.05$) among the accessions (Table 1). At 4 WAT V1, V8 and V9 had significantly ($P \leq 0.05$) lower virus incidence ratings of 4.2%, 8.4% and 4.2% respectively than other accessions. The same trend was observed at 6 WAT and 8 WAT where V1, V8 and V9 disease incidence ratings were 12.5%, 10.5%, 8.4% and 23.3%, 25.5%, 10.0% respectively compared to other accessions (Table 1).

Virus disease severity of 10 eggplant accessions

At 2 and 4 WAT there were no significant difference (P≥0.05) among the all the accessions (Table 1). Disease severity significantly varied at 6 WAT where the highest disease severity was recorded in V5, V6, V7 and V10 with a score of 3, 3, 3 and 3 respectively. Disease severity at 8 WAT in V5 and V7 was 4 and 5 respectively having the highest disease severity, while V1, V8 and V9 were all significantly (p≤0.05) lower in disease severity with 2, 2 and 1. (Table 1).

Plant height of 10 eggplant accessions response to virus

The performance of ten accessions of eggplant on plant height showed that, there were no significant difference (P≥ 0.05) among the accessions at 2 WAT. At 4 WAT the trend was the same but at 6 WAT the V2 recorded the lowest plant height 13.4 cm. At 8 WAT there was significant difference among the accessions where V1, V8 and V9 had the highest plant height of 48.8 cm, 47.1 cm and 45.3 cm respectively (Table 2).

Effect of virus on the yield/ha parameters on eggplant

The number of fruits produced showed that there was significant difference (p≥0.05) among the accessions in eggplant fruits. The V2, V5 and V7 produced the lowest number of fruits with (13.2 kg), (14.3 kg) and (17.9 kg) respectively (Table 2). However, V1, V8 and V9 gave the highest fruit yield (55.3 kg, 32.8 kg and 36.9 kg respectively). (Table 2).

Table 1: Virus disease incidence and Virus disease severity of 10 eggplant accession

Accessions	Virus disease incidence %				Virus disease severity			
	2WAT	4WAT	6WAT	8WAT	2WAT	4WAT	6WAT	8WAT
V1	0.0a	4.2a	12.5a	23.3a	0.0a	0.0a	0.68a	2.00a
V2	0.0a	10.5b	25.4b	38.3b	0.0a	1.00a	2.00b	4.21bc
V3	0.0a	14.8b	25.7b	32.1b	0.0a	1.00a	2.00b	3.31b
V4	0.0a	10.4b	28.8b	38.5b	0.0a	1.00a	2.00b	3.33b
V5	0.0a	18.8b	20.5b	41.7bc	0.0a	1.38a	3.00c	4.11bc
V6	0.0a	19.1b	27.8b	40.5bc	0.0a	1.33a	3.00c	3.67bc
V7	0.0a	12.5b	24.7b	42.1bc	0.0a	1.00a	3.00c	5.00c
V8	0.0a	8.4a	10.5a	25.4a	0.0a	0.68a	1.00a	2.00a
V9	0.0a	4.2a	8.4a	10.0a	0.0a	0.0a	1.44a	1.33a
V10	0.0a	10.5b	27.1b	38.3b	0.0a	1.33a	3.00c	3.00b

Means within each column followed by the same letter(s) are not significantly different at P≤0.05 using the Duncan Multiple Range Test (DMRT). WAT=Weeks after transplanting

Table 2: Effect of virus on growth and yield parameters of ten accessions on eggplant

	Plant height (cm)				Yield of fruits/plot (kg)
Accessions	2WAT	4WAT	6WAT	8WAT	
V1	9.2a	15.5a	30.1a	48.8a	55.33a
V2	5.3a	10.2a	13.4b	28.3b	13.2b
V3	8.1a	12.0a	16.5b	30.1ab	20.0b
V4	7.2a	14.6a	20.5ab	35.2ab	28.1b
V5	7.6a	11.5a	19.3b	30.3ab	14.3b
V6	8.1a	12.2a	17.8b	29.5b	26.0b
V7	7.5a	11.8a	20.0ab	31.2ab	17.9b
V8	10.0a	16.5a	33.3a	47.1a	32.8a
V9	9.2a	18.5a	29.5a	45.3a	36.9a
V10	8.0a	15.3a	22.5ab	33.5ab	21.0b

Means within each column followed by the same letter(s) are not significantly different at P≤0.05 using the Duncan Multiple Range Test (DMRT). WAT=Weeks after transplanting

DISCUSSION

The eggplant varieties exhibited virus symptoms such as mosaic, mottling, vein clearing, stunted plants, fruit deformation and leave curl. Similar observations of these were made by Achiangia *et al*. (2013) on pepper varieties sampled in the Western highlands of Cameroon. Viral symptoms are thought to be spread by aphids as a result of their feeding activities. The result showed that lower disease incidence have significant relationship with yield of crop in any environment and this correspond positively with the findings of Kumar *et al*. (2014), Awasthi *et al*. (2014) and Sharma *et al*. (2017). The virus severity has been found to have a variable effect on crop yield potential, because of the damage caused on the plant and probably the loss of the crop. Disease severity enhance fruit yield, because the higher the proportion of plants with greater disease severity, the greater the expected yield loss. This showed that crop loss was a function of severity of diseased plants and this correspond with the findings of Assabgui and Hall (2016).

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EVALUATION OF EIGHT BAMBARA GROUNDNUT (*Vigna subterranea* (L.) Verdcourt) ACCESSIONS FOR AGRONOMIC CHARACTERS AND PROXIMATE COMPOSITION IN UYO, AKWA IBOM STATE, NIGERIA

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ABSTRACT
Bambara groundnut (Vigna subterranea [L.] Verdc.) is a valuable but underutilised legume crop grown in sub-Saharan Africa. The objective of this study was to evaluate the yield and yield components of eight Bambara groundnut accessions obtained from the National Root Crops Research Institute in Umudike, Nigeria. The experiment was conducted at the Teaching and Research farm of the University of Uyo, Uyo Southern Nigeria during the 2021cropping seasons, using a randomised complete block design with three replications. Growth, yield and nutritional parameters were collected and subjected to analysis of variance, correlation and principal component analysis. Plant height, number of leaves, and leaf area were all significantly different (P<0.05) among the accessions three months after planting. Number of pods per plant, seed weight, and 100-seed weight differed significantly (P<0.05). Caly PSC (2853 kg/ha), Caly SK 46 (2803 kg/ha), Zeina (2538 kg/ha), and BNT (2488 kg/ha) were the top yielders among the accessions. Yields of Bambara groundnut differ significantly (P<0.05) between accessions studied, ranging from 1624.67 kg/ha to 2853.33 kg/ha. Principal component (PC) analysis identified eight influential components, two of which, PC1 and PC3, contributed 27% and 17% of the total variation, respectively. In this study, the correlation analysis revealed that plant height and petiole length, plant height and number of seeds per plot were all negatively correlated. The leaf area and the number of pods per plot, the number of seeds per pod and the fibre content, the leaf area and seed weight, and the plant height and seed weight were all positively correlated. The nutritive value of the eight Bambara groundnut accessions varied significantly (P<0.05). The mean protein levels of eight Bambara nut accessions studied ranged from 18.82 to 20.39%. Findings from this study clearly indicate that Bambara groundnut is suitable for production in Uyo, Akwa Ibom State. High yielding accessions identified in this study are recommended for increased production in Akwa Ibom State
***Keywords**: Accessions, Bambara groundnut, Proximate, Yield, Uyo*

INTRODUCTION

The Bambara groundnut (*Vigna subterranea* (L. Verdc) belongs to the *leguminosae* family and has been believed to have originated in the Sahel region, which is now West Africa. Bambara groundnut is a staple food in some semi-arid regions of Africa (Gonné *et al.,* 2013). It is an underutilised food legume (Azam-Ali *et al.,* 2001) that plays an important role in initiatives to maintain food security in Sub-Saharan Africa (Koné *et al.,* 2015). Bambara groundnut is an herbaceous, short-leaved annual crop plant that grows to a height of about 15 cm and has numerous nitrogen-fixing nodules on the roots that help to improve the soil (Yakubu *et al.,* 2010). Its edible seeds are high in calories, vitamins, and vegetable proteins (Minka and Bruneteau, 2000). In addition to nutritional benefits, the roots, leaves, and seeds are used in traditional medicine (Maphosa and Jideani, 2016). This leguminous crop is well adapted to the tropics and can thrive in a variety of environmental conditions, including marginal soils where other leguminous crops cannot be grown (Abejide *et al.,* 2017). Bambara groundnut cultivation has declined in Nigeria's Sahel and Sudan Savannah zones over the last 20 years. Bambara groundnut contains a substantial supply of minerals such as phosphorous, calcium, zinc, and iron, enabling it to be a complete diet and people can easily survive by feeding specifically on Bambara groundnut diet or providing all of their nutritional requirements. Bambara is used to make a variety of dishes, including a local dish known as 'okpa' in Nigeria (Oluwole and Oluremi, 2012). The seed contains approximately 24% protein, 64% carbohydrates (53% starch, 10% dietary fibre), and 6% total fat, providing nutrition and a balanced diet for humans (Azman *et al*., 2019). However, one of the drawbacks of most underutilized and neglected crop species, including Bambara groundnut, is a lack of established breeding programmes; as a result, landraces of Bambara groundnut have remained the primary source of planting materials used by farmers (Mayes *et al.,* 2015). Despite the vast genetic diversity of Bambara groundnuts, Akwa Ibom State has not fully utilized this unique resource in terms of variety selection and development. It is necessary to assess its yield potential in Akwa Ibom State and determine the nutrient quantities of the selected accessions. This study will make a significant contribution by identifying high yielding Bambara groundnut accessions that are adaptable to Akwa Ibom State for increased production in Akwa Ibom State.

MATERIALS AND METHODS

Experimental site

The experiment was conducted at the Teaching and Research farm of the University of Uyo, Uyo Southern Nigeria during the 2021cropping seasons. Uyo lies between latitude 15^o 02′ North and longitude 07^{o}56′ East of the Greenwich meridian and altitude 38m above sea level. It is located in the humid high rainfall area of Southern Nigeria, with an annual rainfall of over 2500mm and an average daily sunshine of 3 hours 31 minutes. Throughout the year, the temperature ranges from 23^{o}C to 34^{o}C. (Ndaeyo, 2003).

Plant materials, field layout and data analysis

Three replications of each treatment were used in the randomised complete block design (RCBD) of the field experiment. Eight accessions of Bambara nuts were obtained from the National Root Crops Research Institute in Umudike: Zeina 22, Regal green 27, Caly SK 144, BNT 89, Caly PSC 6, Caly SK 46, SDR 21 and Caly 4. Each replication was divided into 9m^2 plots (3m x 3m). Each block had 8 plots, and twenty-four seeds were sowed in each plot to a depth of 5 cm. There were 30 cm between seeding locations. Data were collected on various agro-morphological parameters from the five (5) plants in the middle of each plot and the growth and harvest stages served as the basis for the evaluation and. Data collected were subjected to Analysis of Variance (ANOVA) and the means were separated using the Least Significant Difference (LSD) test at a 5% level of significance.

Sample collection

Mature and dried *Vigna subterranean* (L.) Verdc seeds used for this study were harvested from the experimental site, dried in the sun, carefully removed from their hulls, ground into powder using a mortar and pestle, and stored in a plastic bag ready for analysis.

Proximate composition

The moisture content was determined by drying 5 g of powdered sample to constant weight in a 105 ^{o}C oven. The moisture content of the seed was calculated as the difference in weight between before and after drying (AOAC, 2006). Ceirwyn (1998) described a method for determining ash content that involved dry ashing in a muffle furnace at 600 ^{o}C until greyish white ash was obtained. According to the AOAC (2006) method, crude lipid content was determined using a soxhlet apparatus and n-hexane as the solvent. The crude protein of the sample was calculated by multiplying the value obtained from Kjeldahl's nitrogen analysis by a protein factor of 6.25 (AOAC, 2006). Available carbohydrate was calculated by subtracting the sum of the percentages of ash, crude lipid, crude protein, and crude fibre from 100%. The calorific value was calculated using the equation described by Asibey-Berko and Taye (1999).

$$Available\ Carbohydrate\ (\%) = 100 - (\%\ ash + \%\ protein + \%\ lipid\ \%\ fibre)$$

$$Energy\ (kcal/100g) = (crude\ protein\ x\ 2.44) + (crude\ lipid\ x\ 8.37) + (available\ carbohydrate\ x\ 3.57)$$

RESULTS AND DISCUSSION

Variation among growth characters of eight Bambara groundnut accessions

Table 1 shows the mean values of various growth parameters for the eight Bambara groundnut accessions three (3) months after planting. The results in Table 1 indicate that plant height, number of leaves, and leaf area differed significantly (P≤ 0.05) among the eight accessions, but petiole length did not. The tallest plant was Caly SK 144 (56.50 cm), followed by BNT 89 (39.00 cm) and SDR 21 (37.80 cm). These three accessions had plant heights greater than the grand mean (37.52 cm), while Caly PSC had the shortest plant height (29.78 cm) at 3 MAP (Table 1). At 3 MAP, the number of leaves of the various accessions studied differed significantly. BNT 89 had the most leaves (533.40), followed by SDR 21 (37.80) and Caly PSC (449.80), while Caly SK 144 had the fewest leaves (171.00). The petiole length of the Bambara groundnut studied did not differ significantly at 3 MAP, as shown in Table 1. Caly 4 had the longest petiole length (2.90 cm), followed by Caly PSC (2.50 cm), and Regal green 27 had the shortest (2.04 cm). Table 1 also showed that the leaf area of the accessions studied varied significantly (P0.05) at 3 MAP. The leaf area's grand mean was 25.03 cm^2. SDR 22 had the largest leaf area (33.20 cm^2), followed by Caly 4 (27.40 cm^2), and Zeina 22 had the smallest leaf area (19.75 cm^2).

Table 1: Mean values of growth parameters of eight Bambara groundnut accessions at 3 MAP

Accessions	Plant Height	Number of leaves	Petiole Length	Leaf Area
SDR 21	37.80	498.80	2.30	33.20
Caly 4	36.20	432.25	2.90	27.40
Caly PSC	29.78	449.80	2.50	25.55
Caly SK 144	56.50	171.00	2.10	25.12
Grand mean	33.76	423.57	2.26	25.03
Regal green 27	32.50	410.60	2.04	24.30
Caly SK 46	34.38	432.00	2.10	24.20
BNT 89	39.00	533.40	2.20	20.68
Zeina 22	34.02	413.60	2.30	19.75
Grand mean	37.52	423.57	2.30	25.03
LSD (P≤ 0.05)	4.43	188.76	NS	7.42

Yield and yield related traits variation in eight Bambara groundnut accessions

The mean values of different yield parameters of eight Bambara groundnut accessions at harvest are shown in Table 2. The number of pods, weight of dried pods, seed weight, weight of 100 seeds, and dry matter of Bambara groundnut accessions differ significantly (P<0.05). There was a significant difference (P<0.05) in the number of pods per plant among the Bambara groundnut accessions. Caly SK 144 had the most pods per plant at harvest (110.00), followed by Zeina 22 (83.33) and SDR (77.33). Caly SK 46 produced the fewest pods per plant (66.33). At harvest, the weight of dried pods varies significantly among Bambara groundnut accessions. Caly 4 had the highest dried pod weight (115.33 g), followed by Caly SK 114 (111.00 g) and Caly SK 46 (103.00 g). Regal green had the smallest weight of dried pods (56.00 g). The yield (seed weight) of the Bambara groundnut accessions differed significantly (P<0.05). Caly PSC had the highest yield (2853.33 kg/ha), followed by Caly SK 46 (2803), Zeina 22 (2538.67 kg/ha), BNT 89 (2488.67 kg/ha), and SDR 21 (2357.33 kg/ha). The seed weights of these five accessions were greater than the grand mean (2331.00 kg/ha). Regal green had the lowest yield (1624.67 kg/ha). The weight of 100 seeds of the Bambara groundnut accessions differed significantly (P<0.05). Zeina 22 had the highest 100 seed weight (86.00 g), followed by Caly SK 46 (83.00 g) and Caly 4 (82.00g). Caly PSC had the lightest weight of 100 seeds (66.67 g). Table 2 also showed that there was a significant difference (P<0.05) in dry matter between Bambara groundnut accessions. Regal green had the highest dry matter

(128.00%), followed by Caly 4 (85.33%) and Caly PSC (84.00%). Caly SK 46 had the least dry matter (43.00%).

The objective of this study was to identify high yielding and stable Bambara groundnut accessions that are adaptable to Uyo production environments, as well as to determine the relationships between the traits (plant height, grain yield, hundred grain weight, leaf area, and petiole length). Plant growth traits (plant height, number of leaves, and leaf area) showed highly significant ($P< 0.05$) differences three months after planting. This demonstrates that the climatic conditions in the Uyo production environment were variable. Bambara groundnut grows best in climates with abundance of sunlight, high temperatures, and rain (Mabhaudhi and Modi, 2013). The yield in this study ranged from 1624.67 kg/ha to 2853.33 kg/ha, which was considerably higher than the yields reported by Unigwe *et al.* (2016) and Shegro *et al.* (2013). Their yields ranged from 9.90 to 126.03 kg/ha and from 13.33 to 191.73 kg/ha. This suggests that the Bambara groundnut genotypes used in this study were capable of adapting to the production environments in Uyo, Akwa Ibom State. Temperature, altitude, rainfall, soil type, and genetic constitution are all factors that influence Bambara groundnut growth (Shegro *et al*., 2013). According to Sagoe *et al.,* (2021), environmental conditions and genetic constitution are the two most important factors influencing crop yield performance. Among the accessions evaluated, four accessions; Caly PSC (2853 kg/ha), Caly SK 46 (2803 kg/ha), Zeina (2538 kg/ha) and BNT (2488 kg/ha) were top yielders. According to Ellah and Singh (2008), Nigeria has the highest Bambara groundnut yield potential of any African country, ranging between 500 and 2600 kg/ha. According to Unigwe *et al.* (2016), Bambara groundnut is very adaptable compared to other crops and grows well under harsh environmental conditions (high wind, heavy rain, and cold temperature), despite the fact that Uyo, Akwa Ibom State, is located in Nigeria's humid rainforest zone, which experiences seasonal heavy rain. In most crops, yield and other yield traits are reported to be highly influential parameters for crop improvement (Khan *et al*., 2020). Grain yields per hectare ranged from 115.34 kg/ha to 1446.67 kg/ha. Light, temperature, water, moisture, rainfall, soil texture, and nutrition are all environmental factors that affect plant growth (Mabhaudhi and Modi, 2013). Berchie *et al.* (2010) reported pod and seed yields of 4173.05 and 3084.43 kg/ha, respectively, in Ghana. Researchers have found significant variation in grain yield and other traits among landraces (Alake *et al.,* 2015). This suggests that Bambara groundnut grown in Uyo, Akwa Ibom State, can produce high yields. There was a significant difference in hundred seed weight among the accessions in this study. In this study, the 100-seed weight ranged from 66.67 to 86.00 g. According to Akpalu *et al.* (2012), these findings demonstrate the significance of seed quality in determining seed yield. Seed size can be used to predict seed vigour, which is a component of seed quality (Mandizvo and Odindo, 2019). In the evaluation of morphological traits, hundred seed weight has been cited as an important yield enhancing trait (Unigwe *et al.* 2016). It is an important yield measure and an appropriate indicator for observing the tradition of quantitative traits influenced by genotype and environment (Rogé *et al.,* 2016). Interestingly, phenotypic variation among genotypes was significant in the study, indicating that accessions had high genetic diversity for the traits of interest.

Table 2: Mean values for yield characters of the eight accessions of Bambara groundnut

Parameters	Number of pods per plant	Weight of dried pods	Seed weight (kg/ha)	100 seeds weight	Dry matter
Zeina 22	83.33	81.00	2538.67	86.00	63.33
Caly SK 46	66.33	103.00	2803.33	83.00	43.00
Caly 4	69.67	115.33	1674.67	82.00	85.33
Caly SK 144	110.00	111.00	2307.33	80.00	45.67
SDR 21	77.33	76.33	2357.33	78.00	45.33
Grand mean	78.13	88.92	2331.00	76.83	68.42
BNT 89	74.33	67.33	2488.67	72.00	52.67
Regal green 27	73.00	56.00	1624.67	67.00	128.00
Caly PSC	71.00	101.33	2853.33	66.67	84.00
LSD ($P\leq 0.05$)	37.64	48.07	1045.52	7.59	35.50

Nutritional qualities of Bambara groundnut accessions

The results presented in Table 3 show the proximate analysis of Bambara groundnut accessions. Table 3 shows that the proximate composition of the eight Bambara groundnut accessions tested differed significantly (P<0.05). Table 3 shows that there was a significant difference (P<0.05) in the moisture content of the Bambara groundnut accessions. Regal green 27 had the highest moisture content (7.91%), closely followed by Caly SK 46 (7.80%) and Caly SK 144 (7.58%). BNT recorded the lowest moisture content (6.39%). Furthermore, there was a significant difference (P<0.05) in the crude fat content of the Bambara groundnut accessions. SDR 21 had the highest crude fat content (6.60%), followed by Caly SK 144 (6.48%), and Regal green (6.38%). Caly SK 46 had the lowest crude fat content (5.80%). The crude fibre of the Bambara groundnut accessions differed significantly (P<0.05). SDR 21 had the highest crude fibre content (5.59%), followed by BNT 89 (5.48%) and Caly PSC (5.42%). Caly SK 46 had the lowest crude fibre content (4.60%). The total ash of the Bambara groundnut accessions differed significantly (P<0.05). BNT 89 had the highest ash content (3.92%), followed by Caly 4 (3.88%) and Caly PSC (3.82%). SDR 21 had the lowest total ash content (3.51%). The protein content of the Bambara groundnut accessions differed significantly (P<0.05). Caly PSC had the highest protein content (20.39%), followed by SDR 21 (20.21%) and BNT 29 (19.87%). Caly SK 46 had the lowest protein content (18.29%). The available carbohydrate of the Bambara groundnut accessions differed significantly (P0.05). Caly SK 46 had the highest available carbohydrate content (60.24%), followed by Zeina 22 (59.62%) and Caly 4 (59.49%). Caly PSC 6 had the least available carbohydrate (56.81%). The current study examined into the variations in the proximate analysis of Bambara groundnut seed during the rainy season. The nutritive value of the eight Bambara groundnut accessions differed significantly. These findings were similar to those reported by Abdalla Saleem *et al*. (2012) when investigating the nutritive value of three Grewia species' leaves and fruits. The proximate and mineral results clearly show the potential of Bambara groundnut as a source of scarce nutrients such as protein. Under proper management, location, and planting season, Bambara groundnut protein content can reach 24. 02%, which compares favourably with that reported for more conventional legumes such as faba beans (Musalam *et al.,* 2004), but is higher than the records of Nworgu (2004) which was 18.3%, Aletor and Omodara (1994) which was 10.4%. The protein content of the Bambara groundnut seed investigated in this study ranged from 18% to 20%, which was higher than the 7% minimum crude protein level required for optimum rumen function (van Soest, 1994; Fasakin, 2004). The current study's high ash content could be attributed to high concentrations of minerals that are precursors to proximate formation. The ash content in this study was less than 8%, as reported by Gohl (1981), who concluded that ash content greater than 8% indicates fat contamination. Abdalla Saleem (2012) added that high ash contents are also indicative of low organic matter. The moisture content of the eight Bambara groundnut accessions studied in this study was less than 8%, which is considered low. Bambara nut seeds are known for their low moisture content, which indicates that they have good storage qualities. The storage value is reduced when there is a high moisture content. Okonkwo and Opara (2010) obtained a similar result for the same plant.

Table 3: Proximate analysis of Bambara groundnut accessions

Accessions	Moisture (%)	Crude Fat (%)	Crude Fibre (%)	Ash (%)	Protein (%)	Carbohydrate (%)
Caly SK 46	7.80	5.80	4.60	3.55	18.29	60.24
Zeina 22	6.80	5.96	4.71	3.58	19.35	59.62
Caly 4	6.74	5.91	4.65	3.88	19.34	59.49
Caly SK 144	7.58	6.48	5.32	3.58	18.82	58.23
BNT 89	6.39	6.30	5.48	3.92	19.87	58.06
Regal green 27	7.91	6.38	5.35	3.60	18.82	57.96
SDR 21	7.18	6.60	5.59	3.51	20.21	56.92
Caly PSC	7.25	6.32	5.42	3.82	20.39	56.81
LSD ($P \leq 0.05$)	0.04	0.04	0.06	0.06	0.13	0.33

Pearson correlation coefficients (r) between the growth and yield traits of twelve accessions of Bambara groundnut

Table 4 displays the Pearson correlation coefficients (r) between the evaluated agronomic traits and nutritional qualities of the Bambara groundnut accessions. The correlation coefficient of the Bambara groundnuts accessions studied showed both positive and negative associations with yield and yield-related traits (Table 4). Plant height had a positive but significant association (r = -0.421*) with leaf area. Plant height recorded a positive and highly significant correlation (r = 0.526**) with weight of hundred seeds. Number of pods per plant recorded a positive association (r = 0.178) with seed weight. Weight of dried pods recorded a negative and significant relationship (r = -0.426*) with protein content. Weight of hundred seeds had a positive correlation (r = -0.135) with seed weight. Fibre had a positive and highly significant association with fat content (r = 0.942**). Protein had a negative but highly significant relationship (r = -0.574**) with moisture. Also, protein recorded a positive and significant (r = 0.453*) relationship with fat as well as a positive and highly significant relationship (r = 0.575**) with fibre. Carbohydrate had a negative but highly significant correlation (r = -0.730**) with protein. The specific coefficient, according to Silva *et al.* (2016), is a correlation estimate for the purpose of selection for direct and indirect breeding because it indicates how closely two or more traits are genetically and non-genetically related. In this study, plant height and petiole length were negatively correlated, while leaf area and number of pods per plot, number of seeds per pod and fibre content, leaf area and seed weight, plant height and seed weight were positively correlated. The positive correlations among and between the various traits indicate that selecting for any of these traits in a Bambara groundnut improvement programme will have a positive influence on selecting for related traits (Unigwe *et al*., 2016). It is critical for breeding programmes to develop vegetative growth and yield collections (Gao *et al.,* 2020). Selecting for these traits may be useful in breeding Bambara groundnut for future production (Alake and Ayo-Vaughan, 2017).

Table 4: Correlations Pearson correlation coefficients (r) between the growth and yield traits of eight accessions of Bambara nut

	PH	LN	PL	LA	NPPP	WDP	SW	WHS	DM	M	Fat	Fibre	Ash	Protein
PH														
LN	-0.228													
PL	-0.063	0.036												
LA	0.421*	-0.111	0.041											
NPPP	0.030	0.007	-0.255	0.243										
WDP	0.201	0.158	0.184	0.101	0.183									
SW	-0.052	0.118	0.175	0.095	0.178	0.383								
WHS	0.526**	-0.250	-0.158	0.184	0.163	0.169	-0.135							
DM	-0.032	-0.216	-0.073	-0.174	-0.219	-0.043	-0.332	-0.377						
M	-0.069	-0.220	0.204	-0.204	-0.258	0.316	-0.011	0.012	0.343					
Fat	0.126	-0.242	-0.449*	-0.054	-0.208	-0.126	-0.310	0.264	0.290	0.131				
Fibre	0.056	-0.166	-0.491*	0.037	-0.193	-0.189	-0.307	0.294	0.264	0.012	0.942**			
Ash	-0.106	0.070	-0.148	0.113	0.047	-0.211	0.149	0.193	-0.407*	-0.641**	-0.154	0.043		
Protein	0.185	-0.163	-0.413*	0.249	0.160	-0.426*	-0.224	0.134	0.141	-0.574**	0.453*	0.575**	0.418*	
CHO	-0.096	0.273	0.474*	-0.096	0.077	0.264	0.310	-0.283	-0.308	-0.009	-0.873**	-0.925**	-0.107	-0.730**

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Principal component analysis for agronomic traits and nutritional qualities of Bambara groundnut accessions.

Results presented in Table 5 shows the principal component analysis of agro-morphological traits and nutritional qualities of the Bambara groundnut in this study. The first five principal components (PCs) with Eigen values greater than 1.0 jointly accounted for 74.37% of the total variation in the accessions (Table 5). The traits of importance for the first component involved agronomic traits and nutritional qualities of agronomic interest. Principal component one (PC1), with eigen value of 4.17, contributed 27.81% of the total variability. PC2, with eigen value of 2.62, accounted for 17.52% of total variability. PC3, with eigen value of 2.00, accounted for 13.34%, PC4, with eigen value of 1.23, accounted for 8.20%, while PC5, with eigen value of 1.12, accounted for 7.47% of total variability observed among the eight Bambara groundnut accessions. In PC1, the traits that accounted for most of the 27.81% observed variability among the eight accessions of Bambara groundnut included fat (0.86), fibre (0.91) and protein (0.77). In PC2, the traits that accounted for most of the 17.52% observed variability among the eight accessions of Bambara groundnut included ash (0.73). In PC3, the traits that accounted for most of the 13.34% observed variability among the eight accessions of Bambara groundnut included plant height (0.71) and weight of dried pods (0.65). In PC5, the traits that accounted for most of the 7.47% observed variability among the eight accessions of Bambara groundnut included number of pods per plant (0.60). Shegro *et al.* (2013) demonstrated the merits of principal component analysis (PCA) in predicting trait relationships in Bambara groundnut accessions. Ntundu et al (2006) found a strong association between landraces as well. A plant with this strong relationship grows and produces a high yield (Chijioke *et al.,* 2010). In general, the PC analysis of the 15 traits revealed that PC1 was made up of a number of traits that contributed the most variation, followed by PC3. Ntundu *et al.* (2006) reported that leaf morphology, seed size, and colour were morphological criteria used by Tanzanian farmers during selection. PC1 and PC3 made significant contributions to trait association in this study and were responsible for high Eigen values.

Table 5: Principal component analysis for agronomic traits and nutritional qualities of Bambara groundnut accessions.

	Principal Components				
	1	2	3	4	5
Plant height	0.208	0.199	0.714	-0.333	0.018
Leaf Number	-0.329	0.163	-0.332	0.466	-0.049
Petiole length	-0.592	-0.176	0.088	-0.396	-0.238
Leaf area	0.104	0.441	0.449	-0.298	0.306
Number of pods per plant	-0.075	0.486	0.212	0.271	0.608
Weight of dried pods	-0.374	-0.095	0.610	0.465	0.087
Seed weight	-0.452	0.268	0.158	0.403	0.048
Weight of 100 seed weight	0.338	0.302	0.653	0.040	-0.436
Dry matter	0.293	-0.662	-0.139	-0.179	0.462
Moisture	-0.148	-0.807	0.371	0.118	-0.077
Fat	0.863	-0.297	0.112	0.244	-0.110
Fibre	0.913	-0.151	0.020	0.249	-0.126
Ash	0.137	0.738	-0.307	0.002	-0.325
Protein	0.771	0.423	-0.196	-0.140	0.215
Carbohydrate	-0.947	0.080	-0.019	-0.129	0.003
Total	4.173	2.629	2.002	1.231	1.122
% of Variance	27.819	17.526	13.344	8.208	7.479
Cumulative %	27.819	45.345	58.690	66.897	74.377

CONCLUSION

Findings from this study indicate that Bambara groundnut is adaptable to the Uyo environment in Akwa Ibom State. The agronomic characteristics of the accessions in this study varied significantly. Caly PSC (2853 kg/ha), Caly SK 46 (2803 kg/ha), Zeina (2538 kg/ha), and BNT (2488 kg/ha) were the top yielders among the accessions evaluated. These accessions may be suitable for population development as well as for Bambara groundnut production in Uyo, Akwa Ibom State. The genetic potential of the accessions in this study can aid in the selection of desirable parental lines and increase the efficacy of Bambara groundnut breeding programmes. This study revealed that Bambara groundnut grown in Uyo, Akwa Ibom State, and a good source of nutrients. It is recommended that the experiments be repeated in more locations and seasons with more Bambara groundnut accessions of superior traits for high production.

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PRODUCTION AND PREFERENCE FOR SELECTED TOMATO ATTRIBUTES IN AKURE NORTH LOCAL GOVERNMENT AREA OF ONDO STATE, NIGERIA

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ABSTRACT
Tomato which is a fruit vegetable and known to possess great nutritional and economic benefits among farm families was assessed for level of preference and production share, on-farm in Akure north LGA. One hundred and twenty-six tomato farmers were assessed for production and preference information in two communities (Oba-ile and Ogbese) within Akure north LGA Ondo state, Nigeria. These farmers were interviewed using a well-structured questionnaire which captured the socio-economic characteristics and preference indices for the selected tomato attributes. Data were analyzed using descriptive statistics, cross tabs and regression analysis. Results showed that eighty-three percent of the farmers were male with most been middle-aged (43%). Production activities were carried out by at least 6 members of each farming household and the average number of years for educational attainment was twelve (12) years. However, about 33 percent of the farmers had access to extension services while only 13% had access to credit facilities. Farmers in the study area mostly preferred the yield attribute of tomato while the price attribute was least preferred, as in economic terms, the higher the price of a good, the lesser the quantity demanded of the good. The regression analysis revealed age, primary occupation, total farm size and age squared as socio-economic factors influencing the share of tomato cultivated on-farm. However, for a farmer to fully maximise the available scarce resources at his disposal, measures should be put in place to address the low cultivation of tomato in south west Nigeria and greater measures put in place by crop experts to inculcate farmers preferences for tomato attributes that will endear them to cultivate the crop thereby boosting farm income and improving the livelihood of the farm family.
Keywords: *Tomato, Preference, Attributes, Regression, Akure North local government area*

INTRODUCTION
Fruit vegetables are vegetables with a pulpy, seed-rich body which grows on a vine. They are used as vegetables, are higher in calories than leafy vegetables and rich in vitamin C (Segen's Medical Dictionary, 2012). Examples of fruit vegetables include tomato, okra, bell pepper, red pepper, eggplant, water melon amongst others. Tomato (Lycopersicon esculetum) is one of the most widely consumed vegetables in the world today. Nigeria ranks highest in Africa in terms of tomato production, 879,000 t/annum (Ibeawuchi *et al.,* 2015). There are different varieties of tomatoes found in Nigeria today among which are; Roma, Betterboy, Grape, etc. just to mention a few, Oladitan and Oluwasemire (2018) revealed that Tomato production in Nigeria is mainly concentrated in the northern part of the country, however there is some production in the middle belt and south-western part of the country as well. Tomato production in Nigeria plays an important role in enhancing food and nutrition security (Schreinemachers *et al.,* 2018) as it provides food and raw material for industries, employment for smallholder farming households, and income from sales within the urban, peri-urban and rural areas of the country (Bello and Abdulai, 2016; Food and Agriculture Organization, 2017). The production preferences of farmers are initialized by the traits or attributes of crops they cultivate, which are described as the physiological and phenological characteristics of crops that their physical environment and management practices can influence (van Vliet and Giller, 2017). The preference for a variety of tomato is primarily based on the yield of the crop, socio-economic characteristics, attitude and behaviour of the farmers, risks perception, and climatic factors (Oye, 2014; Adegboye *et al.,* 2021). Hence, an increase in fruit vegetable productivity will enhance food nutrition security of both rural and urban households in Nigeria while also addressing the basic needs of the poor rural horticultural farmers.

Over the past ten years in Nigeria, tomato yields have remained very low at an average of 5.47 tonnes/ha relative to the world average yield of 38.1 tonnes/ha (Izuaka, 2020). This could be attributed to differences in climatic factors, lack of good high yielding varieties and inadequate good agricultural practices to the crop on the field. In the humid west to southern regions, production of the crop has been limited majorly by climatic factors, which include low temperature, high humidity and high rainfall (Oladitan and Akinseye, 2014; Oladitan and Oluwasemire 2018). Hence, the need to sensitize farmers in the south and equip them with the needed incentives towards improved tomato production to bridge the demand and supply gap, increase farmers' income, and enhance food nutrition security. It is against this backdrop that this research work was carried out to determine the factors influencing tomato production in Akure North LGA, Ondo state while assessing their preferences for selected tomato attributes.

METHODOLOGY

This study was carried out in Akure North Local Government Area of Ondo state. The Local Government Area (LGA) comprises of five (5) major communities, Iju , Ita-Ogbolu, Oba-ile, Igoba and Ogbese in Akure North LGA. These communities are located between latitudes 5°45' and 7°52' and longitudes 4°20'and 6°05' and the farmers within the communities cultivate a wide range of fruits and vegetable including tomatoes. Two (2) communities (Oba-ile and Ogbese) were randomly selected from the five (5) communities within the LGA based on the prominence of tomato production in the communities. Primary data for the study were obtained with the aid of a well-structured, pre-tested questionnaire distributed randomly to a selected number of farmers in the two communities via sampling proportionate to size thereby, giving a total sample size of 130 respondents, however only 126 were found useful for analysis which captured the socio-economic characteristics and preference of selected tomato attributes among farmers in the study area. Data generated was analyzed using descriptive statistics, cross tabs regression analysis to capture socio-economic characteristics, preference for tomato attributes and factors affecting Percentage of tomato cultivated on the farm.

Regression analysis was used to determine the level of relationship/significance between percentage of tomato cultivated on the farm (dependent variable) and demographic characteristics and production characteristics (independent variables). The regression model is specified in the general form:

$$Y = f(x_1, x_2 ---- x_{10}) \qquad 1$$

Where: $Y =$ Percentage of tomato cultivated on the farm %

x_1 = Age (years)

x_2 = Sex (Male = 1; 0 otherwise)

x_3 = Marital Status (Married = 1; 0 otherwise)

x_4 = Years of schooling (Years)

x_5 = Household size (actual number)

x_6 = Age squared (Actual years)

x_7 = Primary Occupation (Farming 1, 0 otherwise)

x_8 = Extension accessibility (Binary 1/0)

x_9 = Total farm size (actual figure)

x_{10} = Credit access (Binary 1/0)

The attributes of tomato selected for this study were culled from literature and from interaction with farmers. They include but were not limited to; fruit size, tolerance to pest and disease, yield, shelf-life and price of tomato seeds, respectively. The fruit size of tomato can be either medium sized or big for appreciable market value. The tolerance to pest and disease level must be mildly tolerant or tolerant for a farmer to have appreciable gains on his farm. The average yield of tomato in the south west is about 5tons/hectare, therefore to gain an appreciable yield double the volume of status quo, a farmer has to aim at 10/15tons per hectare. The shelf-life of tomato fruits is very paramount to the existence of the tomato enterprise as tomato fruits are highly perishable. The shelf-life can be categorized into fair and good shelf-life respectively. Finally, the price of tomato seeds to cultivate a hectare can range from N20, 000 to as high as N50, 000 depending on the variety and the accessibility of the seeds to the farmers.

RESULTS AND DISCUSSION

Socio-economic Characteristics of Farmers

The summary statistics showed in Table 1 revealed that about 83% of the farmers were male while the average age of farmers was approximately 43 years. The average years of formal education for the entire sample size was approximately 12 years while the tomato farming activities were supported by an average of six members of each farming household. On average, a farmer had an annual income of N241, 580 from previous harvest and 89 percent of the farmers were mainly involved in farming activities. A sizeable (33%) proportion of the farmers had access to extension services while minute (13%) proportion had access to credit facilities for their farming enterprise. Also, about 13% of the farmers on average were in good proximity to source of input (seed) supply and 59 percent had easy access to output market to sell their produce on time.

Farmers' preference for selected tomato attributes

The preference for tomato attributes such as Fruit size, tolerance to pest and disease, yield, shelf-life and price with respect to socio-economic characteristics of the farmers is as shown in Fig 1. 52.38% of the farmers in the LGA did not prefer the fruit size of tomato attribute possibly going by their status quo while 61.90% of farmers did not agree with the price of seed attribute. This may be due to the high cost of seed (inputs) which creates a set- back for farmers when trying to break even in their farming enterprise. About 64.28% of farmers had an interest in the attribute shelf-life of tomato. This depicts that tomato farmers in the study area are seeking for solution to fast deterioration of harvested tomato fruits and seeking for a way to reduce post-harvest loss by the breeding of tomatoes with good shelf-life properties. 57.14% of the farmers showed interest in the attribute tolerance to pest and disease of tomato depicting that after good shelf-life, tolerance to pest and disease is an attribute most farmers in the study area considered. However, yield (65.87%) was the highest sought attribute of tomato by the farmers and this is in line with the study by Kassie *et al.,* 2017 where yield was considered a priority attribute by maize farmers in rural Zimbabwe.

Factors influencing share of tomato planted on-farm

The regression results in Table 2; revealed age, age squared, primary occupation and total farm size as socio-economic variables influencing share of tomato production on-farm. The age of the farmers within the study area had a positive and significant influence on the share of tomato planted on-farm. This is expected as most of the farmers are middle aged and able-bodied men who are still in their active years and productive in farm engagement. The primary occupation of the respondents was also positive and significant at $p \leq 0.05$ signifying that most of the respondents were into full time farming activities and very few diversified their source of income. The variables total farm size and age squared were significant but negative depicting that as total farm size of the farmer increases, the percentage of tomato cultivated decreases. This can be attributed lack of information or awareness on the nutritional or economic benefits of cultivating tomatoes. Most of the farmers in the study area would rather cultivate staples and pulses to achieve food security whilst neglecting nutrition security. The significance of age squared variable explains the law of diminishing returns. The older the farmer gets the less productive they become. Hence, an increase in the age of the farmer, decreases the percentage of land allotted to tomato production due to exigencies of old age and the possibility of dearth in technological know-how.

CONCLUSION AND RECOMMENDATION

Most tomato farmers in the study area were middle aged men with secondary school level of education. The preference for selected tomato attributes by the farmers, showcased yield as the most preferred tomato attribute, followed closely by good shelf-life and then tolerance to pest and disease of tomato attributes, respectively. The factors influencing the percentage of tomato to cultivate positively or negatively on- farm were; age, total farm size, primary occupation of farmer and the age squared of farmers. Therefore, to promote tomato production in Akure north LGA,, there should be awareness on the nutritional and economic benefits inherent in tomato production and subsequent consumption in order to boost the demand and inadvertently the supply of this fruit vegetable in the study area.

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Table 1: Summary statistics of variables employed in the analysis

Variables	Description	Mean	Standard Deviation
Sex	Gender of the farmer (Male/Female	0.83	0.38
Age	Age of farmer (Years)	42.60	11.75
School Years	Educational level	12.13	4.50
Household size	Farm household size	6.46	2.56
Revenue	Previous year's income	241580.2	198531.7
Primary Occupation	Mail occupation of farmer	0.89	0.32
Extension access	Services by extension agents	0.33	0.47
Credit Access	Availability of credit	0.13	0.33
Distance from input market	Distance to source of seeds	13.45	47.89
Distance from Output market	Distance to supply of produce	59.19	356.86

Source: Field survey, 2022

Table 2: Result of linear regression analysis showing demographic characteristics Influencing share of tomato production

Variable	Coefficients	Standard Error	Y-Value
Gender	(2.900)	5.81	(0.50)
Age	1.396	0.675	2.07**
Household size	(0.172)	1.198	(0.14)
Educational level	0.796	0.538	1.48
Primary Occupation	16.199	7.802	2.08**
Total farm size	(0.995)	0.413	(2.41)***
Marital Status	4.033	9.889	0.41
Extension access	(1.367)	4.842	(0.28)
Credit access	5.881	7.467	0.79
Age squared	(0.015)	0.007	(1.98)**

R Squared = 0.81; Adjusted R^2 = 0.79; Prob > F = 0.00 **Significant at 5%; ***Significant @ 1%; () signifies – ve

Source: Field survey, 2022

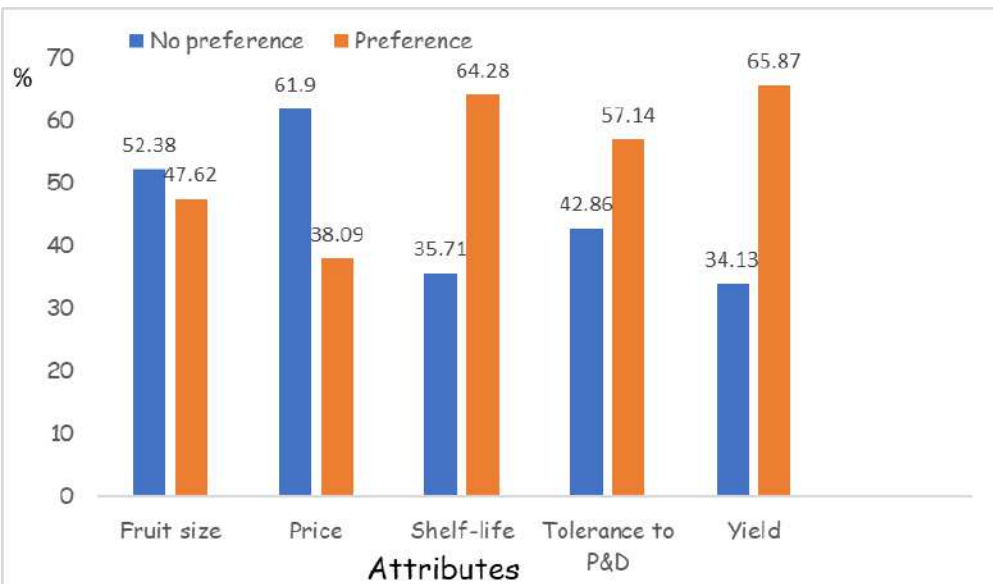

Fig. 1: Farmers' preference for attributes of tomato

CORRELATION AND PATH ANALYSIS IN CARROT AS INFLUENCED BY IRRIGATION INTERVAL, NITROGEN LEVELS AND INTRA-ROW SPACING AT DADIN-KOWA, GOMBE STATE

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ABSTRACT
To determine characteristics that contribute to the yield of carrots under the influence of irrigation interval, nitrogen levels, and intra-row spacing, field trials were conducted during the 2010/2011, 2011/2012, and 2012/2013 dry seasons at the Federal College of Horticulture Research Farm, Dadin-Kowa, Gombe State. The treatments consisted of three irrigation intervals (5, 7, and 9 days), four nitrogen rates (0, 50, 100, and 150kg N/ha), and three intra-rows spacing (5, 1,0, and 15 cm). The treatments were combined and laid in a split-split-plot design with irrigation interval in the main plot, and nitrogen levels in sub-plots while intra-row spacing was assigned to the sub-sub-plots. The treatments were replicated three times in each season. The characters studied are plant height, number of leaves per plant, fresh weight of shoot per plant, dry weight of shoot per plant, root length per plant, root diameter per plant, fresh weight of root per plant, dry weight of root per plant, cracked root per plant, carotene content and root yield. All characters studied were found to be positively and highly significantly correlated with root yield in all three years of investigations. This study has confirmed that all the growth and yield characters considered had a positive association with root yield. And thus, made a significant contribution to root yield. Therefore, they should constitute important traits when breeding for high-yielding carrot varieties.
Keywords: *correlation, path analysis, characters, irrigation, nitrogen, spacing and carrot*

INTRODUCTION

The carrot (*Daucus carota* L.) is an important vegetable because of its high nutritive and medicinal value. It is valued as food because of its high carotene content and vitamin A, which is important in protecting against blindness in children. Carrot has a long storage life compared to many other perishable vegetables. Accurate information on the yield of carrots in Nigeria is difficult to come by, however, yields of about 4 t/ha have been reported by (Hamma *et al.,* 2012) under irrigation conditions in Zaria, Nigeria. This is low when compared to a yield of 20-40 t/ha obtained in Mauritania and Niger Republic, 25-45 t/ha in Senegal and the Cape –Verde, and 40-50 t/ha in Chad (Lannoy, 2001). This low yield may be attributed to complex issues such application of adequate amounts of water for irrigation, the application of nitrogen, and optimum population and plant density. Hence the objective of this research is to determine the influence of irrigation interval, nitrogen levels, and intra-row spacing on the growth and yield of Carrot under irrigated conditions in Dadin-kowa, Yamaltu Deba L.G.A, Area of Gombe State, Nigeria. Parts of the results obtained in this study showed that application of water at every 5-day interval and application of 150 N/h combined with 15cm intra-row spacing resulted in optimum growth and yield of carrots in Yamaltu Deba L.G.A, area of Gombe State, Nigeria (Mahmoud *et al.,* 2019). To determine characters that contribute to the yield of carrots under the influence of irrigation interval, nitrogen levels and intra row spacing correlation and path analysis were carried out. This is because the estimation of a simple correlation between various agronomical characteristics may provide good information necessary for crop production when selection is based on two or more traits simultaneously. Mukhtar (2009), Sadek *et al.* (2006), and Babaji *et al*. (2007) observed that association among traits might be measured by genotypic or phenotypic coefficients of correlation depending on the types of studied material, crops, and the kind of experimental design. Therefore, information obtained from correlation coefficients for growth and yield characters could also be useful as an indicator of the more important parameters under consideration.

MATERIALS AND METHODS

Field trials were conducted during the dry seasons of 2010/2011, 2011/2012, and 2012/2013 at the Teaching and Research Farm of the Federal College of Horticulture Dadin-Kowa, northern Guinea savanna ecological zone of Nigeria (Latitude 11°30" N, Longitude 10° 200" E and 240m above sea level). Soil samples from the study area were taken randomly to a depth of 0-30 cm using a tubular auger. The samples were mixed thoroughly in a container after which a representative sample was scooped out from the bulk and analyzed to determine the initial soil fertility levels using standard procedures as described in the report by (Mahmoud *et al.,* 2018 and 2019) and the result of the analysis is presented in Table 7. The treatments, which were laid in a split-split plot design with three replications consisted of three (3) irrigation interval (5, 7, and 9 days) and was assigned to the main-plot, four (4) nitrogen levels (0, 50, 100 and 150kg/ha) which were assigned to the sub-plot and three (3) spacing (5, 10 and 15cm) assigned to sub-sub-plot treatments. The experimental plots were properly ploughed and harrowed twice to obtain a fine tilth. A furrow of 75cm in between a strip of 2m was dug and used as a distributor channel. Later, the strips were encircled with raised bunds, into basins of 2-meter length. Land preparations were carried out in early October. Drainage channels were constructed at the tail end of the field. The variety used for this research is Nantes. A dose of half the nitrogen rate and a full dose of phosphorus as well as a full dose of potassium were applied at two weeks after sowing. Urea (46%N), muriate of potash (60% K_2O_5), and single superphosphate (18%P_2O_5) were used as sources of nitrogen, phosphorus, and potassium, respectively. The second dose of nitrogen was applied as a side dressing at six weeks after sowing. Weeds were properly controlled by hand hoe. Three hoe weeding were carried out in each season. No incidence of pests and diseases was recorded throughout the period of experimentation in all seasons.

The characters studied are plant height, number of leaves per plant, fresh weight of shoot per plant, dry weight of shoot per plant, root length per plant, root diameter per plant, fresh weight of root per plant, dry weight of root per plant, cracked root per plant, carotene content and root yield. The growth parameters assessed at 9WAS were plant height, length, and number of leaves. Five plants were selected randomly from each plot and were tagged at 3 WAS for recording various growth and yield parameters. Plant height was recorded from the base of the root to the top of the plant and the average plant height was then expressed in cm. The length of leaves was measured from the base to the tip of the leaves expressed in cm. The number of leaves in five tagged plants was counted and the average value was worked out. The yield parameters assessed at harvest were the length of the carrot, carrot diameter, carrot fresh weight, and carrot yield per ha. The length of the carrot was measured in five randomly selected plants from the base of the root to the top of the root and the average carrot length was expressed in cm. The circumference of five carrots selected randomly was recorded at the basal portion of the root with the help of thread and scale and the average carrot diameter was expressed in cm. The fresh weight of five carrots selected randomly after harvest was recorded and the average fresh weight of carrot was expressed in grams/plant. The total root yield was computed from the yield of the net plot and expressed in kg per ha. The data was subjected to analysis of variance (ANOVA) and the means were separated using Duncan's Multiple Range Test (Duncan, 1955). All statistical procedures were done as described by Gomez and Gomez (1984). The strength of the relationship between growth and yield parameters was studied using correlation coefficient analysis (Little and Hills, 1978 Babaji *et al.,* 2007).

RESULTS AND DISCUSSIONS

Simple Correlation matrix involving root yield, growth, and yield parameters of carrot

The simple correlation matrix between root yield, some growth, and yield components during three years of investigation were presented in Tables 1,2, and 3 for the 2010/2011, 2011/2012, and 2012/2013 dry seasons respectively. The characters studied are plant height, number of leaves per plant, fresh weight of shoot per plant, dry weight of shoot per plant, root length per plant, root diameter per plant, fresh weight of root per plant, dry weight of root per plant, cracked root per plant, carotene content and root yield. All characters studied were found to be highly significantly correlated with root yield in all three years of investigations. It was also noted that the relationship between plant height, mean number of leaves per plant, fresh weight of shoot per plant, dry weight of shoot per plant, root length per plant, root diameter per plant, fresh weight of root per plant, cracked root per plant and carotene content were all found to be positively in all the three years of study as shown in Tables 1, 2 and 3.

The Direct and Indirect Contribution of Growth and Yield Parameters of Carrot to Root Yield

The partitioning of the total correlation into direct and indirect effects of some growth and yield characters on the root yield of carrots was positive throughout the period under consideration. The highest individual contribution was from the fresh weight of root per plant while the highest combined contributions were from the fresh weight of root per plant combined with root length per plant and from the fresh weight of root per plant combined with root diameter per plant as shown in Tables 4,5 and 6.. The significant and positive correlations between pod yield and growth characters indicated the importance of good vegetative development as being necessary for high yields. This is in conformity with the work of Wright (1934) who noted a highly significant positive relationship between yield and vegetative characters. The positive significant relationship between yield and yield characters indicates that these characters are important yield indices (Mukhtar *et al.*, 2013; Babaji *et al.,* 2005; Babaji *et al.,* 2007). All the direct and indirect effects were positive throughout the period under consideration. This suggests that these characteristics are important in root yield and the higher the direct or indirect effect the more critical the determinant in yield and thus constitute important characteristics that the breeders should consider when breeding for high-yielding varieties.

CONCLUSION

Based on the results of this work, it can be concluded that all the growth and yield characters considered in this work made significant contributions to yield and thus constitute important characters when breeding for high-yielding varieties.

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Table 1: Simple Correlation matrix involving root yield, growth and yield parameters of carrot during 2010/2011 dry season at Dadin-Kowa

	1 PH	2 NLP	3 FWSP	4 RLP	5 RDP	6 FWRP	7 CRP	8 RYield
1 PH	1.000							
2 NLP	0.78210***	1.000						
3 FWSP	0.79234***	0.92972***	1.000					
4 RLP	0.65502***	0.90706***	0.83045***	1.000				
5 RDP	0.68248***	0.90828***	0.95583***	0.83122***	1.000			
6 FWRP	0.77357***	0.96716***	0.94167***	0.89459***	0.90302***	1.000		
7 CRP	0.77109***	0.83796***	0.80732***	0.79778***	0.80595***	0.66605***	1.000	
8 RYield	0.84217***	0.96675***	0.94243***	0.91345***	0.89568***	0.86642***	0.89364***	1.0

Table 2: Simple Correlation matrix involving root yield, growth and yield parameters of carrot during 2011/2012 dry season at Dadin-Kowa

	1 PH	2 NLP	3 FWSP	4 RLP	5 RDP	6 FWRP	7 CRP	8 RYield
1 PH	1.000							
2 NLP	0.65121***	1.000						
3 FWSP	0.64311***	0.79264***	1.000					
4 RLP	0.41363***	0.61934***	0.67321***	1.000				
5 RDP	0.59864***	0.76723***	0.76563***	0.79642***	1.000			
6 FWRP	0.66871***	0.84324***	0.79231***	0.73214***	0.87763***	1.000		
7 CRP	0.69561***	0.74322***	0.73613***	0.62415***	0.79342***	0.56732***	1.000	
8 RYield	0.74962***	0.81633***	0.87362***	0.74962***	0.64923***	0.76234***	0.76348***	1.000

Table 3: Simple Correlation matrix involving root yield, growth and yield parameters of carrot during 2012/2013 dry season at Dadin-Kowa

	1 PH	2 NLP	3 FWSP	4 RLP	5 RD	6 FWRP	7 CRP	8 RYield
1 PH	1.000							
2 NLP	0.59632***	1.000						
3 FWSP	0.61324***	0.67934***	1.000					
4 RLP	0.52476***	0.51934***	0.58688***	1.000				
5 RDP	0.51495***	0.86413***	0.69776***	0.72106***	1.000			
6 FWRP	0.69862***	0.81564***	0.71144***	0.68993***	0.78909***	1.000		
7 CRP	0.58432***	0.69442***	0.71314***	0.61788***	0.68817***	0.52004***	1.000	
8 RYield	0.69341***	0.79326***	0.82562***	0.65666***	0.61996***	0.65993***	0.68974***	1.000

Table 4: The direct and indirect effects of root yield, growth and yield parameters of carrots during the 2010/2011 dry season at Dadin-Kowa

Parameters	PH	NLP	FWSP	RLP	RD	FWRP	CRP	**Total corr.**
PH	**0.979**	0.820	0.522	0.000	0.000	-0.913	-0.359	1.048
NLP	0.824	**0.974**	0.416	0.000	0.000	-0.813	-0.334	1.067
FSWP	0.946	0.751	**0.540**	0.000	0.000	-0.960	-0.370	0.906
RLP	0.922	0.816	0.417	**0.000**	-0.217	-0.926	-0.396	0.616
RD	0.894	0.786	0.522	-0.052	**0.000**	-0.668	-0.376	1.106
FWRP	0.877	0.777	0.508	0.000	0.000	**-1.020**	-0.328	0.814
CRP	0.848	0.785	0.483	0.000	0.000	-0.808	**-0.414**	0.893

Table 5: The direct and indirect effects of root yield, growth, and yield parameters of carrot during 2011/2012 dry season at Dadin-Kowa

Parameters	PH	NLP	FWSP	RLP	RD	FWRP	CRP	**Total corr.**
PH	**0.416**	0.300	0.536	0.100	-0.259	-0.097	-0.099	0.897
NLP	0.312	**0.400**	0.456	0.085	-0.254	-0.093	-0.103	0.803
FSWP	0.340	0.278	**0.656**	0.076	-0.291	-0.118	-0.095	0.846
RLP	0.364	0.297	0.439	**0.115**	-0.206	-0.115	-0.100	0.794
RD	0.312	0.295	0.553	0.068	**-0.345**	-0.062	-0.080	0.741
FWRP	0.270	0.250	0.520	0.088	-0.142	**-0.149**	-0.084	0.752
CRP	0.317	0.318	0.480	0.088	-0.214	-0.096	**-0.130**	0.763

Figures highlighted represent direct effects

Table 6: The direct and indirect effects of root yield, growth and yield parameters of carrot during 2012/2013 dry season at Dadin-Kowa

Parameters	**PH**	**NLP**	**FWSP**	**RLP**	**RD**	**FWRP**	**CRP**	**Total corr.**
PH	**0.20110**	0.50259	0.58872	-0.06715	-0.30004	-0.04319	-0.07723	0.80480
NLP	0.13944	**0.72482**	0.43365	-0.05648	-0.32585	-0.04305	-0.08053	0.79200
FWSP	0.15952	0.42352	**0.74215**	-0.05682	-0.37268	-0.04957	-0.08074	0.76539
RLP	0.16603	0.50333	0.51848	**-0.08133**	-0.23529	-0.06021	-0.08165	0.72935
RD	0.13205	0.51690	0.60533	-0.04188	**-0.45692**	-0.03656	-0.06077	0.65813
FWRP	0.12467	0.44785	0.52799	-0.07028	-0.23977	**-0.06967**	-0.07176	0.64902
CRP	0.13271	0.49880	0.51203	-0.05675	-0.23730	-0.04273	**-0.11702**	0.68974

Figures highlighted represent direct effects

Note: PH=plant height, NLP= number of leaves per plant, FWSP=fresh weight of shoot per plant, RLP=root length per plant, RDP= root diameter per plant, FWRP=fresh weight of root per plant, CRP=cracked root per plant, and RY= root yield

Table 7: Physico-chemical characteristics of soils uof the experimental site in 2010, 2011 and 2012 dry season at Dadin-kowa

Soil composition	**Soil depth 0 – 30 cm**		
Particle size (g/kg)	**2010**	**2011**	**2012**
Clay	22.32	21.30	22.44
Silt	18.56	18.40	19.42
Sand	59.12	60.03	58.14
Textural class	Sandy clay	Sandy clay	Sandy clay
Chemical properties			
PH in water	7.2	7.6	7.4
PH in 0.1ml CalCl2	6.5	6.7	6.6
Organic Carbon g/kg	0.58	0.61	0.63
Available P (mg/kg)	6.25	6.29	6.32
Total Nitrogen	0.07	0.10	0.09
Exchangeable Cations (c mol/kg)			
Ca	2.63	2.69	2.67
Mg	0.63	0.78	0.79
K	0.18	0.22	0.26
Na	0.08	0.10	0.17
CEC	9.25	9.47	9.52

KOLANUT PROCESSING FOR QUALITY IMPROVEMENT AMONG KOLANUT PROCESSORS IN OGUN STATE OF NIGERIA

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ABSTRACT
Nigeria produces about 50% of the world's kolanut and it is mostly consumed within. This study examined Kolanut processing for quality improvement among kolanut processors in Ogun State of Nigeria. The study was carried out in Ogun state, Nigeria. One hundred and eight (108) kolanut processors' information was used for analysis. Descriptive statistics was used as analytical technique. The mean age of kolanut processors in the study area was 59 ± 14. Ninety four percent of the processors are female. In the study area 42.6% of the processors do not have formal education while 47.4% have a level of education (primary/secondary). Majority (96.3%) of the processors in the study process more of gbanja/goro type of kolanut. One hundred percent of the processors affirmed that they process their raw kolanut to avoid spoilage. Also 48.1% of the processors reported that to reduce the bitter taste of kolanut they store the nut for a long time or allow it to be well dried Eighty percent of the processors use leaf to preserve kolanut. They use this to avoid spoilage (33.3%), to enhance the appearance of kolanut (27.8%) and to avoid being heated (20.4%). On the other hand, 77.8% of the processors use nylon to preserve kolanut and some of the reasons why they use it is to make it airtight thus avoiding spoilage, it also enhance storage for a long time. Majority (96.3%) of the processors use chemical to preserve their nut. This study recommended that the right processing techniques should be put in place to reduce its bitterness and sensitization on the non usage of chemicals to preserve kolanut.
Keywords: *Chemical, Kolanut, Post harvest, Processing*

INTRODUCTION

Kola an evergreen tree and a member of sterculiaceae familyis an important commodity crop in West Africa and other tropical regions of the world (Onaolapo and |Onaolapo, 2019). It is native to tropical Africa with its center of diversity in West Africa especially Cote d'Ivoire and Ghana (Gestrich *et al*. 2021). Among about 40 Cola species in West Africa, the Cola nitida and Cola acuminata are the species of real economic importance (Asogwa *et al*.2011; Adesida *et al.* 2021). They are important economic crops in the forest areas of West and Central Africa, Caribbean Islands, Mauritus, Sri Lanka and Malaysia (Adesida *et al*. 2021). Although Cola nitida is of more economic importance in Nigeria especially in the north, Cola acuminate has its origin and is consumed mainly among the Yoruba tribe of Western part of Africa.Kolanuts are extremely popular due to their high caffeine content. Kolanuts have a bitter taste and contain between 1-1.5% caffeine by weight (Clayon, 2002). They are also a source of antioxidants and contain small amounts of theobromine, d-catechin, L-epicatehin, kolatin, phlobaphens, antioxidant pigment, betaine and protein. Kola extract isa popular ingredient in fat loss supplements. It suppresses hunger, aids digestion of food and acts as a diuretic.

Cola acuminata: The processing of *cola acuminata* begins with a meticulous inspection to separate healthy pods from those afflicted by weevils, diseases, or deformities. Following this, the seed coat or testa of the nuts from the healthy pods is removed. This is done by immersing the nuts in clean water for 24 hours to encourage rotting, after which the nuts are peeled and rinsed in fresh water.The rinsed nuts are then gathered in wide, flat baskets to allow excess water to drain before being placed in a room at ambient temperature for three days for curing. During this curing process, defective or infested nuts are identified and removed, and there might be some moisture reduction through sweating.Finally, the nuts are sorted by size and stored in large baskets for proper storage.

Cola nitida: For Cola Nitida, the testa or seed coat of the fresh nuts can be made to rot by placing them on the bare ground with intermittent moistening, covering them with jute bags for 3-4 days. This method causes the nuts to become wet and turn black while also aiding the maturation of premature nuts. Alternatively, the testa of fresh nuts can be soaked in water for 24 hours. After soaking, the nuts are peeled, rinsed, and collected in baskets to drain excess water. During this process, defective and infested nuts are removed.Next, the nuts are cured in flat baskets for three days. Throughout this period, they are subject to regular inspection to eliminate any remaining defective or infested nuts.For storage, the nuts can be transferred to baskets lined with polythene sheets, followed by layers of paper (such as old newspapers) and fresh leaves from specific plant species. These layers are replaced during weekly inspections. Alternatively, the nuts can be stored in jute bags lined with thin transparent polythene sheets, layered with paper and fresh leaves. After two months, the frequency of inspections can be reduced to intervals of 2-3 weeks.These processing techniques are crucial for maintaining the quality and safety of cola nuts for various purposes, including their use in the production of cola-flavored beverages.

Nigeria is the leading world producer of Kolanut (Amon-Arma *et al.* 2021). It is estimated that Nigeria produced 171428.8 metric tonnes of fresh nut in 2021 (FAOSTAT, 2021). Kola has numerous socio-economic as well as nutritional importance. Kola nut is an important article of trade in West Africa and in the trans-Saharan trade routes for many centuries. Kola nut was harvested in 257114 hectares in 2021 (FAOSTAT, 2021). Kolanut is majorly consumed within Nigeria thus efforts must be put in place to increase its consumption through post harvest processing to reduce its bitter taste (Asogwa *et al*. 2012). This study thus seeks to examine Kolanut processing for quality improvement among kolanut processors in Ogun State of Nigeria

METHODOLOGY

The study was carried out in Ogun state, Nigeria. Shagamu town was purposively selected because of the high concentration of kolanut marketers/processors in this area. One hundred and fifteen (115) processors were randomly selected and after sorting out for missing data one hundred and eight (108) kolanut processors' information was used for analysis.

Analytical techniques

Descriptive statistics was used to analyse the data retrieved from the information collected.

RESULTS AND DISCUSSION

Table 1 presented the socio economic characteristics of kolanut processors in Ogun state. The mean age of kolanut processors in the study area was 59 ± 14years. Kolanut processors in the study area are middle aged thus they are still active and could be sensitized and trained on the right processing techniques to improve the taste of kolanut. Ninety four percent of the processors are female.This finding is in conformity with Oluyole *et al*. 2023 which confirmed that men are more into production of tree crops while women are into processing and marketing. In the study area, 42.6% of the processors do not have formal education while 47.4% have a level of education (primary/secondary). Kolanut processors do not really need formal education for their trade, most times they get trained informally from marketers who have been in this trade for a while (Source??).

Table 1: Socio Economic Characteristics of Kolanut Processors in Ogun State

Variable	Freq(108)	%
Age (years)		
<30	1	1.9
31-60	60	55.5
>60	46	41.6
Mean 59 ± 14		
Sex		
Male	6	5.6
Female	102	94.4
Educational Status		
No formal education	46	42.6
Primary	44	40.7
Secondary	18	6.7

Source: Field Survey, 2021

Table 2 presented the quality improvement among kolanut processors. Majority (96.3%) of the processors in the study process more of gbanja/goro type of kolanut.Gbanja/goro is *cola nitida* and it is one of the most popular specie of economic importance in Nigeria (Odo *et al*. 2023). One hundred percent of the processors affirmed that they process their raw kolanut to avoid spoilage. Also 48.1% of the processors reported that to reduce the bitter taste of kolanut they store the nut for a long time or allow it to be well dried. Good post harvest processing techniques could also reduce the bitter taste of kolanut to enhance its consumption. Eighty percent of the processors use leaf to preserve kolanut. They use this to avoid spoilage (33.3%), to enhance the appearance of kolanut (27.8%) and to avoid being heated (20.4%). On the other hand, 77.8% of the processors use nylon to preserve kolanut and some of the reason they use it is to make it airtight thus avoiding spoilage, it also enhance storage for a long time. Majority (96.3%) of the processors use chemical to preserve their nut. They use chemicals such as Gamallin 20 and Phostocin to prevent weevil infestation on kolanuts. They use the two chemicals together probably to make preservation more effective. Eighty three percent of the processors affirmed that they ferment their kolanut before peeling. The reasons for this were to ease peeling, to enhance long term storage and to enhance the appearance of the nut.

Table 2: Quality Improvement among kolanut processors

Variable	Freq(N=108)	%
Type of Kola processed		
Local Kolanut	4	3.7
Gbanja/Goro	104	96.3
Why do you process your kolanut		
To avoid spoilage	108	100.0
How do you reduce the bitter taste of kolanut		
Store the nut for a long time/well dried	52	48.1
Nothing could be done to remove the bitterness	40	37.2
Others	16	14.8
Do you use leaf to preserve kolanut?	86	79.6
Reasons for using leaf		
To enhance the appearance of the kolanut	30	27.8
To dry up the nut quickly	8	7.4
To be used as airtight	8	7.4
To preserve the nut to avoid spoilage	36	33.3
To improve taste (to reduce bitterness)	4	3.7
To avoid being heated	22	20.4
Do you use nylon to preserve your nut	96	77.8
Why do you use nylon to preserve kolanut		
Nylon is airtight and avoid spoilage of nut	54	50.0
Nylon saves labour and does not need to be changed regularly as leaf	6	5.5
Leaf makes kolanut to burn	4	3.7
Nylon moistens nuts	6	5.6
Nylon enhances storage for a long time	34	31.4
Leaf dries up quickly	2	3.8
Do you use chemical to preserve your nut?	~~104~~	~~96.3~~
Yes	??	??
No	??	??
Chemicals used to preserve kolanut		
Gamallin 20 and Phostocin	84	80.8
Gamallin 20 alone	10	9.6
Phostocin alone	10	9.6
Do you ferment your kolanutbefore Peeling?	~~90~~	~~83.3~~
Yes		
No		
Why do you ferment before peeling?		
To ease peeling	36	40
To enhance long term storage	36	40
To enhance colour	8	8.9
To enhance the appearance of the nut	10	11.1

Source: Field Survey, 2021

CONCLUSION

In the context of this study, kolanut processing reduces the bitter taste of kolanuts, especially, when the kolanuts are stored for a long time or allow it to be well dried. The use of leaves to preserve kolanuts avoid kolanut spoilage; it enhances the appearance of kolanuts and it avoids kolanuts from unnecessarily being heated. It is quite disheartening that majority of the processors still use chemicals such as gamallin 20 and phostocin to preserve kolanuts against insecticidal infestation. The study therefore recommended that sensitization on the non-usage of chemicals to preserve kolanuts should be intensified.

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IN VITRO REGENERATION OF TOMATO (*Solanum lycopersicum L.)*

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ABSTRACT
Tomato (Solanum lycopersicum) production is challenged by a wide range of biotic and abiotic stresses, which are the most important constraints for the plant yield and productivity. Sterilization of explants is a pre-requisite step for carrying out any plant tissue culture work for further biotechnology applications. In this study, various concentrations of sodium hypochlorite (NaOCl) with a drop of Tween 20 (T20) were used as surface sterilization treatments, 3.5% NaOCl+ T20 for 20mins, 1.0% NaOCl for 25mins, 10% NaOCl for 5mins, 2.5% NaOCl for 10mins, and 5.25% NaOCl for 10mins. The tomato seeds were thereafter rinsed with sterile double distilled water at least five times to remove traces of sterilant and further blotted on sterile filter paper before culturing. Seeds sterilized with 3.5% solution of sodium hypochlorite for 20mins and 2.5% solution of sodium hypochlorite for 10mins with a drop of non-ionic surfactant (Tween 20) had the highest mean number of leaves (14 ± 0.58) and (12 ± 1.15) which is essential for regeneration purposes using aseptic cotyledonary leaf as explants. The lowest percentage of seed germination were recorded while using the 10% of sodium hypochlorite for sterilization. Therefore, the reported sterilization treatments could be useful for carrying out any biotechnological applications including the clonal propagation of high-value commercial cultivars, virus-free plants and genetic transformation in tomato crop improvement programme.
Keywords*: Sterilization, In vitro Regeneration, explant, Tomato.*

INTRODUCTION

Tomato *(Solanum lycopersicum L.)* belonging to the family *Solanaceae* has a much lower sugar content than other edible fruits and considered as a fleshy vegetable *(Bhatia et al; 2004)*. The fruits are essential source of nutrition for substantial portions of the world's human population because this vegetable crop is widely cultivated and consumed extensively as both fresh vegetable and concentrated processed products *(Beecher, 1998)*. Tomato is grown in tropical, sub-tropical and temperate areas. From the socioeconomic outlook, tomato is well-known as 'Red Gold' in the farming community due to its prominent economic status. However, its productivity is weakened by a wide range of biotic and abiotic stresses which are most important constraints for plant yield and productivity. Abiotic stress conditions such as drought, salinity and heat have been studied in agricultural plants due to the economic losses that they cause every year worldwide *(Martinez et al. 2018)*. Likewise, biotic stresses caused due to pathogen attack such as., bacteria, fungi, virus and nematodes etc. also stimulate adverse effects on plants. Therefore, there is a pressing need for biotechnological interventions to increase the productivity of this crop. The *in vitro* culture of tomato has been successfully used in the different biotechnological applications including the clonal propagation of high-value commercial cultivars, virus-free plants and genetic transformation *(Namitha and Negi, 2013)*. The introduction of qualitative traits into commercial tomato cultivars is substantial, the aim being to ameliorate their nutritional value, productivity, abiotic stress resistance and application in molecular farming *(Gerszberg et al., 2015)*. These crop species exhibited extraordinary nutritional value that's why it is considered to be preventive food *(Raiola et al., 2014)*.

Recently, this crop has gained huge popularity due to its anti-cancer and antioxidant characteristic (*Khuong et al., 2013*). Tomato is rich in vitamins such as vitamins A and C, fiber and considerable quantities of antioxidants such as flavonoids, zeaxanthin, β-carotenes, lutein, and lycopene *(Hobson and Davies, 1971)*. The compound lycopene protects cells and organs in the human body from harmful oxygen free radicals; therefore, they decrease the risk of cancers *(Rao and Agarwal, 2000)*. Tomato is a predominantly inbreeding species and its genetic variation tends to decrease. So, these problems hamper to improve tomato characters through conventional breeding program.

A major limitation to aseptic culture establishment is microbial contaminants which may be introduced into the culture medium from explants and affect the potential of plant regeneration *(Jeffery 2005)*. Surface sterilization of explants is therefore an important precondition in any tissue culture experiment to minimize the chances of contamination. Since, surface sterilization requires the use of chemicals that are, toxic to microorganism but nontoxic to plant material preferably at low concentrations, and in order to find an optimized protocol for sterilization of a specific tissue, three factors are to be taken into consideration viz., sterilant, its concentration and the treatment duration. Maintaining an aseptic or sterile condition has been identified as a pre-requisite step in successful tissue culture procedures *(Badoni and Chauhan, 2010)*. The sterilizing agents used for optimization of in vitro sterilization protocol are ethanol, sodium hypochlorite (NaOCl), calcium hypochlorite, mercuric chloride (HgCl2) and hydrogen peroxide which have been reported toxic to the explants used in plant tissue culture. Therefore, their appropriate minimal concentration and exposure time of sterilants to the explants is an essential step before culturing to achieve maximum survival rate for regeneration purposes.

Proper concentrations of surface sterilizer and explants responsive hormones along with time period are limiting factors for a successful regeneration of tomato plants *in vitro*. So, it is necessary to develop a reproducible *in vitro* regeneration protocol of tomato. Considering all above aspects, the present study was undertaken to determine suitable concentrations and accurate exposure time of surface disinfectant to drastically reduce contamination, thereby increase germination rate in tomato for high frequency plantlet for regeneration and fruit setting.

MATERIALS AND METHODS

Plant materials collected

Seeds of tomato (*Solanum lycopersicum*) (UC82) were obtained from the gene bank of National Horticultural Research Institute (NIHORT) Ibadan, Nigeria. This research work was carried out in the Biotechnology Laboratory of the institute.

Regeneration media

The regeneration media was prepared and adjusted to pH 5.8, melted in a microwave oven. About 50-100 ml of the medium was dispensed into each previously sterilized culture jars, autoclaved at 121°C at 15 psi for 15 min. The efficiency of sterilization was ascertained using Bowie-Dick auto clave tape which changed from blue to black. The preparation was allowed to cool overnight before inoculation process. The seeds were inoculated onto sterile, cooled and solidified regeneration medium (RM). The various constituent of the media used are:

RM1 = MS + 30 g L-1 sucrose + 8 g L-1 agar gel *(Cortina et al., 2004)*
RM2 = MS + 30 g L-1 sucrose + 2 g L-1 phytagel *(Cortina et al., 2004)*

Surface Sterilization

Seeds of UC82 tomato were soaked in distilled water for 30-45mins in order to identify and discard non viable seeds. Various concentrations of sodium hypochlorite (NaOCl) with a drop of Tween 20 (T20) was used as surface sterilization treatments for the presumable viable seeds, duration of treatment was also taken into consideration.

Table 1: Treatment concentration

Sterilants	Reagents	Treatment Duration (mins)
S1	3.5% NaOCl + T20	20
S2	1% NaOCl + T20	25
S3	10% NaOCl + T20	5
S4	2.5% NaOCl + T20	10
S5	5.25% NaOCl+ T20	10

The seeds were rinsed with sterile double distilled water at least five times to remove traces of sterilant and further blotted on sterile filter paper before culturing. It is worthy of mention that the study was carried out in triplicate for each sterilant, 5 seeds in each culture jar, totaling 15 seeds for each sterilant concentration used, also two different gelling agents were used which are agar and Phytagel.

Tomato seed Germination

In-vitro tomato seedlings were produced according to the methods described by (*Cortina et al. 2004)*. Surface-sterilized tomato seeds were inoculated on germination medium (GM). Each culture jar containing germination medium was inoculated with 15 sterilized seeds and were covered to be in the dark at 25 ± 2°C for 3 - 5 days to germinate and then exposed to a 16/8 hrs light photoperiod with light intensity of 1500 lux for 7 - 10 days at the same temperature. Data were taken 12-14 days after inoculation.

RESULTS

Table 2: Plant Parameters obtained from RM1

Sterilants	Treatment Duration (mins)	Number of seeds inoculated	Number of germinated seeds	Germination percentage (%)	Number of Leaves	No. of Leaves ± S.E	Average plant height(cm)
S1	20	15	14	93.3	42	14 ± 0.58	5.47
S2	25	15	3	20.0	9	3 ± 3.00	7.00
S3	5	15	8	53.3	20	6.67 ± 1.67	5.67
S4	10	15	5	33.3	14	4.67 ± 4.66	6.20
S5	10	15	5	33.3	20	6.67 ± 4.41	7.00

RM: Regeneration media

Table 3: Plant Parameters obtained from RM2

Sterilants	Treatment Duration (mins)	Number of seeds inoculated	Number of germinated seeds	Germination percentage (%)	Number of Leaves	No. of Leaves ± S.E	Average plant height(cm)
S1	20	15	9	60.0	24	8 ± 4.16	5.50
S2	25	15	8	53.3	23	7.67 ± 4.09	7.00
S3	5	15	7	46.7	19	6.33 ± 3.28	6.10
S4	10	15	14	93.3	36	12 ± 1.15	5.40
S5	10	15	12	80.0	22	10.67 ± 1.33	6.13+

Figure 1: Media with Phytagel

Figure 2: Media with Agar

DISCUSSION

In the present study, effect of different concentrations on sodium hypochlorite and drop of T20 on efficiency of seed germination to produce aseptic cotyledonary leaves for regeneration was evaluated. It was observed from the study that is (Table 2), 3.5% NaOCl for 20mins (S1) was found to be the best concentration for sterilization, seeds that were sterilized with S1 has the highest germination rate of 93.3% which signifies no contamination in the culture jars, 1.0% NaOCl for 10mins has the lowest germination rate of 20.0% due to contamination. S1 also has the highest number of leaves 42(14 ± 0.58) which is essential for regeneration purposes using aseptic cotyledonary leaf as explant.

However, from (Table 3), 2.5% NaOCl with drop of T20 for 10mins (S4) had no contamination thereby having the highest number of leaves 32(12 ± 1.15), S1 which had the highest germination rate in table 1 recorded no germination in one of the culture jars which in turn narrowed the germination rate to 60%.

Among the different concentration of sodium hypochlorite (NaoCl) used for surface sterilization, the maximum aseptic germination was achieved at 3.5% and 2.5% respectively in both RM1 and RM2, While the lowest percentage of seed germination were recorded while using the 10% of sodium hypochlorite for sterilization, Inhibition of seeds germination at higher concentration might be due to peroxiding action of chloride atoms and ions that combines with proteins causing the death of biological organisms *(Pauling, 1955)*. In contrast to our observations, many researchers have previously recorded different treatment combinations and concentrations of sterilants for different durations such as 70% ethanol for one minute followed by soaking in 4% NaOCl *(Soundarajan, 2015)*, 70% ethanol for 30 minutes and 20% NaOCl for 20 minutes *(Manawadu et al., 2014)*, 70% ethanol for 10 seconds followed by continuous shaking *(Chandra et al., 2013)* and 0.1% HgCl2 for 3 minutes, respectively.

CONCLUSION

The study has shown that contaminant free cultures could be obtained with an efficient sterilization protocol as well as the derivation of aseptic cotyledonary leaves for in vitro regeneration for indirect shoot and root organogenesis from local tomato cultivar which could be useful for crop genetic improvements and micro propagation purposes. All the concentrations of sodium hypochlorite solution (NaOCl) used for surface sterilization has significant effect on seed germination.

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CONSUMPTION PATTERN OF PROCESSED GINGER AMONG HOUSEHOLDS IN IDO LOCAL GOVERNMENT AREA, IBADAN

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ABSTRACT

This study investigates the consumption patterns, level of awareness of the health benefits of processed ginger and factors influencing processed ginger's purchase decision among households in Ido local government Area of Ibadan, Oyo state. The respondents for the study were selected through two-stage sampling techniques. Data was collected with the use of structured questionnaire. Descriptive statistics and probit regression were used for data analyses. Result showed that average age of respondents was 42 years and most (95.0%) of them were aware of processed ginger's health benefits. About (38%) of the respondents obtained their information by word of mouth. About 46% of the respondents prefer to consume ginger as herbal tea/drink, Household size, education, training on the health benefits of processed ginger are factors with statistically significant influence on processed ginger's purchase decision. It is recommended that training sessions on health benefits and marketing campaigns should be implemented on its main usage as an herbal tea or drink to increase regular consumption.

Keywords*: Consumption patterns, Processed ginger, Ido local government, Food processing*

INTRODUCTION

Unhealthy dietary patterns and poor eating habits have been identified as primary promoters of major diseases including heart disease, stroke, chronic lung disease, cancer, and diabetes on a global scale (WHO, 2011). The growing interest of consumers in achieving optimal health, prolonging life expectancy, and enhancing their quality of life has led to a renewed focus on the consumption of functional foods, which are commonly recognized for their medicinal and health-enhancing properties (Kotilainen *et al*., 2006). Ginger, scientifically known as *Zingiber officinale Rosc*., is a root and spice crop that belongs to the Zingiberaceae plant family. The name "Zingiber" is derived from the Greek word "Zingiberis", which originates from the Sanskrit name "Singabera". Ginger has been used as a medicinal remedy since ancient times and continues to be a crucial cooking spice worldwide. Processed ginger products offer a level of convenience and satisfaction that fresh ginger lacks. In today's fast-paced world, consumers are drawn to the ease of incorporating ginger into their diets without the hassle of peeling, grating, or chopping fresh ginger rhizomes. Processed ginger products like ginger paste and ginger powder are readily available and save valuable time in meal preparation. According to Anita *et al*. (2020), processed ginger in the form of ginger candy can reduce the vomiting rate in pregnant women during their first trimester.

According to Onwusiribe *et al*. (2020), Ginger is perishable and given the poor state of storage and other infrastructural facilities in Nigeria, post-harvest losses are massive, thus, there is market glut during harvest periods and marked scarcity during off-seasons. This phenomenon makes the need for value addition (such as processing and packaging) very pertinent to improve the shelf life of fresh ginger and to attract a fair price to the farmers. From an economic point of view, the importance of reducing food wastage is often emphasized to enhance resource efficiency. Processed ginger products, such as ginger paste, ginger powder, and ginger-infused oils, have longer shelf lives compared to fresh ginger. This increased shelf life translates into reduced food waste, which is not only economically advantageous for consumers but also aligns with sustainability goals by minimizing resource wastage.

Numerous studies have substantiated the advantageous effects of ginger products on human health. Despite the increasing recognition of its consumption and health benefits, the level of awareness remains notably inferior in comparison to other spices such as onion and locust bean, as highlighted by Oguntoye *et al*., (2020). Furthermore, limited research has been conducted on the consumption of processed ginger, the extent of awareness regarding its health benefits, and the factors that influence the decision to purchase processed ginger. These factors serve as the basis for conducting the present study.

MATERIALS AND METHOD

The study was conducted in Ido local government. Ido local government is one of the thirty-three local governments in Oyo state. It was carved out of Akinyele local government in 1989. According to the 2006 census, it has an area of 986 km^2 and a total population of 103,261. The major towns within the local government are Ido, Apata, Ijokodo, Omi adio, Akufo, and Apete.

A two-stage sampling procedure was used to select 80 respondents for the study. The first stage of the sampling involves a purposive selection of Ido local government of Oyo state, after which twenty respondents was randomly selected from each of the four major towns in Ido local government which are: Ido, Apata, Omi adio and Apete which will make a total of eighty respondents.

METHODOLOGY

Descriptive statistics

Descriptive statistics was used to analyze the socio-economic characteristics of the respondents, consumption patterns and level of awareness of the health benefits of processed ginger.

The Probit Model

Probit regression was employed in the analysis of factors influencing processed ginger's purchase decision. The probit model is as specified: $yi^* = Xi\,\gamma + ui$

Where:

yi^* = latent variable that defines the rule as to whether a household would decide to consume ginger or not

Xi = a vector of exogenous variables

γ = coefficients associated with the repressors (X) including the constant term

ui = error term assumed to be normally distribution with zero mean and unit variance

RESULTS AND DISCUSSION

Table 1: Socio-economic characteristics of the respondents.

Variables	Category	Frequency	Percentage	Mean
Gender	Male	25	31.3	
	Female	55	68.8	
Religion	Islam	45	56.3	
	Christianity	35	43.8	
Marital status	Single	12	15.0	
	Married	62	77.5	
	Divorced	2	2.5	
	Widow	4	5.0	
Age	≤ 30	22	27.5	
	31- 40	12	15.0	
	41- 50	21	26.3	42
	51- 60	19	23.8	
	> 60	6	7.5	
Education level	Primary education	1	1.3	
	Secondary education	24	30.0	
	Tertiary education	55	68.8	
Household size	1-3	22	27.5	
	4-6	54	67.5	4
	≥ 7	4	5.0	
Monthly income	≤ 30000	11	13.8	
	30001 – 70000	27	33.8	
	70001 – 110000	34	42.5	75775
	110001 - 150000	4	5.0	
	150001 - 200000	4	5.0	
Monthly food expenses	≤ 4000	15	18.8	
	4001 – 8000	29	36.3	
	8001 – 12000	25	31.3	8678
	12001 – 16000	8	10.0	
	16001 – 20000	3	3.8	

Monthly expenses on processed ginger	≤ 300	15	18.8	
	301 – 600	43	53.8	123
	601 – 900	21	26.3	
	901 – 1200	1	1.3	

Source: Field survey, 2023

The result revealed that most of the respondents were female (68.8%) with a mean age of 42 years which signifies that they are in active age group which means level of consumption and awareness about the health benefits of processed ginger will be high. The mean household size was 4 persons. Most of the respondents had tertiary education level (68.8%) which could be of a great factor to their level of consumption and awareness about the health benefits of ginger. About 43% of the respondents had average monthly income of ₦75775, about 36% of the respondents spends between ₦4001 to ₦8000 monthly on food with average monthly food expenses of ₦8678. About 54% of the respondents spends between ₦301 to ₦600 monthly on processed ginger with average monthly expenses on processed ginger of ₦123

Table 2: Respondent's awareness about the health benefits of processed ginger

Awareness about the health benefits of processed ginger	Frequency	Percentage
Aware	76	95.0
Not aware	4	5.0
Total	80	100.0

Source: Field survey, 2023

Ginger has a lot of health benefits which includes aiding of food digestion, relieves nausea, serves as antioxidant and it boosts the immune system. The result shows that most (95.0%) of the respondents were aware about the health benefits of processed ginger. This is a relatively high level of awareness which is expected to stimulate consumers towards its consumption.

Table 3: Sources of information about the health benefits of processed ginger

Sources of information about the health benefits of processed ginger	Frequency	Percentage
Social media	18	22.5
Electronic media	18	22.5
Print Media	5	6.3
Doctor or Nutritionist	9	11.3
Word of mouth	30	37.5
Total	80	100

Source: Field survey, 2023

There are many sources of information about the health benefits of processed ginger, these sources includes social media, electronic media, print media, doctor or nutritionist and word of mouth. From the result, it was found that most (38%) of the respondents obtained their information by word of mouth which is closely followed by social media and electronic media (23%).

Table 4: Respondent's consumption patterns of processed ginger

Consumption pattern	**Frequency**	**Percentage**
Cooked with food	24	30.0
As herbal tea/drink	37	46.3
Mix with pap	18	22.5
Sauce	1	1.3
Total	80	100.0

Source: Field survey, 2023

Processed ginger is consumed in different forms which includes cooking with food, consumption as an herbal tea or drink, mixed with pap and as a sauce. Most (46%) of the respondents consumed processed ginger as an herbal tea or drink; about 30% consume it by cooking it with food while about 22.5% consumed it with pap while 1.3% of the respondents consumed it as a sauce.

Table 5: Factors influencing purchase decision of processed ginger

Consumption	Coef.	Std. Err.	Z	P>z	[95% Conf.	Interval]
Age	.0089008	.0150626	0.59	0.555	-.0206214	.0384229
Gender	-.6231389	.3800996	-1.64	0.101	-1.368121	.1218426
Marital Status	.1417352	.2451689	0.58	0.563	-.338787	.6222574
Household size	.2404373	.1396126	1.72	0.085*	-.0331984	.5140729
Education	.6957776	.3633412	1.91	0.055*	-.016358	1.407913
Religion	.0645302	.355346	0.18	0.856	-.6319352	.7609957
Income	6.34e-06	5.10e-06	1.24	0.214	-3.66e-06	.0000163
Training	2.13488	.5776398	3.70	0.000***	1.002727	3.267034
_cons	-5.617547	2.1272	-2.64	0.008	-9.786782	-1.448313

Source: Field Survey (2023)

Number of obs = 80, LR chi^2 (8) = 34.65, Prob > chi^2 = 0.0000, Log likelihood = -37.73, Pseudo R^2 = 0.3147

Table 5 shows the results of probit regression analysis carried out to identify the socio-economic determinants of processed ginger's purchase decision. The Log-likelihood function of the estimated model is -37.73 with the associate Chi-square value (34.65) is statistically significant ($P < 0.000$), implying that the probit model can be relied upon to predict the factors influencing processed ginger's purchase decision. Household size, education, training on the enlightenment of health benefits of processed ginger are factors with positive and statistically significant influence on processed ginger's purchase decision. This is in support of the study of Phuah *et al*. (2015) who found statistically significant influence of education and household size on their purchasing behaviour towards functional foods. The positive signs of the coefficients of the significant variables suggest that the variables can substantially enhance the likelihood of consumer decision to purchase processed ginger in the study area.

CONCLUSION AND RECOMMENDATION

Findings reveals that the awareness about the health benefits of processed ginger is relative high in the study area, with most consumers consuming it as herbal tea/drink. Consumer's household size, education, training on the enlightenment of health benefits of processed ginger are strong influencers of processed ginger's purchase decision. Their age, gender and income play little role in explaining ginger's purchase decision. Based on empirical findings of this study, it is recommended that educational programs and training sessions should be implemented to increase awareness about the specific health benefits of processed ginger. These programs should focus on both the methods of processing fresh ginger and the broader health advantages of consuming processed ginger. Also, marketing campaigns on its main usage as an herbal tea or drink should be created and tips on how to incorporate processed ginger into their daily routines should be provided to encourage regular consumption.

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RESIDUAL EFFECT OF ORGANIC MATERIALS IN THE PROPAGATION OF YELLOW FICUS

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ABSTRACT
Yellow ficus (Ficus retusa 'Nitida') as an hedge plant is used for landscaping. To optimize the propagation technology for this important hedge plant, this study was conducted to evaluate the residual effect of organic materials in the varying growth media utilised in the propagation of yellow ficus at the nursery stage. The growth media utilised were topsoil, sawdust, topsoil + cow dung (4:1), topsoil + poultry manure (4:1), cow dung + sawdust (1:4), sawdust + poultry manure + topsoil (1:1:3) and sawdust + cow dung + topsoil (1:1:3). The experimental design was Completely Randomized Design (CRD) with three replications. At initial planting, at 13 weeks after planting (WAP), under nursery conditions, there was significant difference in yellow ficus plants grown in the media sawdust, cow dung and topsoil S+C+T (1:1:3) (26.92) and Topsoil (T) alone (27.13) as they supported greater leaves production though similar in their support, with medium sawdust, poultry manure and topsoil S+P+T (1:1:3) (24.18) closely following, in comparison with Sawdust (S) alone (9.78). At residual planting, Sawdust (S) alone support for leaves production was the poorest from 7WAP till the end of the study. Medium T+C (4:1) performed excellently well and maintained gradual increase in the highest leaves produced throughout the residual planting period. At 13WAP, medium T+C (4:1) supported production of the highest number of branches at both initial and residual plantings. At 13WAP initial planting, S+C+T (1:1:3) (6.72) supported longest branch length in yellow ficus while at residual planting, longest branch length was supported by Topsoil alone (8.27) with S+C+T (1:1:3) (6.78) closely following. Positive significant difference in C+S (1:4) (1.00) influence on branch girth was observed at initial planting while widest branch girth was supported by S+C+T (1:1:3) at residual planting. At initial planting, sawdust alone (32.39) supported longest root length closely followed by topsoil alone (26.48). In residual planting, highly significant difference was observed as topsoil alone (14.31) supported longer root lengths of yellow ficus. From this study, the media T+C (4:1), S+C+T (1:1:3) and S+P+T (1:1:3) in this order are recommended for residual use in yellow ficus planting at the nursery stage.
Keywords: growth media, nursery, organic materials, residual, yellow ficus.

INTRODUCTION
Yellow ficus is an economically important and attractive ornamental hedge plant used in landscaping that is relatively hardy when fully established. It is a species of evergreen woody plant in the fig genus, native to the Malay Archipelago and Malesia floristic region and Indochina floristic region, and the Indomalaya ecozone, i.e. of India, Malaysia origin (Gilman and Watson, 1993). It is ornamental plant made up of different species and cultivars and about 70 species of Ficus are found naturally in West Africa. According to Henley *et al*. (2009), Yellow ficus (formerly Ficus microcarpa L.f., now Ficus nitida) also known as Ficus retusa 'Nitida', the Cuban laurel fig, belongs to the genus, Ficus. The plant is 'difficult-to-root but sawdust + cow dung + topsoil (1:1:3) is a medium that most favorably supported establishment and sustenance of yellow ficus plants (Adeoluwa *et al*., 2014) as it encourages early rooting and establishment. Alternative products as components of media mixes for horticultural use are becoming important. Selection of substrates for horticultural use is often based on cost, availability, ease of handling, and consistency. Factors such as transportation costs, consistency of product, disease and insect infestation, and availability of such alternative materials remain the main concerns for growers. Development in the landscape industry leads to new opportunities for use of different types of alternative materials. In recent times, some common organic by-products are marketed to the horticultural industry. They include animal wastes such as poultry litter, poultry manure, cow dung, etc.
As important as the use of topsoil is in raising ornamental plants, the continuous use of topsoil alone in raising ornamental plants in the nursery till maturity or till they are sold off could lead to land degradation over time which may pose a threat to environmental sustainability (Akintoye *et al*., 2012). What is considered a waste by someone, can be another person's material for use; "One man's waste is

another man's treasure" (Sibley *et al*., 2013). This is applicable to agricultural waste materials we find useful for various horticultural purposes. Natural, farm and forestry by-products/ wastes are often abundant and readily available. They could be utilised as components of growth media mixes in ornamental plants production, especially, at the nursery stage. However, the reuse of growth media could be a means of reducing the quantity of topsoil used in raising plants in the nursery, reduce environmental degradation, while ensuring sustainability and preservation of the environment. Removal of plants, bagging them bare root with minimal media, moving them particularly over a long distance and planting them in desired location is possible without loss of plants. This is also done with yellow ficus seedlings ready to be transplanted. This indicates that media from which these nursery plants are removed can be reused. Therefore, this study is aimed at utilising some agricultural waste materials and determining their residual effects in the propagation of yellow ficus at the nursery stage.

MATERIALS AND METHODS

The experimental site was the screen house of the National Horticultural Research Institute, (NIHORT), Ibadan, Oyo State, Nigeria (30 52'E and 70 25'N) between early season May to August, 2022 (initial planting) and late season July to October, 2022 (residual planting). Yellow ficus (Ficus retusa 'Nitida') cuttings with eight (8) nodes each were planted in black polythene nursery bags filled with different growth media. Each nursery bag had a cutting of yellow ficus planted in it. The nursery bag was 10cm by 12cm and medium sized. The growth media utilized in this study include: topsoil alone, sawdust alone, topsoil + cow dung (4:1), topsoil + poultry manure (4:1), cow dung + sawdust (1:4), sawdust + poultry manure + topsoil (1:1:3) and sawdust + cow dung + topsoil (1:1:3). Equal measurement of these different growth media was put in the nursery bags. Each medium had three replications. Topsoil was obtained within NIHORT, Ibadan, Oyo state, Nigeria. Sawdust was obtained from the processed wood from the Wood Processing department of Forestry Research Institute (FRIN), Ibadan, Oyo state, Nigeria. The trees lumbered from which the sawdust were obtained were matured (>20 years). Cured poultry manure from birds raised in battery cages were utilized in this study. Growth media samples were collected prior planting and analysed according to standard procedure (IITA, 1979).

The experimental design was Completely Randomized Design (CRD) with three replicates. Mist propagation technique (Brown, 2011) was utilised to encourage the rooting of the cuttings. Plants were uncovered after three (3) weeks. 450ml of water per plant per week was applied in the course of the trial. Necessary nursery and other agronomic practices were carried out. No insecticide application during the study. Data collection on number of leaves commenced three weeks after plants were uncovered. Data on number of branches and branch length was taken at ninth week after plants were uncovered; and every forth night thereafter. Data collection on branch girth and root length was at the termination of the experiment. On termination of first planting, and at commencement of the residual study, the ficus plants were removed from each medium and fresh cuttings were planted in each following the same procedure as utilised in the first planting. Data collected were subjected to one-way analysis of Variance (ANOVA) using SAS 1999 package to determine the difference in means and Least Significant Difference (LSD) at $p < 0.05$ probability level was used to compare the treatment means (SAS, 1999).

RESULTS AND DISCUSSION

Media analysis

The results of the physical and chemical analyses of the media utilized in this study are presented in Tables 1a and 1b.

Soil Analysis

The topsoil was sandy loam in texture with pH 7.7. The available N=0.03%, P=8.2%, K=9.59cmolkg-1, Na=35cmolkg-1, Ca=42.16cmolkg-1, Mg=4.64cmolkg-1; Fe=0.79mgkg-1, Zn=2.92mgkg-1 and Mn=58.6mgkg-1.

Growth media initial and residual plantings effects on yellow ficus plants

(i) Root length in yellow ficus as influenced by growth media at initial planting and the residual effects

At initial planting, Sawdust alone (32.39) supported roots production as well as longest root length in yellow ficus plants production and growth in the nursery (Table 2). Positive significant difference was observed in the root length of plants in the medium sawdust alone (32.39) compared with those in C+S (1:4) (7.10) and T+P (4:1) (8.67). Plants in this medium (sawdust alone) most likely had earlier rooting and longer roots (Table 2). This is supported by Olosunde (2003), that the medium in which a plant is grown do have an effect on the percentage of rooting and quality of root such plants will have. Also, growing and penetrating roots can easily move sawdust aside as it is light (Adeoluwa *et al*., 2014) and such allows the roots movement towards available water and nutrients resulting in longer roots. The heavier or more compact the soil or medium, the more difficult for roots movement resulting in compact and shorter roots. Akinyele (2010) corroborated that using sawdust as the rooting medium resulted in seedlings with longer root lengths compared to those in topsoil as rooting medium. However, it is suggested that in this study, due to lack of adequate nutrients, over time, sawdust alone could not sustain the growth and development of the yellow ficus plants as evident in the plants' poor number of leaves and branches produced, branches length and girth. No significant difference was observed between T+P (4:1) (8.67) and C+S (1:4) (7.10).

All the other media showed similarity in their influence on root development of the yellow ficus plants (Table 2). They include topsoil alone (26.48), S+P+T (1:1:3) (17.81), S+T+C (1:1:3) (11.25) respectively. This shows the degree of their influence in supporting root development, establishment, growth and survival of the yellow ficus plants.

Residual effects

The medium Topsoil alone supported longer root lengths of yellow ficus, 14.31 compared to C+S (1:4) (3.33) and T+P (4:1) (3.00) (Table 2). This could be as result of the sandy loam texture of the topsoil. T+P (4:1)) and C+S (1:4) influence on root length was not significantly different from each other at residual planting.

(ii) Number of branches production in yellow ficus as influenced by growth media at initial planting and the residual effects

At initial planting, there were no significant differences in the influence of the various growth media on the number of branches produced by the yellow ficus cuttings planted in them from the 9WAP to 11WAP in this study (Table 3). However, at 13WAP yellow ficus plants in the medium T+C (4:1) 7.53 produced the highest number of branches, outperforming the other media but closely followed by those in Topsoil alone (6.47), T+P(4:1) (6.25) and S+C+T (1:1:3) (5.58) respectively (Table 3). There was positive and highly significant difference between T+C (4:1) 7.53 and C+S (1:4) 3.83 (Table 3). C+S (1:4) medium least supported branching in yellow ficus under nursery conditions throughout the experiment, closely followed by sawdust alone.

Residual effects

There was no significant media influence on branches production within the 11 weeks of planting. At 13WAP, T+C (4:1) (3.30) highly significantly supported number of branches produced compared with the other growth media but closely followed by S+C+T (1:1:3) (2.73) (Table 3). Plants in sawdust alone (1.50) performed least in branches production. This could be as a result of a low and eventual depletion of nutrient content in the medium over time. The other media were similar in their support for branch production.

(iii) Branch length in yellow ficus as influenced by growth media at initial planting and the residual effects

At 9WAP, no significant difference in the influence of the media on branch length of yellow ficus plants was observed at initial planting (Table 4). However, at 11WAP, S+C+T (1:1:3) and topsoil alone, in a similar manner supported the growth of longest branches in yellow ficus plants. Furthermore, at 13WAP in the same trend, S+C+T (1:1:3) (6.72) supported longest branch length in yellow ficus in comparison with sawdust alone (2.92) medium. C+S (1:4) 3.40, and sawdust alone (2.92) significantly least supported branch length increase throughout this study.

Residual effects

No significant difference was observed on influence of the planting media on branch lengths of yellow ficus seedlings (Table 4).

(iv) Branch girth in yellow ficus as influenced by growth media at initial planting and the residual effects

At initial planting, positive highly significant difference in C+S (1:4) (1.00), influence on branch girth compared with the media S+P+T (1:1:3) (0.29) and T+P (4:1) (0.26) which show similarity in their influence on yellow ficus under nursery conditions was observed (Table 5). No significant difference observed in S+C+T (1:1:3) (0.18), topsoil alone (0.16), T+C (4:1) (0.16) and sawdust alone (0.15) support for branch girth (Table 5).

Residual effects

In the residual studies, S+C+T (1:1:3) (0.15) highly significantly supported branch girth of yellow ficus plants and were wider than those in T+C (4:1) (0.12) (Table 5). C+S (1:4) (0.05), S+P+T (1:1:3) (0.06) and T+P (4:1) (0.05) were similar in their influence on branch girths of the yellow ficus plants in them. C+S (1:4) (0.05) and T+C (4:1) (0.12) media were absolutely different in their support for branch girth of yellow ficus plants in them despite they both contained cow dung as a source of nutrients. Medium C+S (1:4) indicated a limitation in available nutrients due to sawdust content compared to the topsoil advantage in medium T+C (4:1) which eventually affects the branch girths development of yellow ficus plants. Also, highly significant difference was observed in influence of S+T+C (1:1:3) (0.15) on branch girths of yellow ficus plants compared with S+P+T (1:1:3) (0.06) despite they both contained cow dung and poultry manure respectively as complementary source of nutrients. This suggest that cured cow dung as constituent of growth media supports yellow ficus growth as earlier reported by Adeoluwa *et al*. (2014). Sawdust alone least supported branch girth in yellow ficus growth under nursery conditions at both plantings.

(v) Leaves production of yellow ficus as influenced by growth media at initial planting and the residual effects

At 3WAP, the medium topsoil alone supported leaves production best in comparison with all the media at initial planting (Table 6). At 7WAP and 11WAP, there was no significant difference in media influence on the number of leaves produced by yellow ficus plants in this study. However, at 9WAP, all media influenced increased number of leaves production and performed similarly except T+P (4:1) (18.08) which supported highest number of leaves production, closely followed by S+C+T (1:1:3), (16.92), Topsoil alone (16.07) and T+C (4:1) (15.40) respectively. The medium sawdust alone least supported yellow ficus leaves production from 7WAP till the termination of the experiment.

At 13WAP, Yellow ficus plants performance in the various media varied as observed in this study (Table 6). The media topsoil alone (27.13) and S+C+T (1:1:3) (26.92) supported greater leaves production though they performed similarly in their support of yellow ficus survival and growth under nursery conditions. There was no significant difference in plant performance between media T+P (4:1) and T+C (4:1) in their influence on leaves production (Table 6). This suggests that either of these media could be used in planting yellow ficus in the nursery. Presence of cow dung or poultry manure in these media will provide nutrients for the plants; as organic materials improve soil structure and aeration thereby making air and water necessary for plants growth, improves water holding capacity (Onemli, 2003), lessens evaporation (Kushwaha *et al*., 2001). Nutrient is made available to the plants in a slow-releasing manner ensuring early rooting and survival of this difficult-to-root plant.

Residual effects

At residual planting, no significant difference on leaves production in yellow ficus seedlings were observed amongst the media at 3WAP, 5WAP and 9WAP in this study. More variations in growth media support for leaves production was observed as the weeks after planting increased. At 7WAP, the media C+S (1:4) (15.67) and S+C+T (1:1:3) (15.00) showed similar influence in their support for leaves production in yellow ficus seedlings compared with the other media. Sawdust alone support for leaves production was the poorest from 7WAP residual planting till the end of the study. At 11-13WAP, S+C+T (1:1:3), S+P+T (1:1:3), T+C (4:1) and T+P (4 :1) all performed and maintained positively significant support of leaves production in yellow ficus plants planted in them in a similar trend across the weeks. However, at both periods, T+C (4:1) 21.32 and 22.37 at 11WAP and 13WAP respectively, outperformed and were significantly different from all other media in supporting leaves production of yellow ficus plants at residual. It was closely followed by S+C+T (1:1:3) 16.90 and 18.70; C+S (1:4) 16.47 and 16.87 and S+P+T (1:1:3) 14.73 and 16.87 across 11WAP and 13WAP respectively. These aforementioned media (T+C (4:1), S+C+T (1:1:3), T+P (4 :1), S+P+T (1:1:3), and C+S (1:4) compared with topsoil alone indicated the advantage of the presence of poultry manure, cow dung and sawdust in improving soil structure and texture; growth media porosity and aeration. According to Carter (2002), organic matter even in small amounts have effects on the soil/medium physical, chemical and biological properties. The extra source of nutrients and slow-nutrient releasing ability of poultry manure and cow dung in the media ensures availability of the required nutrients to the plants despite the soil was planted in previously. This availability of the required nutrients to the plants gradually will ensure more leaves production which is a vital part in hedge plant growth. Therefore, either of these media could be utilised for production in the nursery for a longer period and for residual use in yellow ficus propagation and growth.

CONCLUSION AND RECOMMENDATION

In conclusion, the media T+C (4:1), S+C+T (1:1:3), S+P+T (1:1:3) and T+P (4 :1) in this order are recommended for residual use in yellow ficus planting at the nursery stage. It is of note that each of these growth media has manure in them. However, cow dung is favored in media mixes for yellow ficus production based on their influence and support of the plants in the nursery and residual plantings. Cow dung which is often plant based will encourage easier rooting and establishment with available nutrients for a longer period.

Table 1a: Analysis of growth media, agricultural waste and topsoil utilized in yellow ficus production

Available macronutrients									
Growth media	N	P	Ca	Mg	K	Na	Fe	Zn	Mn
	%	%		c mol kg^{-1}				mg kg^{-1}	
TS	0.03	8.2	42.16	4.64	9.59	35	0.79	2.92	58.6
S	0.1	15	39.79	22.75	69.18	38	17	5.65	149.5
PM	1.05	0.015	8.1628	5.314	1.76	2.934	0	23.5	155.6
S+P+T	0.25	17.1	40.04	34.1	36.49	9.55	0.16	1.1	42.8
T+P	0.55	17.9	65.79	39.96	54.18	10.42	8.41	11.47	94.6
C+S	0.43	0.023	13.514	4.483	28.431	47.053	0	2.6	201.4

KEY

TS= Topsoil, S= Sawdust, PM= Poultry manure, S+P+T=Sawdust+Poultry manure+Topsoil (1:1:3), T+P= Topsoil+Poultry manure, C+S= Cowdung+Sawdust

Table1b: Soil analysis

	%SAND	%CLAY	%SILT	PARTICLE SIZE	pH
Topsoil	58.4	12	29.6	Sandy loam	7.7

Table 2: Root length of yellow ficus plants in response to growth media at initial and residual plantings

Growth media	**Root length (cm) at 13WAP**	
	Initial planting	**Residual planting**
Sawdust + Cow dung + Topsoil	11.25ab	8.11ab
Topsoil+Poultry manure	8.67b	3.00b
Sadust alone	32.39a	5.60ab
Cow dung + Sawdust	7.10b	3.33b
Sawdust + Poultry manure + Topsoil	17.81ab	5.18ab
Topsoil + Cow dung	11.15ab	8.16ab
Topsoil alone	26.48ab	14.31a
LSD	23.56	9.43

Means with the same letters are not significantly different at P<0.05 along columns

Table 3: Number of branches of yellow ficus plants in response to growth media at initial and residual plantings

Growth media	**Number of branches 9WAP - 13WAP**		
		Weeks after Planting (WAP)	
Initial planting	**NBR9**	**NBR11**	**NBR13**
Sawdust + Cow dung + Topsoil	5.17a	5.17a	5.58a
Topsoil+Poultry manure	6.58a	6.58a	6.25a
Sadust alone	3.56a	6.69a	4.56a

Cow dung + Sawdust	4.00a	4.00a	3.83a
Sawdust + Poultry manure + Topsoil	4.08a	4.08a	4.83a
Topsoil + Cow dung	6.47a	6.47a	7.53a
Topsoil alone	6.33a	6.33a	6.47a
LSD	3.36	3.95	3.21
Residual planting			
Sawdust + Cow dung + Topsoil	2.40a	2.77a	2.73ab
Topsoil+Poultry manure	2.15a	2.33a	2.52ab
Sadust alone	2.00a	2.17a	1.50b
Cow dung + Sawdust	2.33a	4.00a	3.22ab
Sawdust + Poultry manure + Topsoil	2.56a	3.00a	2.53ab
Topsoil + Cow dung	2.33a	3.89a	3.30a
Topsoil alone	2.98a	2.33a	2.08ab
LSD	2.07	2.16	1.74

Means with the same letters are not significantly different at P<0.05 along columns; NBR=number of branches

Table 4: Branch length of yellow ficus plants in response to growth media at initial and residual plantings

Growth media	**Branch length 9WAP - 13WAP**		
	Weeks after Planting (WAP)		
Initial planting	**BL9**	**BL11**	**BL13**
Sawdust + Cow dung + Topsoil	4.26a	5.35a	6.72a
Topsoil+Poultry manure	3.52a	3.61ab	4.27ab
Sadust alone	1.61a	2.16b	2.92b
Cow dung + Sawdust	2.84a	3.86ab	3.40ab
Sawdust + Poultry manure + Topsoil	3.90a	4.72ab	5.63ab
Topsoil + Cow dung	3.37a	3.59ab	4.31ab
Topsoil alone	4.17a	4.97a	6.39ab
LSD	11.78	2.80	3.80
Residual planting			
Sawdust + Cow dung + Topsoil	2.63a	4.47a	6.78a
Topsoil+Poultry manure	2.43a	3.23a	4.53a
Sadust alone	2.47a	2.47a	4.23a
Cow dung + Sawdust	1.67a	4.13a	6.45a
Sawdust + Poultry manure + Topsoil	2.37a	4.27a	4.38a
Topsoil + Cow dung	2.97a	5.27a	5.80a
Topsoil alone	1.83a	6.90a	8.27a
LSD	2.04	4.96	6.72

Means with the same letters are not significantly different at P<0.05 along columns; BL= branch length

Table 5: Branch girth of yellow ficus plants in response to growth media at initial and residual plantings

Growth media	Branch girth (cm) at 13WAP	
	Initial planting	**Residual planting**
Sawdust + Cow dung + Topsoil	0.18b	0.15a
Topsoil+Poultry manure	0.26ab	0.05bc
Sadust alone	0.15b	0.04c
Cow dung + Sawdust	1.00a	0.05bc
Sawdust + Poultry manure + Topsoil	0.29ab	0.06bc
Topsoil + Cow dung	0.16b	0.12ab
Topsoil alone	0.16b	0.12abc
LSD	0.78	0.078

Means with the same letters are not significantly different at P<0.05 along columns

Table 6: Number of leaves of yellow ficus plants in response to growth media at initial and residual

Growth media	Number of leaves 3WAP - 13WAP Weeks after Planting (WAP)					
Initial planting	**NL3**	**NL5**	**NL7**	**NL9**	**NL11**	**NL13**
Sawdust + Cow dung + Topsoil	3.28bc	7.76ab	16.56a	16.92ab	25.54a	26.92a
Topsoil+Poultry manure	5.88ab	11.55ab	17.18a	18.08a	25.83a	24.18ab
Sadust alone	5.30abc	9.07ab	7.60a	7.51b	11.16a	9.78b
Cow dung + Sawdust	2.31c	5.17b	11.77a	9.67ab	14.50a	14.61ab
Sawdust + Poultry manure + Topsoil	4.32bc	9.06ab	13.20a	11.13ab	17.93a	19.50ab
Topsoil + Cow dung	5.09abc	12.67a	13.17a	15.40ab	20.27a	24.23ab
Topsoil alone	8.07a	11.80a	16.50a	16.07ab	25.23a	27.13a
LSD	3.24	6.56	12.28	9.64	17.00	15.27
Residual planting						
Sawdust + Cow dung + Topsoil	2.86a	5.92a	15.0a	12.93a	16.90ab	18.70ab
Topsoil+Poultry manure	4.12a	5.72a	12.08ab	11.73a	14.42ab	15.25ab
Sadust alone	3.28a	4.50a	4.83b	5.31a	7.19b	7.17b
Cow dung + Sawdust	5.00a	4.13a	15.67a	14.11a	16.47ab	16.87ab
Sawdust + Poultry manure + Topsoil	3.51a	5.07a	9.47ab	14.13a	14.73ab	16.87ab
Topsoil + Cow dung	3.98a	5.47a	13.92ab	15.17a	21.32a	22.37a
Topsoil alone	3.54a	6.88a	8.93ab	8.87a	12.64ab	14.53ab
LSD	3.59	4.95	9.43	11.51	14.08	15.10

plantings

Means with the same letters are not significantly different at P<0.05 along columns; NL= number of leaves

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RESPONSE OF CASHEW SEEDLINGS TO POULTRY MANURE AND PALM KERNEL CAKE ORGANIC FERTILIZERS IN THE NURSERY

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ABSTRACT
Cashew, Anacardium occidentale, belongs to the Anacardiaceae family of plants. Although, Cashew is a tropical crop of economic importance which is mostly cultivated in many agro-ecological zones in Nigeria. Its growth is majorly hindered right from the nursery as a result of poor depleted soils Hence, the need to evaluate the response of organic fertilizers as an alternative to chemical fertilizer which was carried out in the nursery for cashew seedlings growth. Poultry droppings (PD) and palm kernel cake (PKC) were applied to supply 5kgN/ha and 10kgN/ha to the cashew seedlings. Large cashew nut size was planted into 2.5kg topsoil (0 – 30cm) obtained from Cocoa Research Institute of Nigeria (CRIN) using completely randomized design at three replicates. Data on plant height, stem diameter, leaf area and number of leaves were taken. All data were subjected to analysis of variance using GENSTAT with means separated using LSD values. The results indicated poultry manure and palm kernel cake at four tons/ha significantly (p> 0.05) increased the growth parameters considered at twelve weeks after sowing. It could therefore be concluded that optimal and sustainable growth performance of cashew seedlings can be attained by the use of organic fertilizer materials especially those of rather than total dependence on costly and scarce chemical fertilizers.
***Keywords**: Cashew, palm kernel cake, poultry manure*

INTRODUCTION

Cashew trees are spread throughout the tropics. The cashew tree is easily cultivated and grows with minimum of attention where more than 65% of the farming families who are small holder farmers depends on the crop as a major source of income (CBN, 2005; Aikpokpodion, *et al*., 2009). Cashew is a prime tree crop of economic importance in Nigeria. Cashew is grown majorly for its edible nuts and the oil contained in the shells. Cashew nuts are edible when roasted and used extensively in the confectionery and baking trade.It is an important commodity crop with great potentials as foreign exchange earner and source of industrial raw materials. Cashew production in Nigeria is faced by a number of problems ranging from urbanization, years of abandonments due to poor appleand nut pricingand poor soil. The establishment of cashew is often affected by poor soils (Topper, 2001). Cashew requires fertile soils and needs soil fertility amendmentlike other tree crops for optimum cashew seeding growth andoptimal production of nuts and apples. (Ibiremo, 2008). Tropical soils are highly leached and low in exchangeable bases; N, P, water holding capacity and organic matter. Hence, most of the essential nutrients found in them are below the critical level (Egbe and Chude, 1987) and there is need for amendment. Most farmers cannot afford inorganic fertilizers due to its high cost and scarcity, coupled with its negative effects on the environment therefore the need for research into low cost, internally sourced, cheap and adoptable organic materials that can serve as fertilizer in cashew seedlings. Poultry manure and Palm kernel cake (PKC) are examples of organic materials easily available for use as soil ammendment.

One of the largest and fastest expanding agro-based industries in the world is the poultry sector (Power and Dick, 2000; Kelleher *et al*., 2002; Sharpley *et al*., 2007). Manure usage is an essential component of sustainable agriculture. Poultry manure has been used as a fertilizer in organic crop development for centuries and has long been regarded as one of the most desired natural fertilizers due to its high nitrogen content. (Sloan *et al*; 2003), it has the potential to be recycled on agricultural land. Beneficial usage is based on their ability to improve soil properties such as plant nutrient availability, soil reaction (pH), organic matter content, cation exchange capacity, water holding capacity, and soil tilt. Poultry waste contains all important nutrients, including micronutrients, and has been proven to be an excellent source of plant nutrients. (Kelley *et al*., 1996; Williams *et al*., 1999; Chan *et al*., 2008; Harmel *et al*., 2009). Poultry manure has a high nitrogen and nutrient content. It has been proven that chicken manure contains

1.8% nitrogen, 1.5% phosphate, and a nitrogen-phosphorus-potassium (NPK) ratio of 2:2:1. (Sloan *et al*; 2003).

Palm kernel cake from agro-processing industries is an excellent source of nitrogen (Kolade *et al*., 2006). Palm kernel cake is a significant byproduct derived from the residuals of the monocotyledonous oil palm (Elaeis guineensis Jacq.) (Mohamed *et al*., 2012). In the oil palm sector, 3% the fresh fruit bunch is palm kernel cake, according to Rupani *et al*. (2010). Therefore, programs for soil amendment can employ the use of these nutrients, which are frequently allowed to go to waste. Therefore, the application of PKC could be a method for improving the fertilizer value of manure. This is because oilcakes is known to have higher nutritional contents, specifically nitrogen (5.20% N and 0.77% P), than manure (0.50% N and 0.06% P). (Opoku, 2011). The aim of this research was to assess growth response of Cashew seedlings to applied agricultural waste on a depleted soil in Ibadan.

MATERIALS AND METHODS

The experiment was conducted at the screen house of the Cocoa Research Institutes of Nigeria (CRIN)from 23rd June – 18th September, 2023**.** Composite soil samples was collected within the CRIN premises, which was air dried, crushed and sieved with a 2mm sieve, and thereafter, representative samples of both the soil and the treatment used, were taken to the laboratory for pre-cropping physical and chemical analysis using standard procedures: soil pH was determined in distilled water at soil to water ratio 2:1, total N by Kjedahl method, available P using Bray-P1extraction and molybdenum blue colorimetry, exchangeable K, C. The experiment was arranged in a Completely Randomized Design (CRD). There were five treatments which were: Poultry droppings (PD) at two levels, Palm Kernel Cake (PKC) at two levels, PD+ PKC at two levels and Control and replicated three times to give eighteen experimental units.

Poultry droppings (PD1), Palm Kernel Cake (PKC1) and PD1+PKC1 were measured to supply 10kgN/ha to each 2.5kg polythene, while PD2, PKC2 and PD2+PKC2 were measured to supply 5kgN/ha. Two each of 15kg large cashew nut size gotten from CRIN nursery unit was sown into each treatment including the control. Parameters measured during the experiment were: plant height, number of leaves, stem girth, stem diameter and leaf area at 4, 6, 8, 10 and 12 WAS respectively. Data obtained were subjected to analysis of variance (ANOVA) using GENSTAT and the significant means differences were separated using LSD at 5% level of probability.

RESULTS AND DISCUSSION

Some physical and chemical properties of the soil used for the experiment are presented in Table 1. The soil is slightly acidic (pH 6.3), this falls within the acceptable range of 5.5 -7.5 for tree crops (Egbe *et al*., 1989). The total N, available P, K and Ca values were below the required value for optimum cashew production since they are lower than the critical level determined for cashew in Nigeria (Egbe, *et al*., 1989). The organic carbon content of the soil was low as well. The deficiency of essential macro – nutrient elements of the soil suggest that the soil will require the use of soil amendments for better crop performance. The use of organic materials in form of poultry manure and palm kernel cake however will help increase the nutrient content of the soil since they are rich in both micro and macro nutrient elements (Table 1). Poultry manure (PD1) gave the highest plant height at twelve weeks after sowing compared with other treatments sources used in this experiment and this was significantly different from the other treatments (Table 2). Number of leaves in the soil amended with PD1 was significantly higher than the control (Table 3). Stem diameter was highest in PKC_1, this was closely followed by PD_1+PKC_1, though only PKC_1 was significantly higher than the control at twelve weeks after sowing (Table 4). These results were consistent with the earlier works of Adeniyan and Ojeniyi (2005) and Akanbi *et al*, 2013 who reported that organic manure improved the growth performance of cashew seedlings significantly. Table 5 shows that PD_1 and PKC_1 gave the highest leaf area which were significantly higher than the control.

CONCLUSION

It can be deduced from the studies that poultry manure (PD) performed better than PKC and can be used alone or in combination with PKC for cashew seedling production. Also, the study could be extended to six months to ensure proper mineralization of the organic materials.

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Table 1: Pre-planting properties of soil and chemical properties of organic materials used

Properties	Soil sample	PKC	PD
Chemical properties			
Organic Carbon (gkg^{-1})	20.67	0.04	0.32
Total Nitrogen (gkg^{-1})	0.68	0.20	0.30
Available phosphorus ($mgkg^{-1}$)	2.98	0.43	0.17
Exchangeable bases ($cmolkg^{-1}$)			
Potassium (K)	0.12	0.64	0.14
Calcium (Ca)	0.27	0.16	0.25
Magnesium (Mg)	0.66	0.04	0.07
Sodium (Na)	0.42	0.30	---
Manganese (Mn)	0.03	0.08	30.47
Exchangeable acidity ($cmolkg^{-1}$)			
Aluminum (Al)	0.22		
Hydrogen (H)	0.10	--	--

ECEC			
Base saturation (%			
pH (H_2O) 2: 1	6.34	7.32	--
Physical properties (gkg^{-1})			
Sand	810	----	---
Silt	121	--	--
Clay	69	---	--
Textural Class	Sandy Loam		

PD_1: Poultry manure @ 4tons/ha, PKC_1: Palm Kernel Cake@4tons/ha, PD_2: Poultry manure @ 2tons/ha, PKC_2: Palm Kernel Cake@2tons/ha

Table 2: Effect of organic materials used on Plant height of Cashew seedlings

	Weeks after Sowing				
	4	6	8	10	12
Control	23.5	24.4	25	30.5	35.8
PD_1	33.0	37.2	39.2	42.2	53.3
PD_1+PKC_1	31.8	32.8	36.8	39.0	41.7
PD_2	30.8	29.6	29.7	30.5	41.5
PD_2+PKC_2	32.3	35.5	37	39.7	40.5
PKC_1	20.8	34.8	36.6	41.5	47.8
PKC_2	17.1	23.0	29.4	31.1	33.4
LSD	10.20	12.08	11.57	11.32	12.7

PD_1: Poultry manure @ 4tons/ha, PKC_1: Palm Kernel Cake@4tons/ha, PD_2: Poultry manure @ 2tons/ha, PKC_2: Palm Kernel Cake@2tons/ha

Table 3: Effect of organic fertilizers on Number of leaves of Cashew seedlings

	Weeks after Sowing				
	4	6	8	10	12
Control	9	11	12	14	16
PD_1	6	22	24	26	26
PD_1+PKC_1	7	16	20	20	24
PD_2	9	11	12	14	17
PD_2+PKC_2	9	17	20	24	25
PKC_1	6	18	18	20	23
PKC_2	2	3	7	10	14
LSD	3	7	8	9	10

PD_1: Poultry manure @ 4tons/ha, PKC_1: Palm Kernel Cake@4tons/ha, PD_2: Poultry manure @ 2tons/ha, PKC_2: Palm Kernel Cake@2tons/ha

Table 4: Effect of organic materials on Stem diameter of Cashew seedlings

	Weeks after Sowing				
	4	6	8	10	12
Control	5.69	6.75	6.98	7.23	7.59
PD_1	4.50	6.67	7.17	7.78	8.01
PD_1+PKC_1	5.18	7.98	8.66	8.39	8.51
PD_2	4.57	5.46	6.31	6.51	6.70
PD_2+PKC_2	5.49	7.44	7.75	8.14	7.09
PKC_1	4.43	5.08	6.68	6.77	8.60
PKC_2	3.27	3.70	4.10	5.00	5.60
LSD	1.105	1.03	0.917	1.097	0.84

PD_1: Poultry manure @ 4tons/ha, PKC_1: Palm Kernel Cake@4tons/ha, PD_2: Poultry manure @ 2tons/ha, PKC_2: Palm Kernel Cake@2tons/ha

Table 5: Effect of organic fertilizers on leaf area of Cashew seedlings

	Weeks after Sowing				
	4	6	8	10	12
Control	56	57	65	69	100
PD_1	55.5	85.8	88.1	94.6	121
PD_1+PKC_1	62.8	76.3	82.4	94.8	117.8
PD_2	72.4	80.9	83.7	110.0	119
PD_2+PKC_2	79.5	87.2	95.8	100.5	114.4
PKC_1	50.2	55.8	56.1	59.5	128
PKC_2	58	68	70	72	82
LSD	30.51	33.50	32.15	33.97	41.10

PD_1: Poultry manure @ 4tons/ha, PKC_1: Palm Kernel Cake@4tons/ha, PD_2: Poultry manure @ 2tons/ha, PKC_2: Palm Kernel Cake@2tons/ha

ASSESSMENT OF SOIL FERTILITY STATUS OF SOME SELECTED KOLA PLANTATIONS IN OSUN STATE, NIGERIA

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ABSTRACT
The study was carried out to evaluate the soil fertility status of some selected kola plantations in Osun state so as to improve the productivity. Ten core soil samples at 0-15cm and 15-30cm depth were randomly collected in each plantation using soil auger and bulked into composite samples to obtain representative soil samples. The soil samples were air dried, sieved through 2mm sieve and some physico- chemical properties were determined following standard laboratory technique. Results showed that the pH of the soil ranged from 6.60- 6.90 in Ife south L.G.A and it was 6.4-6.5 at Odo- Otin L.G.A. Soil organic carbon was moderate and Nitrogen contents were low compared to critical level .While the soil exchangeable cations (K+, Ca, Mg) and Available Phosphorous were found adequate for optimal kola production in Nigeria.The plantations would need N based fertilizer augmentation for sustainable kola production.
Keywords*: Soil fertility, Kola, Plantation*

INTRODUCTION
Kolanut is an important economic cash crop to a significant proportion of Nigeria population who are involved in kolanut farming, trading and Industrial utilization. There is also increase in demand for its usage in pharmaceutical industries and for production of soft drinks, wines and candles. Its uses have inevitably created a high demand in excess of its production (Oladokun 1985). While the demand is rising, Nigeria Kolanut production remains low because many of the trees are unfruitful and have very low yield due to the old age, incompatibility and soil nutrient depletion. The removal of essential plant nutrient through kola pod harvesting over a long period without any nutrient addition to kola farms have also led toa steady decline in yield. Tree crop farming in Nigeria has been based on the exploitation of fertility build up by the forest. It is, however, important to note that nutrient are removed annually from the farm through crop harvests. The calculated amounts of N, P, K removed from one hectare of kola soil per year were 130.9kgN, 10.3KgP and 138.74kgk respectively through harvesting of pods (Ayodele, 1989). There is a need to increase plantation acreage and nut yield per tree. These can be achieved through detailed study of existing conditions of the farms (Adebowale *et al*, 2021). Ndagi 2012, Adebowale and Odesanya 2015, observed that old kola nut trees need adequate soil amendment as a result of nutrient mining through harvesting of kola pod without replacement via fertilizer application. Therefore, the objective of this study was to investigate the soil nutrient fertility status of kola plantation in some selected local government area of Osun State to improve kola productivity.

MATERIALS AND METHODS
Soil samples were collected from kola plantations in two local government areas of Osun State namely (Ife south and Odo Otin L.G.A). In each of the plantations visited ten core soil samples at 0-15cm and 15-30cm depth were randomly collected using soil auger and bulked into composite samples to obtain the representative soil samples for each kola plantation. The labelled samples were brought to the laboratory for processing and analysis. The soil samples were air dried, sieved through 2mm sieve and some physical and chemical properties determined following standard procedure (IITA, 1979).

RESULTS AND DISCUSSION
Particle size and pH
Table 1 and 2 indicates the results of soil analysis for both locations selected in Osun State. The results showed that the sand, clay and silt contents at 0-15cm depth were 672.2g/kg, 212g/kg and 112.8g/kg respectively at Ife South L.G.A while at Odo Otin L.G.A, the sand, clay and silt contents were 695.2g/kg, 172g/kg and132.8g/kgsoil. At 15-30cm depth the values were695.2g/kg, 172g/kg and 122.8g/kg sand, clay and silt at Ife south while 675.2g/kg, 192g/kg and 132.8g/kg were recorded at Odo Otin L.G.A. This

observation similar with results of Adebowale et ai,2021, who reported that soil values decreased with depth at Odo Otin L.G.A. Meanwhile it was opposite side at Ife South L.G.A. The soil of both site evaluated is texturally classified as sandy loam. The soil pH ranged from 6.6 -6.9 with a mean value of 6.8 at Ife South L.G.A and 6.4 -6.5 with a mean value of 6.45 at Odo Otin L.G.A respectively. The soil pH values of both locations evaluated fall within the range required for optimal kola production.

Organic Carbon (OC)

The soil organic carbon contents at 0-15 cm depth in Ife south LGA ranged from 14.8g/kg and 21g/kg with an average value of 17.9kg/soil while it was 9.3g/kg to 21.1g/kg with a mean value of 15.2g/kg at Odo Otin L.G.A. The organic carbon content was 21g/kg and 21.2kg/g at both locations assessed. The value is moderate however it is below the critical level of 30g/kg required for kola production in Nigeria (Egbe *et al*1, 1989). The soil organic carbon contents decreased down the soil profile. The higher organic matter content at the upper depth (0-15cm) may be attributed to accumulation and decomposition of large amount of leaf litters falls over the years (Iloyanomon and Ogunlade, 2011).

Total Nitrogen (N)

The soil nitrogen contents at the upper depth (0-15cm) for both locations assess ranged from 0.7g/kg to 0.8g/kg with an average value of 0.75g/kg in Ife South and 1.0-1.5g/kg with average an value of 1.25g/kg in Odo Otin L.G.A respectively. These values obtained fall below the critical value of 10g/kg soil required for sustainable kola production in Nigeria as reported by (Egbe *et al*,1989). The N contents decrease with increase in depth with higher N found at Odo Otin soil (1.5g/kg) compared to N at Ife south (0.8g/kg) soil. Therefore, there will be need for N application in all kola plantation evaluated in Osun State.

Available Phosphorous

The soil available phosphorous contents were higher at the topsoil(0-15cm) with a value of 15.17mg/kgP at Ife South and 19.11mg/kgP in Odo Otin soil respectively. Soil available P contents of the study area were adequate and well above the critical level of 6.0mg/kg required for kola production (Egbe *et al*,1989). This result is similar to the report of Iloyanomon *et al*, 2011, that high P in the soil as a result of the fast decomposition of the kola leaves. There is no need of phosphorous fertilizer application.

Exchangeable Potassium (K)

The exchangeable potassium (K) in soil contents of the locations was found to be adequate for kola. The upper depth (0-15cm) of the soil in Ife South had 0.13cmol/kg soil, while the soil potassium value at Odo Otin is 0.25cmol/kgsoil. The soil K^+ in Odo Otin L.G.A was higher than the K contents at Ife South. These values obtained were higher than the critical value of 0.12cmol/kg soil as reported by Egbe *et al*, (1989). This could be as a result of possible fixation of potassium in the study site which makes it easier for the roots to absorb nutrients as reported by Adebowale *et al*, 2021.

Exchangeable Calcium (Ca)

The calcium contents of the soil ranged from 13.28 to 15.46cmol/kg with a mean value of 14.37cmol/kg at Ife South and 12.97- 13.28cmol/kg with a mean value of 13.13cmol/kg at Odo – Otin L.G.A. Ife South recorded the highest calcium with a values of 15.46cmol/kg at 0-15cm depth, while the least value of 12.97cmol/kg was recorded at Odo Otin L.G.A. However, calcium content was higher than the critical level of 0.8cmol/kg required for sustainable kola cultivation as reported by (Egbe *et al*,1989). The calcium contents in Ife South soil decreased with increasing depth.

Exchangeable Magnessium (Mg)

The magnesium contents of the two locations evaluated were found suitable for kola production. Soil Mg contents at the topsoil (0-15cm) in Odo Otin was higher with value of 2.07cmol/kg while the least value 1.03cmol/kg Mg was recorded at Ife South L.G.A. The Mg contents were adequate and well above the critical level of 0.08cmol/kg required for optimal kola production. There is no need for magnesium fertilizer at both locations evaluated. The magnesium contents decreased with increasing depth at both locations. This is in contrast to the report of Adebowale and Odesanya (2012) which observed that there was gross deficiency of Magnesium contents in kola soil at Odogbolu L.G.A in Ogun state.

Sodium (Na)

The Na contents of the soil ranged from 0.89-0.92cmol/kg at Ife South and it was 0.89-0.95cmol/kg in Odo Otin. The mean value of 0.95cmol/kg was recorded in Ife South while a mean value of 0.92cmol/kg was recorded at Odo –Otin L.G.A. The mean Na contents values of both locations assessed were similar with the findings of Adebowale *et al*, 2021.

Table 1: Soil Physical and Chemical Properties in Ife South L.G.A

Soil depth (cm)	Sand g/kg	Clay g/kg	Silt g/kg	pH	OC g/kg	N g/kg	P mg/kg	K cmol/kg	Ca cmol/kg	Mg cmol/kg	Na cmol/kg
0-15	675.2	212	112.8	6.9	21.0	0.8	15.17	0.13	15.46	1.03	0.92
15-30	695.2	172	132.8	6.6	14.8	0.7	16.29	0.16	13.28	0.96	0.89
Mean	685.2	192	122.8	6.8	17.9	0.75	15.73	0.15	14.37	1.03	0.95

Table 2: Soil Physical and Chemical Properties in Odo Otin L.G.A

Soil depth (cm)	Sand g/kg	Clay g/kg	Silt g/kg	pH	OC g/kg	N g/kg	P mg/kg	K cmol/kg	Ca cmol/kg	Mg cmol/kg	Na cmol/kg
0-15	695.2	172	132.8	6.4	21.1	1.5	19.11	0.25	12.97	2.07	0.95
15-30	675.2	192	132.8	6.5	9.3	1	18	0.22	13.28	2.01	0.89
Mean	685.2	182	132.8	6.45	15.2	1.25	18.56	O.24	13.13	2.04	0.92

CONCLUSION

The study was carried out in two local government areas of Osun State (Ife South and Odo Otin L.G.A) to evaluate the soil nutrient status of some selected kola plantations in the areas for optimal kola production. The soil pH in both study locations were suitable for sustainable kola production. Soil organic carbon contents was moderate and total N contents is not adequate for kola cultivation. While soil Available P and exchangeable cations (K, Ca, Mg) were adequate for kola plantations evaluated in both sites. In conclusion, Nitrogen based fertilizer would be required to improve the soil N loss in evaluated site in order to enhance kola productivity and yield**.**

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COLLEGIAL EFFECTS OF SOILLESS ORGANIC WASTE PACKAGE ON GROWTH AND PERFORMANCE OF CARROT (Daucus carrota) IN ILE-OLUJJI

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ABSTRACT
A nursery experiment was conducted at Teaching and Research Farm, Federal Polytechnic, Ile-Oluji, to examine the effects of organic soil-less substrates on the performance of two varieties of carrot (Daucus carrota, L): Thelma F1 (SMTH) and Finger F1 (SMFIN). The organic substrates materials (SM) was made up of the following proportions: cocoa pod husk (CPH) 25%, Stone dust (SD) 5%, cocoa dry leaves (CDL) 10%, poultry manure biochar (PMB) 20%, pig biochar (PB) 15% and fallow top soil (FTS) 25%. The materials were milled and made up to 25kg which was allowed to stand for twenty one (21) days in an air tight bag before it was used to fill the seed trays. The experiment consisted of four treatment combinations; SMTH, SMFIN, CTH, and CFIN. The experimental design used is Completely Randomized Design (CRD). Arrangement of the seed trays at the nursery followed space of (3x1) m^2. Twelve (12) plots were used for this factorial experiment with six hundred seedlings (600) representing one treatment combination. The total seedlings used were two thousand four hundred (2,400). Data were collected on growth characters of carrot from twenty (20) plants in each cell given a total of two hundred and forty (240) plants sampled. Data collected were subjected to analysis of variance (ANOVA) while significant treatment means were separated using Least Significance Difference (LSD) test at 5% level of probability using Gentstat software. The result from this investigation confirmed that organic soil-less substrates improved growth characters of cucumber at all stages of the experiment compared to control. The use of this organic package is suggested for carrot farmers in Ile-Oluji, Nigeria.
Keywords: *Soilless Organic Waste, Package, Carrot, Daucus carrota*

INTRODUCTION
Soil-less is the practice of growing crops without using soil. The practice is used to control soil related problems emanated from agricultural land use and high price of haulage of top soil in our society (Agbona *et al,* 2023). Some of the soil-less materials that can be use as organic substrates for growing crops are; sawdust, coco peat, peat moss, woodchips, fleece, marc, bark etc. (Agbona *et al*, 2023). The nutritional value of carrot merits special attention. It is a rich source of vitamins A and E. Both hot and sweet carrots contain more vitamin C to prevent flu colds than any other vegetable crop (Bosland and Votava, 2010).

MATERIALS AND METHODS
The experiment was conducted at the nursery site of the Teaching and Research Farm, Federal Polytechnic, Ile-Oluji, Ondo State, between September and December, 2022. The organic waste used for this Research project was sourced from Teaching and Research Farm, Federal Polytechnic, Ile-Oluji, and the seeds from aggro-allied shop located in Akure. The varieties used for the experiment is; Thelma F1and Finger F1 carrot which was placed on a seed sourcer, dressed with dressed seed fungicide and sprinkled with moderate water to give the seeds damp condition for quick germination. (Agbona *et al*, 2020).

Preparation of experimental site, soil-less material & filling of seed trays
The site for the experiment was cleared, and fumigated to prevent insect attack on the seedlings. The seed trays and other necessary equipment needed for the experiment were washed and dried in the sun for three days before the commencement of the experiment. The soil-less materials (cocoa pod husk) CPH, (stone dust) SD, (cocoa dry leaves) CDL, (pig biochar) PB, and (poultry manure biochar) PMB. All were

milled separately and allowed to stay for three days before been mixed together in the ratios below (Agbona *et al*, 2023):

Table 1: soilless materials in different mixing ratios in 25kg bag

S/N	Soilless Materials	Percentage (%)	Mixing ratio	Quantity (Kg)
1	CPH	50	50/100 x 25	12.5
2	SD	5	5/100 x 100	1.25
3	CDL	10	10/100 x 25	2.5
4	PB	20	20/100 x 25	5
5	PMB	15	15/100 x 25	3.75
	Total			25

The materials were later allowed to stay in a mildly perforated rice bag covered completely for 21 days. This is to allow all the micro-organisms in the materials to mix and react together. Later, the material gave rise to soilless organic material formulated for this trial experiment. A total of six seed trays were filled with the soilless materials and wetted to field capacity after standing in the bag for 21 days. The seed trays were left to stand for 14 days to allow the micro-organisms full establishment under irrigation for the two weeks. Water was applied every three days for three times before planting of seeds.

Treatments, experimental design and allotted technique

The treatments and the variety of the carrot was replicated three times given a total of nine replications. A set of seed trays contained 200 cells and three trays will give rise to 600 cells for each treatment variety. A total of 20 seedlings was sampled randomly from each seed tray which was arranged in Completely Randomized Design (CRD) in the nursery. For each variety of carrot a total of two hundred and forty (240) seedlings were sampled.

Crop establishment

The carrot seeds were placed on a seed sourcer wetted lightly and planted in the seed trays in the evening and they were placed on two days wetting regime (Oyewusi *et al*, 2020). The seed trays were later arranged in their respective plots for the commencement of the research.

Other agronomic practices

Watering was done twice a week throughout the period of the experiment. Weeds were controlled through the hand picking. Kaocide was used to control leaf rot, a fungus and nematicide for soiless materials treatment before planting.

Growth parameters measured

The parameters measured in the course of this experiment are; Germination count, germination percentage, plant height, numbers of leaves, stem girth, fresh shoot weight, fresh root weight and total biomas. Others include total water utilization and dry matter yield of pepper.

Chemical analysis of the soil.

Soil samples were collected from the field using soil auger. The soil was sieved with 2mm sieved range before being subjected to laboratory analysis. The samples were collected and analyzed for routine chemical analysis as described by Carter (1993). The samples were air dried and sieved using a 2mm sieve before making the determinations. Soil organic matter was determined by the procedure of Walkley and Black using the dichromate wet oxidation method (Nelson and Sommers, 1996)., total N was determined by micro-Kjeldahl digestion method (Bremner, 1996)., Available P was determined by Bray-1 extraction followed by molybdenum blue colorimetry (Frank *et al*, 1998). Exchangeable K, Ca, Mg were extracted using 1.0N ammonium acetate. Thereafter, K was determined using a flame photometer and Ca Mg were determined by EDTA titration method (Hendershot and Lalande, 1993). The pH was determined in water (1/2) medium using the digital electronic pH meter.

Statistical analysis

Data collected were subjected to analysis of variance (ANOVA) while significant treatment means were separated using the Least Significance Difference (LSD) test at 5% level of probability using Genstat software.

RESULTS AND DISCUSSION

Chemical composition of the soilless materials

Samples of the six soilless materials used for the purpose of this experiment were taken and analysed as presented in the tables 2 and 3. On table 2, chemical composition of the substrates that made up the soilless package shows that the components contained the needed nutrients such as: N, P, Na, Ca, Mg, %C, N that is higher in values than the composition of top soil and sand stone powder on table 3 and 4.The pH of the soil-less growth media is 5.57 in value which is considerably good for vegetable production.

Table 2: Chemical composition of the soil-less materials

S/N	Soiless materials	1:50 H_20 pH	ASH	% C	N	P	K	Mg/100g Na	Ca	Mg
1	Substrate organic materials formulated	5.57	14.530	85.470	1.68	25.78	9.43	7.52	8.24	3.96
2	Cocoa dry leaves	3.80	17.822	82.178	1.16	51.89	0.80	0.60	6.02	2.84
3	Pig biochar	3.81	31.357	68.421	1.50	17.53	1.12	0.70	7.38	3.14
4	Ficus leaves	5.27	14.286	85.714	1.46	6.00	7.80	6.66	19.56	8.94
5	Poultry biochar	5.71	2.326	97.674	1.58	45.79	9.90	0.4	31.36	12.96
6	SAtone dust	5.67	97.976	2.024	0.11	1.32	0.10	0.02	1.26	0.72

Table 3: Chemical composition of stone dust

1:2 1:H_2O pH	(%)			mg/ kg		Cmol / kg		
5.67	Oc	Om	N	P	K	Na	Ca	Mg
	0.10	0.17	0.11	2.33	1.03	1.36	3.00	1.20

Effects of soil-less organic growth media on carrot growth characters.

Percentage germination of carrot varieties

The percentage germination of the carrot varieties is presented on table 4. The soilless organic growth media produced the highest percentage germination from Thelma variety compared to Finger F1 variety (Fig. 1)

Table 4: Effects of soilless organic substrates on percentage germination.

TREATMENTS	PERCENTAGE GERMINATION
SMFINR1	65.3
SMFINR2	66.4
SMFINR3	78.7
SMTELR1	62.9
SMTELR2	66.8
SMTELR3	77.9
CTELR1	68.8
CTELR2	71.7
CTELR3	74.5
CFINR1	69.1
CFINR2	68.9
CFINR3	73.6

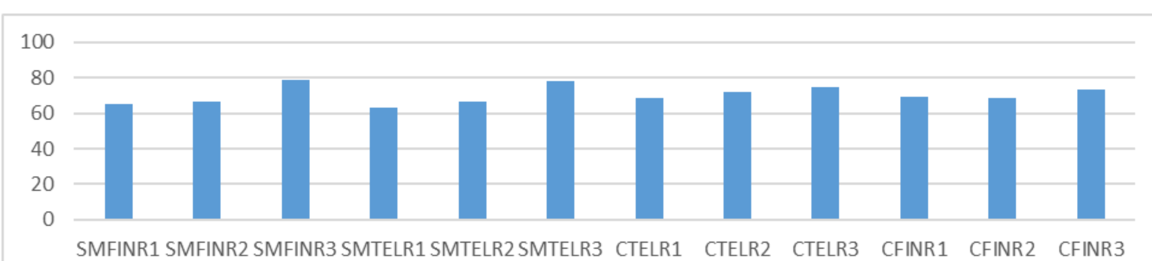

Fig. 1: Bar chart showing the effects of soilless organic growth media on percentage germination of varieties of carrot.

Effects of soilless organic growth media on growth parameters of carrot in the nursery.

Tables 5,6, and 7 shows the effects of soilless organic growth media on carrot's growth characters in the nursery. The effects on plant height, and stem girth were all significant at all the stages of the experiment. This may be as a result of moderate nitrogen value of 1.65 (Table 3) of the substrates. However, number of leaves was not significant as a result of slow nature of the plant to produce leaves. But in all the stages of the experiment, Finger F1 variety performed better than Thelma variety in terms of plant height, numbers of leaves and stem girth. (fig. 2,3,4 and 5).

Table 5: Mean effects of organic soilless growth media on plants height of carrot at 9, 16 and 23 days after planting.

Treatments	Mean effects on plant heights	Mean effects on number of leaves	Mean effects on stem girth
SMTELR1	7.40	2.00	1.37
SMTELR2	7.33	2.00	1.57
SMTELR3	8.40	2.00	1.27
SMFINR1	8.73	2.00	1.57
SMFINR2	8.47	2.00	1.77
SMFINR3	9.33	2.00	1.87
CTELR1	6.87	2.00	1.27
CTELR2	6.00	2.00	1.00
CTELR3	6.53	2.00	1.20
CFINR1	6.20	2.00	1.20
CFINR2	5.77	2.00	1.10
CFINR3	6.20	2.00	1.17
F-test	**	***	**
F-test (Plant height)	0.002 (Significant)	0.431 (NS)	0.042 (Significant)
CV%	6.211	11.122	7.125
LSD (0.05)	0.802	0.683	0.409

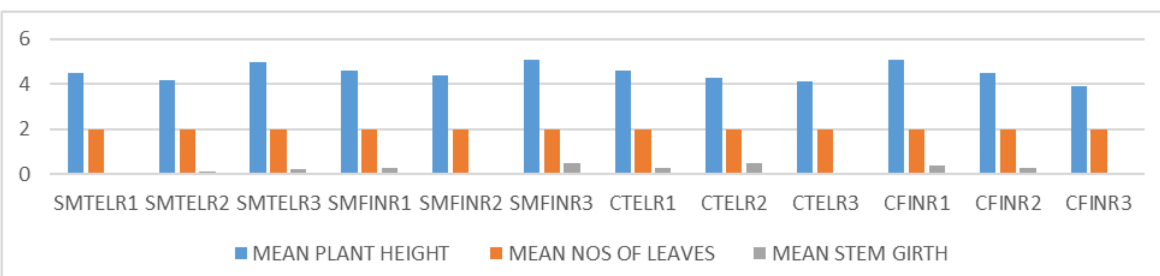

Fig. 2: Bar chart showing effects of soilless organic growth media on growth parameters of carrot at 9 days after planting.

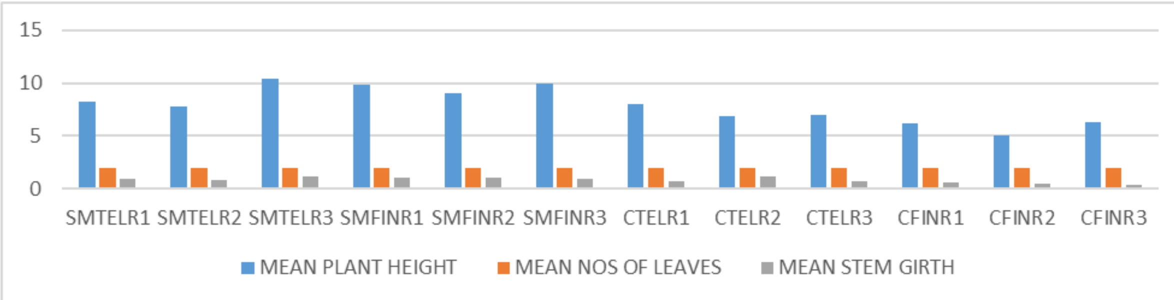

Fig. 3: Bar chart showing effects of soilless organic growth media on growth parameters of carrot on 16 days after planting.

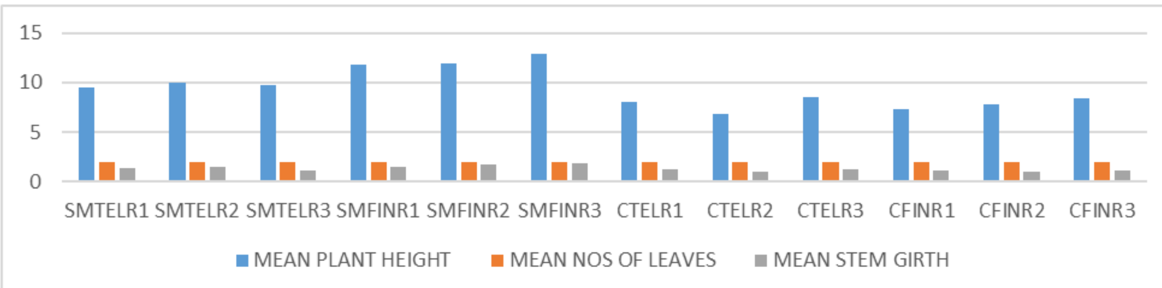

Fig. 4: Bar chart showing the effects of soilless organic growing media on growth parameters of carrot in the nursery at 23 days after planting.

EFFECTS OF ORGANIC SOILLESS GROWTH MEDIA ON YEILD COMPONENTS OF CARROT.

The experiment was terminated at 30 days after planting and the results obtained shows that Thelma variety performed better than Finger F1 variety. (Fig.5). This may be as a result of fast and high germination count and percentages recorded for the varieties grown on the growth media 9 days after planting.

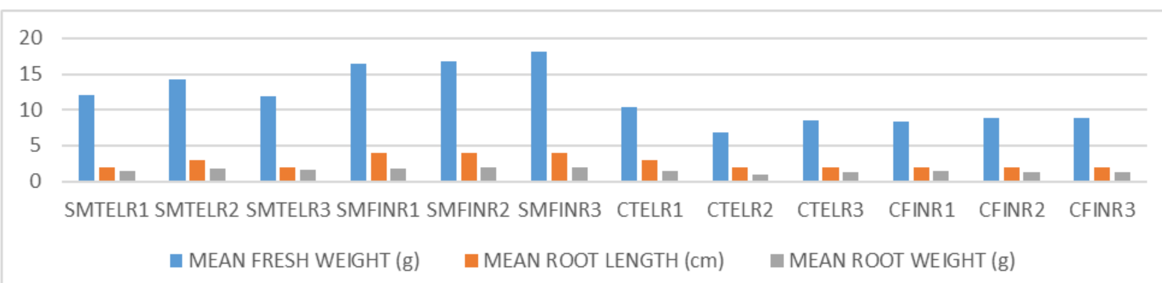

Fig. 5: Bar chart showing effects of soilless organic growth media on yield components of carrot at termination stage 30 days after planting

CONCLUSION AND RECOMMENDATION

The results obtained from this project affirmed the fact that soil-less organic growth media improved growth and yield component of carrot. In all, Finger F1 variety performed better than Thelma variety. It is therefore recommended that soil-less organic growth media with the proportions used in this experiment (Table 1) is good for raising Finger F1 carrot variety in the nursery in Ile-Oluji this was in line with the increase in performance of tomatoe raised on soil-less materials in the nursery.

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AGRONOMIC AND YIELD DIVERSITY AMONG THIRTY-THREE ACCESSIONS OF AFRICAN EGGPLANT (Solanum aethiopicum), SOURCED FROM NATIONAL HORTICULTURAL RESEARCH INSTITUTE GENEBANK.

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ABSTRACT

African eggplant (*Solanum aethiopicum*) is known for its multiple purpose as the fruits can be consumed raw or prepared as sauce; and the leaf as vegetable and it is also a good source of mineral nutrients. Despite this socio-economic importance, there is paucity of information on the genetic diversities of its species thereby creating gaps in selection and adoption for scientific research. Thirty-three accessions of African eggplant were evaluated for qualitative and quantitative traits to provide necessary information for genetic improvement most especially on earliness in fruiting and yield for this important but less utilized fruit vegetable. The experimental design was Randomized Complete Block Design (RCBD) in triplicates. Variability of studied traits was evaluated by Analysis of Variance (ANOVA) which revealed significant differences ($p < 0.05$) among the accessions for all the traits studied. Nhep2101 exhibited highest number of branches (7.26) and Nhep2142 gave the least (3.50). Number of fruits per cluster was highest in Nhep2115 (6.17) and the least was recorded in Nhep2142 (1.83). The highest number of harvested fruits were observed in Nhep2123 (113.67) while the lowest number of fruits was recorded in Nhep2142 with 20 fruits. Accessions Nhep2104, Nhep2110 and Nhep2115 were ranked as the top three superior accessions useful in breeding for earliness while accessions Nhep2123, Nhep2124 and Nhep2121 will give more income to farmers by weight. The wide range of variations observed could be a good tool when making selection in future breeding programme for desired traits and farmers adoption.
Keywords: Accession, Agronomic diversity, *Solanum aethiopicum*, African eggplant

INTRODUCTION

The genus Solanum belongs to the family Solanaceae which is a large family that has been the source of many morphologically different domesticated species (Sharmin *et al*., 2011). Out of about 2300 species that have been identified in the family, nearly one-half of them belongs to the genus Solanum according to Agnieszka *et al*., (2007) who reported detailed taxonomic audit of the genus Solanum. The common name 'eggplant' encompasses three closely related cultivated species endemic to Africa, belonging to the genus Solanum L., subgenus Leptostemonum (Dunal) Bitter. Two sections exist in this subgenus namely: Section Melongena and Section Oliganthes. Section Melongena comprises two species which include *S. melongina* and *S. macrocarpon* while Section oliganthes has only one species named *S. aethiopicum*. This species is further grouped into different ecotypes which are Aculetum, Gilo, Kumba and Shum group as revealed by similarities in genotypic characterization through varied phenotypes in existence (Sharmin *et al*., 2011).

Some authors, however, have argued that the four groups in *S. aethiopicum* be treated as different species since they all display varied phenotypes and genotypes using a combination molecular marker (Nunome *et al*., 2003; Sifau *et al*., 2014). Apart from the four species mentioned above, taxonomists have also identified and reported other Solanum species including *S. incanum, S. scabrum, S. dasyphyllum* and *S. erianthum* (Agniezka *et al*., 2007; Osei *et al*., 2010; Aguoru *et al*., 2015; Mariola *et al*., 2014; Sifau *et al*., 2014) while many species are yet to be identified, named and classified systematically (Agniezka *et al*., 2007). The various species are known for their ethnobotanical uses most especially as food and trado-medicine. The African eggplant (*S. aethiopicum* L.) is the third most consumed fruit vegetable in tropical Africa after tomato and onion both in quantity and value and this is followed by okra. The high nutritive value of the leaves and the high leave and fruit yield (*S. macrocarpon*), as well as high resistance to pests and diseases make the crop interesting for development (Bonsu *et al*., 1998). Consumer preference for a variety of African eggplant is based on among others such as size, form, colour and taste (sweet or bitter). The leaves, fruits and roots have a variety of medicinal uses (Bukenya-Ziraba *et al*., 2004). *Solanum aethiopicum* are used as a medicine to treat diarrhea, hypertension etc. (Adeniji and Aloyce, 2012).

The selection of many diverse cultivars of African eggplant by small scale farmers as well as existence of germplasm collections have not improved breeding activities, instead, the long period of selection by these peasant farmers has resulted in several landraces which gave rise to different traits being exhibited by the crops. This includes earliness, colour, size and sweetness. In essence, the African eggplant has long been neglected by formal crop improvement programmes except in breeding programmes where it is used as a source of specific trait(s). Systematic characterization of African eggplant varieties or lines using morphological traits is needed to fuel breeder's efforts in improving species (AVRDC, 2003). There is therefore the need to characterize *S. aethiopicum* germplasm collected from different eco-geographical zones in Nigeria for the development of a new variety. Despite its socio-economic significance, local genetic varieties of this species are still less known, while the adopted enhanced varieties introduced constitute a serious threat to the local ones (Bationo-Kando *et al*., 2015).

Determination of existence of morphological and yield related traits among the accessions will help in laying foundation for better management, improvement, and germplasm expansion. The objective of this research, therefore, is to investigate the variations that exist among the thirty-three accessions of *S. aethiopicum* and to assess their flowering and yield performance to generate information that will help in breeding new varieties as well as assist in expansion and conservation of the existing germplasm.

MATERIALS AND METHODS

Thirty-three accessions of *Solanum aethiopicum* (African eggplant) were sourced from the genebank of National Horticultural Research Institute (NIHORT) headquarters, Idi-Ishin, Jericho Reservation area, Ibadan, Oyo State for characterization and evaluation of both qualitative and quantitative traits. The experiment was carried out at the Research field of NIHORT, Ibadan, Latitude 7.4028ºN and Longitude 3.8152ºE. Seeds of the African eggplants were sown in seedling trays filled with steam sterilized loamy soil and raised in the screenhouse of Genetic Resources Unit of NIHORT for five weeks. Plants were transplanted to the field using a Randomized Complete Block Design (RCBD) with three replications. The plot size was 2 m^2. The row-to-row distance was 0.6 m and plant-to-plant distance was 0.5 m. Each accession was planted in a separate plot to make 33 plots per replicate and a total of 99 plots with ten plants per plot. Cultural practice of manual weeding was carried out during the experimental period to reduce the competitiveness of soil nutrients between the plants and the weeds and to reduce the insects and rodent infestation during the period. Fertilizer was not added to assess the performance of each accession to utilize optimally available soil nutrients and productivity when planted by resource-constrained farmers. However, Laraforce with active ingredient of Lambda-cyhalothrin was applied at the rate of 20 ml/20L of water as and when due to prevent defoliation as well as cross pollination by insects.

Data collection and analysis

Data were collected from five randomly tagged plants per plot for seven agronomic traits {days to flowering, days to 50% flowering, number of branches per plant, plant height (cm), stem girth (mm), petiole length (mm) and peduncle length (mm); five yield related traits {number of fruits per cluster, number of fruits harvested per plot, weight of fruits harvested per plot, fruit length (mm) and fruit width (mm)} and ten qualitative related traits (stem colour, petiole colour, leaf hairs, sepal colour, fruit colour, fruit shape, fruit position, fruit-end shape, presence/absence of stripes) using IBPGR descriptor (1990).

Statistical analysis

The qualitative data collected were subjected to analysis of variance while significant means were separated using minitab 19 software. Correlation among the quantitative traits were also estimated using Pearson correlation coefficient.

RESULTS AND DISCUSSION

The results of this study showed significant variations for all the observed traits at 5 % ($p < 0.05$) level of probability. This creates a great scope for making selection in future breeding work especially in those areas of interest that will benefit the African eggplant farmers (Table 1). Phenotypic assessment of the accessions revealed that 100 % of the accessions have green stem colour, green petiole colour, green sepal colour, white petals colour, direct fruit position and presence of stripe. Three separate fruit colours were observed among the accessions, 45.45 % white, 9.09 % light green and 45.45 % lemon green. Three different fruit shapes were also observed, and these include oval (51.51 %), long (30.30) and round (18.18 %) while 69.69 % have pointed end shape and 30.30 % flat end shape (Table 2). These results confirm the report of Osei *et al*., 2010 who observed existence of distinct variations among the twenty-eight (28) African eggplants characterized for morphological traits in Tanzania. The number of days to flowering varied from 90.67 to 105.00. The mean for number of branches is 5.45 and the extreme values are 3.50 and 7.27 while the mean for plant height is 53.49 cm and the range varied from 41.17 cm to 74.50 cm (Table 3). The genetic variability exhibited by the accessions is very important for germplasm expansion and breeding advancement and this agrees with the work of Plazas *et al*., 2014 who discovered diversity and variability among different varieties of Solanum studied.

For the earliness, Nhep2104 was the earliest accession which flowered at 91 days followed by Nhep2110 and Nhep2115 at 93 days. Accessions of Nhep2115, Nhep2128 and Nhep2141 had the highest number of fruits per cluster 6 which were not significantly different from one another. The highest number of harvested fruits per plot (114 fruits) was recorded in Nhep2123 followed by Nhep2124 and Nhep2121 with 95 and 94 fruits per plot respectively. In terms of weight of harvested fruits per plot, accession Nhep2150 gave the maximum weight of 2283g followed by Nhep2139 and Nhep2121 with 2166g and 2150g respectively. Variations observed among the studied accessions are tools when making selection for breeding. Nhep2115 flowers early and have highest number of fruits per cluster, therefore, cross between Nhep2115 and Nhep2123 will produce a hybrid for earliness and high yield (Table 4). This result is comparable to what was obtained by Bationo-Kando *et al*., 2015 who reported 68.4 – 94.0 of days to flowering and 1.3 – 5.3 number of fruits among the Solanum aethiopicum studied in Burkina Faso.

Correlation coefficient between pairs of twelve quantitative traits is as shown in Table 5. This is used to show the relationship between variables. There is a significant positive relationship between number of fruits harvested per plot and number of branches per plant, number of fruits per cluster and weight of fruits per plot. Petiole length also exhibited positive correlation with fruit length. High negative correlation was observed between fruit width and number of fruits harvested. Bationo – Kando *et al*., 2015 reported both positive and negative correlations among the accessions in their work which is similar to the result of this study. The correlation will help to facilitate identification of reliable traits during selection by breeders.

CONCLUSION

The study showed a high level of variability among the traits studied. The variations exhibited among all the accessions was a useful tool when making selection based on those traits for advancement in future breeding programmes for a particular trait. Accessions, Nhep2104, Nhep2110 and Nhep2115 are to be considered for early flowering while accessions, Nhep2123, Nhep2124 and Nhep2121 were high yielders with relation to numbers of harvested fruits per plot. Hybridization between these accessions especially, Nhep2123 and any of the early flowering accessions will give a high yield and better income for farmers. However, there is need to engage our farmers in participatory varietal selection to give an output of their desire.

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Table 1: Mean square from ANOVA for agronomic and yield related traits of 33 *Solanum aethiopicum*

Source	Df	Dff	d50f	Nob	Ph (cm)	Nftc	Nfh	Wfh	Frtl (mm)	Frtwd (mm)	Stg (mm)	Ptl (mm)	Pdl (mm)
Accession	32	35.12*	37.86*	2.98*	164.12*	3.35*	1066.10*	560103*	261.56*	237.98*	15.96*	34.25*	18.93*
Error	66	0.41	0.50	0.06	2.23	0.06	193.40	97659	2.06	1.21	0.24	0.40	0.45
Total	98												
Mean		98.38	102.80	5.45	53.49	4.69	71.89	1569.60	56.81	34.27	13.76	16.66	16.07
S. E		0.06	0.07	0.03	0.15	0.02	1.39	31.20	0.14	0.11	0.05	0.06	0.07

$p < 0.05$ is considered significant. *refers to strong, positive correlation. Df = degree of freedom; Dtf = days to first flower; d50f = days to fifty percent flowering; Nob = number of branches; Ph = Plant height; nftc = Number of fruits per cluster; nfh = Number of fruits harvested; wfh = weight of fruits harvested; Flnt = fruit length; Fwdt = fruit width; Stg = stem girth; ptl = petiole length; pdl = peduncle length.

Table 2: Quality assessment of 33 accessions of S. aethiopicum

Accessions	Stem colour	Petiole colour	Leaf hairs	Petal colour	Sepal colour	Fruit colour	Fruit shape	Fruit position	Fruit end shape	Stripe presence
Nhep2101	Green	Green	very few	White	Green	White	Oval	Direct	Pointed	Presence
Nhep2103	Green	Green	very few	White	Green	Lemon green	Oval	Direct	Pointed	Presence
Nhep2104	Green	Green	very few	White	Green	Light green	Oval	Direct	Pointed	Presence
Nhep2106	Green	Green	very few	White	Green	Lemon green	Oval	Direct	Flat	Presence
Nhep2110	Green	Green	very few	White	Green	Lemon green	Oval	Direct	Pointed	Presence
Nhep2111	Green	Green	very few	White	Green	Lemon green	Oval	Direct	Flat	Presence
Nhep2112	Green	Green	very few	White	Green	White	Oval	Direct	Pointed	Presence
Nhep2113	Green	Green	very few	White	Green	Lemon green	Long	Direct	Pointed	Presence
Nhep2114	Green	Green	very few	White	Green	White	Oval	Direct	Pointed	Presence
Nhep2115	Green	Green	very few	White	Green	Lemon green	Long	Direct	Pointed	Presence
Nhep2116	Green	Green	very few	White	Green	Lemon green	Long	Direct	Pointed	Presence
Nhep2117	Green	Green	very few	White	Green	White	Round	Direct	Flat	Presence
Nhep2119	Green	Green	very few	White	Green	Light green	Oval	Direct	Flat	Presence
Nhep2120	Green	Green	very few	White	Green	Lemon green	Oval	Direct	Pointed	Presence
Nhep2121	Green	Green	very few	White	Green	White	Oval	Direct	Pointed	Presence
Nhep2123	Green	Green	very few	White	Green	White	Round	Direct	Flat	Presence
Nhep2124	Green	Green	very few	White	Green	White	Oval	Direct	Pointed	Presence
Nhep2125	Green	Green	very few	White	Green	White	Oval	Direct	Pointed	Presence
Nhep2126	Green	Green	very few	White	Green	White	Round	Direct	Flat	Presence
Nhep2128	Green	Green	very few	White	Green	Lemon green	Long	Direct	Pointed	Presence
Nhep2129	Green	Green	very few	White	Green	White	Round	Direct	Flat	Presence
Nhep2130	Green	Green	very few	White	Green	Lemon green	Long	Direct	Pointed	Presence
Nhep2132	Green	Green	very few	White	Green	Lemon green	Long	Direct	Pointed	Presence
Nhep2134	Green	Green	very few	White	Green	Lemon green	Oval	Direct	Pointed	Presence
Nhep2135	Green	Green	very few	White	Green	Lemon green	Oval	Direct	Pointed	Presence
Nhep2136	Green	Green	very few	White	Green	White	Long	Direct	Pointed	Presence
Nhep2137	Green	Green	very few	White	Green	Lemon green	Long	Direct	Pointed	Presence
Nhep2138	Green	Green	very few	White	Green	Lemon green	Oval	Direct	Pointed	Presence
Nhep2139	Green	Green	very few	White	Green	White	Long	Direct	Pointed	Presence
Nhep2140	Green	Green	very few	White	Green	White	Long	Direct	Pointed	Presence
Nhep2141	Green	Green	very few	White	Green	White	Round	Direct	Flat	Presence
Nhep2142	Green	Green	very few	White	Green	Light green	Round	Direct	Flat	Presence
Nhep2150	Green	Green	very few	White	Green	White	Oval	Direct	Flat	Presence

Table 3: Mean data for agronomic related traits of 33 S. aethiopicum accessions

Accessions	Dff	d50f	Nob	Ph (cm)	Stg (mm)	Ptl (mm)	Pdl (mm)
Nhep2101	104.00	109.33	7.26	57.67	19.59	23.14	20.20
Nhep2103	100.67	104.00	5.83	48.33	11.79	18.58	15.16
Nhep2104	90.67	94.67	5.67	52.33	10.81	16.98	18.94
Nhep2106	93.67	97.33	6.17	62.33	11.86	15.34	14.13
Nhep2110	92.67	97.67	4.33	46.00	10.36	19.98	19.21
Nhep2111	101.00	109.33	4.67	41.50	12.22	14.76	13.70
Nhep2112	98.67	103.00	5.00	54.50	12.53	20.27	15.05
Nhep2113	98.00	104.67	6.17	43.50	12.59	16.52	18.01
Nhep2114	100.67	104.33	5.83	52.50	13.28	16.80	17.78
Nhep2115	92.67	98.00	6.67	74.50	13.14	20.74	14.51
Nhep2116	93.67	98.00	6.50	59.50	14.96	14.04	18.41
Nhep2117	105.00	109.67	4.67	50.50	17.63	14.69	14.84
Nhep2119	102.00	106.67	5.50	52.33	13.74	12.87	11.64
Nhep2120	100.67	105.67	4.67	58.67	14.15	14.21	15.20
Nhep2121	98.67	104.00	7.00	47.67	12.19	15.20	18.47
Nhep2123	105.00	107.67	6.50	58.83	19.19	13.92	12.47
Nhep2124	97.67	101.67	6.67	47.33	10.78	10.84	12.15
Nhep2125	96.67	101.33	5.50	54.50	11.71	17.03	14.33
Nhep2126	98.67	102.67	6.00	48.50	14.40	19.57	15.23
Nhep2128	97.00	100.33	5.50	48.50	11.78	16.26	20.08
Nhep2129	98.00	101.00	3.67	41.17	14.08	14.09	14.37
Nhep2130	102.67	105.00	3.50	46.33	12.37	16.81	17.17
Nhep2132	98.67	102.67	5.67	54.17	10.68	21.66	17.72
Nhep2134	97.67	102.00	5.67	55.83	14.84	14.68	15.18
Nhep2135	96.67	100.67	3.83	60.17	13.04	26.73	22.83
Nhep2136	100.67	105.00	5.50	60.50	15.56	18.09	15.86
Nhep2137	98.00	102.67	4.33	58.00	16.87	13.75	15.49
Nhep2138	99.67	104.00	6.33	57.33	14.56	19.44	15.17
Nhep2139	97.67	102.00	6.33	52.67	15.57	11.91	17.69
Nhep2140	100.00	104.33	5.50	44.33	15.05	11.83	14.29
Nhep2141	97.00	101.00	5.17	69.50	16.12	16.44	12.76
Nhep2142	98.67	104.00	3.50	57.00	11.81	16.16	16.34
Nhep2150	93.67	98.00	4.67	48.67	14.72	16.46	16.01
Min	90.67	94.67	3.50	41.17	10.36	10.84	11.64
Max.	105.00	109.67	7.26	74.50	19.59	26.73	22.83
Mean	98.38	102.80	5.45	53.49	13.76	16.66	16.07
SD	3.48	3.62	1.02	7.53	2.35	3.44	2.58

Dff = days to first flower; d50f = days to fifty percent flowering; Nob = number of branches; Ph = Plant height; Stg = stem girth; ptl = petiole length; pdl = peduncle length.

Table 4: Mean data for yield related traits of 33 S. aethiopicum accessions.

Accessions	Nftc	Nfh	Wfh	Frtl	Frtwd
Nhep2101	2.67	58.50	1358.16	65.96	37.36
Nhep2103	5.00	75.17	1700.20	67.37	32.43
Nhep2104	5.17	75.17	1460.40	69.13	29.44
Nhep2106	5.17	71.50	1622.63	60.31	33.03
Nhep2110	4.50	81.83	1306.83	58.55	22.69
Nhep2111	4.67	60.00	1160.04	51.00	28.24
Nhep2112	4.50	82.50	1673.41	50.46	36.31
Nhep2113	5.33	73.00	1695.29	54.66	28.96
Nhep2114	5.67	72.67	1602.16	44.21	35.05
Nhep2115	6.17	77.50	1905.23	63.68	26.36
Nhep2116	4.50	54.67	1463.68	48.76	30.92
Nhep2117	5.83	65.50	1728.58	45.30	32.64
Nhep2119	5.83	77.00	1516.67	44.84	33.03
Nhep2120	5.17	86.67	1850.00	64.37	30.20
Nhep2121	5.83	94.33	2150.00	51.37	26.07
Nhep2123	5.83	113.67	1733.33	45.56	26.81
Nhep2124	4.17	94.83	1900.00	41.41	40.48
Nhep2125	4.50	82.83	1666.67	50.82	35.76
Nhep2126	4.83	90.17	2150.00	48.16	38.86
Nhep2128	6.00	47.33	1075.00	64.93	56.29
Nhep2129	5.17	60.67	1100.00	46.23	34.50
Nhep2130	5.17	42.17	850.00	62.97	31.23
Nhep2132	5.50	58.83	1650.00	60.38	28.37
Nhep2134	3.67	90.83	1966.67	59.46	32.44
Nhep2135	3.33	36.00	1666.67	78.31	41.88
Nhep2136	3.50	72.00	1750.00	57.16	31.47
Nhep2137	3.33	48.50	941.67	72.79	27.66
Nhep2138	4.17	78.83	1683.33	54.80	32.09
Nhep2139	4.33	92.50	2166.67	72.12	30.66
Nhep2140	4.50	78.33	1050.00	62.59	29.29
Nhep2141	6.00	83.33	1808.33	55.78	37.50
Nhep2142	1.83	20.00	162.00	47.03	70.92
Nhep2150	2.83	75.67	2283.33	54.24	41.95
Min	1.83	20.00	162.00	41.41	22.69
Max.	6.17	113.67	2283.33	78.31	70.92
Mean	4.69	71.89	1569.60	56.81	34.27
SD	1.08	22.08	503.37	9.46	8.99

nftc = Number of fruits per cluster; nfh = Number of fruits harvested; wfh = weight of fruits harvested; Flnt = fruit length; Fwdt = fruit width

Table 5: Pearson Correlation Coefficient of eleven quantitative characters among the 33 eggplant accessions

	Dff	d50f	nob	ph	Nftc	Nfh	Wfh	Frtl	frtwd	stg	Ptl
d50f	0.952*	-									
Nob	-0.015	0.007	-								
Ph	-0.190	-0.214	0.220	-							
Nftc	0.057	0.000	0.248	-0.016	-						
Nfh	0.027	0.005	0.570*	0.013	0.379*	-					
Wfh	-0.122	-0.127	0.541	0.175	0.258*	0.732*	-				
Frtl	-0.255	-0.266	-0.089	0.234	-0.184	-0.257	-0.039	-			
Frtwd	-0.009	-0.039	-0.296	0.029	-0.426*	-0.518*	-0.401*	-0.133	-		
Stg	0.509	0.466	0.178	0.295*	-0.145	0.160	0.132	-0.000	-0.130	-	
Ptl	-0.113	-0.106	-0.056	0.292	-0.180	-0.301	0.059	0.364*	0.074	-0.115	-
Pdl	-0.248	-0.234	-0.051	-0.071	-0.229	-0.454	-0.107	0.527	0.133	-0.153	0.557

$p < 0.05$ is considered significant. *refers to strong, positive correlation. Dff = days to first flower; d50f = days to fifty percent flowering; Nob = number of branches; Ph = Plant height; nftc = Number of fruits per cluster; nfh = Number of fruits harvested; wfh = weight of fruits harvested; Flnt = fruit length; Fwdt = fruit width; Stg = stem girth; ptl = petiole length; pdl = peduncle length.

PRELIMINARY FIELD EVALUATION OF PASSION FRUIT LINES FOR AGRONOMIC PERFORMANCE AND DISEASE EXPRESSION

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ABSTRACT
Passion fruit industry is gradually growing in Nigeria. To this effect, there is need to assess the available germplasm of the crop in a natural open-field environment to determine the productivity potential of each genotype and identify prevalent diseases causing significant damage to the crop. Four Passion fruit lines (LY, PK, WR and YK) were assessed. Line PK was consistently inferior in terms of agronomic performance to lines LY and YK, which are promising. A fungal pathogen (Sclerotia rolfsii), causing damage to the fruit was identified macro-and micro-scopically.

INTRODUCTION

Passion fruit plant (Passiflora spp.), belonging to the family Passifloraceae, is an important woody vine grown in the tropics and subtropics, partly for fresh consumption and more importantly for industrial production of juice, jelly and ice cream (Samyor *et al*., 2020). Passion fruit juice, in addition to its characteristic aroma and flavour, serves as a good source of vitamins, proteins and minerals like K, Ca, P, Fe, Na, Mg, S and Cl (Appleby, 2014). The seed contains piceatannol and Scirpusin B which have strong antioxidant activity that promotes cardiovascular health benefits (Sano *et al*., 2011). Among the diverse species of Passion fruit from which several genotypes are usually obtainable (Nobrega *et al*., 2022), Passiflora edulis Sims (purple) and Passiflora edulis f. flavicarpa Deg. (yellow) are well known and edible. In Nigeria, recent research works have focused extensively on boosting the productivity potential of the crop in an organic system. Ndukwe *et al* (2021) worked on the effect of poultry manure application rate, time and method on the growth and yield of 1-2 genotypes of yellow passion fruit. Similarly, Joseph-Adekunle *et al* (2022) assessed the effect of varied application rates of an organic fertilizer on a genotype of yellow passion fruit. However, there are scarce reports of studies on assessment of performance of several genotypes of Passion fruit simultaneously in the country.

The major aim of evaluating several genotypes of a crop species is to precisely predict future performance (Smith *et al*., 2002). Vilela *et al*. (2022) studied the performance of 32 genotypes of sour passion fruit, identifying the promising lines for productivity, fresh consumption and industrial purpose. The assessment of numerous genetic materials in a specific environment provides information about the adaptability and stability of the concerned material as well as resistance to stress factors, especially biotic (Forster *et al*., 2013). Unlike in temperate region where crops are minimally attacked by diseases, the principal constraint to sustainable productivity of passion fruit tree in the tropics and subtropics is multiple disease infestation (Amata *et al*., 2009). Diseases in the root system and aerial part of the plant, resulting from the presence of fungal, bacterial and viral pathogens are common, causing premature death, defoliation, delayed fruiting, low pulp yield and decreased quality, which has implication for economic losses (Cerqueira-Silva *et al*., 2015). Hence, this research work was carried out to understudy the agronomic performance of four lines of Passion fruit and accurately identify diseases affecting the crop in a natural field environment of National Horticultural Research Institute, Ibadan, situated in South-West, Nigeria.

METHODOLOGY

The experiment was carried out in an open field at National Horticultural Research Institute, Ibadan (latitude N7º24ꞌ36.246 and longitude E3º50ꞌ492ꞌꞌ) between 2020 and 2021.

Seed Propagation

A total of four passion fruit cultivars, including three from Kenya and one from Nigeria were used in this study. These cultivars are Yellow Kenya (YK), Pink Kenya (PK) and Wilt Resistance (WR) from Kenya and a Local Yellow (LY) which is indigenous to Nigeria. Seeds were extracted from matured fruits and thoroughly depulped, after which they were rinsed under tap water and dried at room temperature for 48 hours before they were sown in nursery trays. At 6-leaf stage, seedlings obtained were transplanted into potting bags containing 1.5kg of well drained, sterilized sandy-loam soil for 1 month and afterwards moved to the field. The experiment was laid out in a Randomised Complete Block Design with 3 replicates. The experimental units were established at 2 m × 2 m spacing on field for evaluation of performance and adaptability of the four lines. Agronomic data and disease expression were observed. Data were collected for 8 months on vine length (VL, cm), vine girth (VG, mm), number of branches and only once for yield (kg). Data collected were analysed using descriptive method.

Collection of infected fruit samples

Passion fruits exhibiting visible disease symptoms were sampled on the field. Infected fruits with characteristic yellowing, soft rot and white mycelial growth were brought to the Pathology laboratory of National Horticultural Research Institute, Ibadan, for mycological study.

Isolation of fungus pathogen from infected fruits

The infected fruits were thoroughly rinsed under a running tap. The affected tissues were cut into pieces of 3-5 mm, surface sterilized in 70% ethanol and then rinsed thrice in sterilized distilled water. The samples were blotted dry using Whatman No 1 filter paper. Potato Dextrose Agar (PDA) was used to culture the fungus pathogen(s). Thirty-nine grammes of the medium was dissolved in 1L of distilled water and sterilized by autoclaving at 1210C and 1.5 psi for 15minutes. The sterilized medium was allowed to cool to temperature between 45-500C and then amended with chloramphenicol (60µg /L). The surface-sterilized fruit tissue sample was then picked using sterilised forceps and placed aseptically on 9mm diameter petri-dishes containing the solidified ammended PDA. Incubation was done at 28±2°C for 3-5 days. Sub-culturing of the fungal mycelium was done till pure culture was obtained. The cultural and microscopic morphology of the isolate was studied for identification.

Pathogenicity Test

Pathogenicity test was done according to Koch's postulate (1890). Healthy, matured Passion fruits were used in this study. Fruit surfaces were sterilized with 70% ethanol and punches made on them with the aid of sterilized cork borer, followed by inoculation with 8mm PDA disk of mycelia of the isolated fungus grown for 5 days. Inoculated fruits were covered with the initially cut off fruit parts and incubated in a dessicator under high relative humidity at room temperature for 3-5 days.

RESULTS

Agronomic and Yield Parameters

The evaluation of the four Passion fruit lines was conducted throughout the production cycle. Overall, the lines were observed to be different in their agronomic performance under field condition. Line LY had the highest vine length at 1MAT, followed by YK and then, WR while PK had the least. This trend continued throughout the period of data collection. The highest vine length data (215.7cm) was obtained at 4 MAT on line LY. From 6MAT, there was no record of line PK any longer. Line PK gave the least vine girth from 1-5MAT while line WR consistently ranked third from 1-7MAT. At 1MAT, line YK had the highest vine girth, followed by line LY, and then, WR. At 2-7 MAT, line LY had the highest vine girth, followed by line YK, then WR. At 8MAT, line LY had higher vine length than YK.

Line PK consistently gave the lowest no of branches from 1 to 5MAT while at 3 to 7MAT, WR ranked third with respect to number of branches. At 1MAT, line YK and WR had the highest number of branches, which was followed by line LY. At 2MAT, line YK and LY had the highest number of branches, followed by line WR. At 3-4MAT, line LY had the highest number of branches, followed by line YK and then WR. At 5-7MAT, line YK had the highest number of branches, followed by line LY and then, WR. Yield obtained at harvest for Line YK and LY were 157 g and 165 g respectively while fruits were not recovered from lines PK and WR because they were lost before the end of the season.

Identification of the isolated fungus and Pathogenicity test

The isolated fungus was identified as *Sclerotium. rolfsii* using both cultural and microscopic features according to Barnett and Hunter (1972). The fungal mycelium obtained from infected Passion fruit was first white in colour (Plate A) and afterwards, brown with the presence of bead-like structures (Sclerotia) (Plate B). Hyphae were observed to be hyaline, branched, septate and have clamps. Pathogenicity test revealed that *S. rolfsii* produced the same symptoms, initially observed on infected passion fruit collected from the field. Fruit soft rot and white mycelial growth were observed on inoculated fruits while the uninoculated were healthy, showing no visible disease symptoms.

DISCUSSION

Productivity is an important attribute for selecting genotypes of a crop species for cultivation, whether in organic or conventional farming system (Kokare *et al*., 2014). Passion fruit productivity is considered to be generally low. This has been attributed to many factors, including the cultivation of inappropriate cultivar, genetics of the planting material, biotic stresses and environmental factors (Nogueira 2016; Faleiro *et al*. 2011). This has necessitated research works aimed at selection of superior lines targeted at meeting pre-determined need of end-users. Increased productivity, good fruit quality and resistance to diseases are some of the important traits that passion fruit breeding programs address most times.

In open field cultivation system, evaluation of planting lines for agronomic performance in the scenario of biotic stresses is necessary. Line PK, though in the same environment as lines LY and YK, performed poorly throughout the period of the experiment, with respect to the agronomic parameters evaluated. There are reports of Purple passion fruit, to which Line PK belong, being more vulnerable to diseases and losses eventually (Mwirigi *et al*., 2016). The seemingly good performance of line LY could be a function of adaptive advantage, having been cultivated over the years in Nigeria. Moreira *et al*. (2018) similarly identified two inferior and three superior genotypes with respect to productivity while evaluating some Passion fruit lines. *Sclerotium rolfsii* has diverse host range of more than 500 plants in the tropical, subtropical and warm temperate areas (Wydra, 1996). The sclerotia constitute the primary inoculum of the pathogen and major means of dispersal. Through them, the fungus survives adverse environmental conditions (Okereke and Wokocha, 2007). Management strategies such as crop rotation, weed control and soil processing should be employed against infection of *S. rolfsii* on passion fruit plantation in NIHORT environ.

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Plate A - C: (A) Mycelium growth on PDA; (B): Sclerotia formation; (C): In-vitro growth of S. rolfsii on inoculated passion fruits.

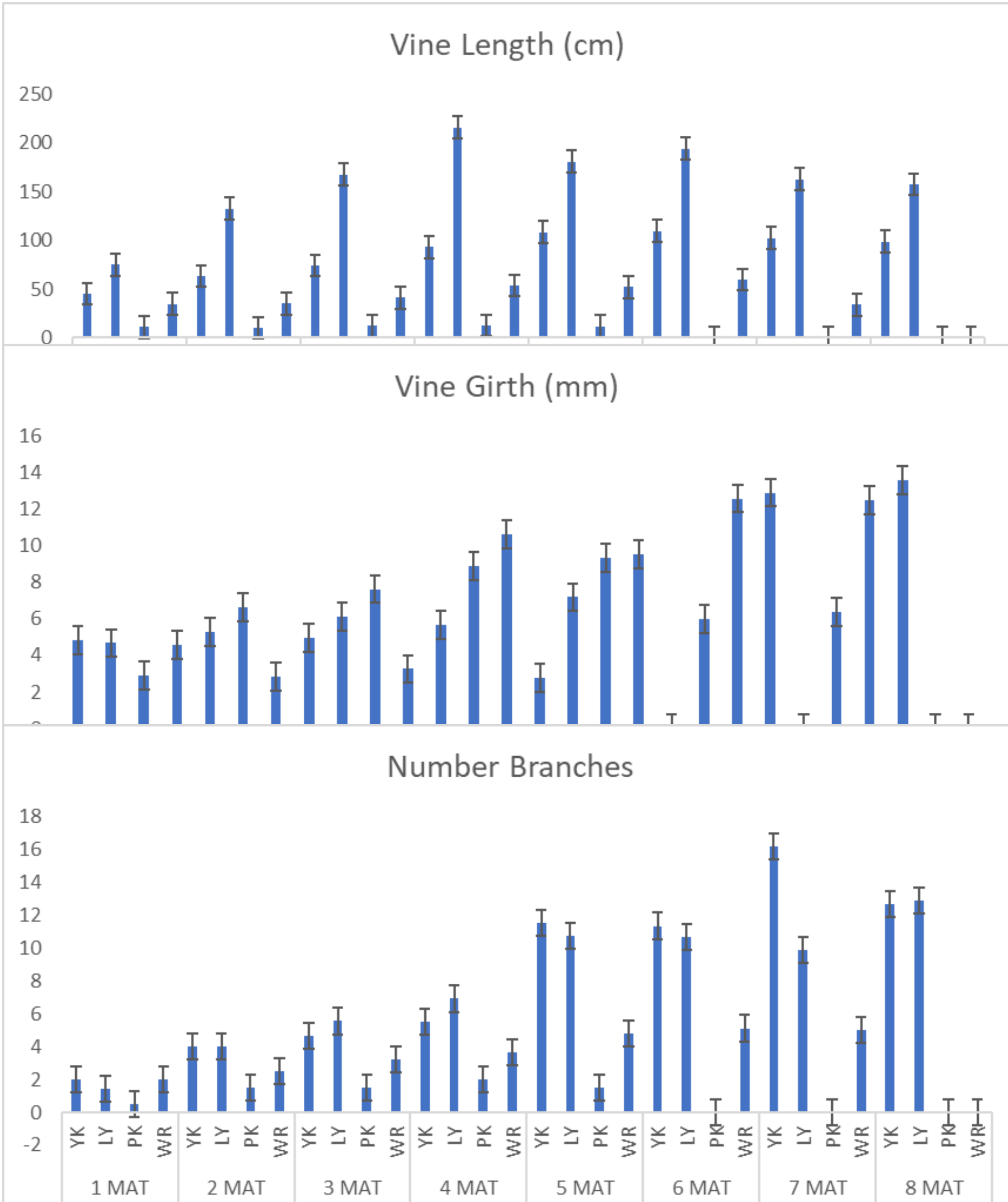

Figure 1. Agronomic parameters of the studied *Passiflora spp.* varieties.

PHENOLIC AND ANTIOXIDANT PROPERTIES OF METHANOLIC EXTRACTS OF AVOCADO SEEDS

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ABSTRACT
Persea americana M. (Family: Lauraceae) grown in tropical and subtropical areas, has several health-related phytonutrients properties including antioxidant, anti-cancer, anti-inflammatory, and anti-neurogenerative effects. Additionally, it contains vitamin C, which helps to boost the immune system and promote healthy skin. In this study, the antioxidant potential of the absolute (100%) and aqueous (80%, 80:20 v/v) methanol extracts of seeds of Persea americana Mills was examined through three models using 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assay, FRAP, and TAC. The total phenolic contents of the methanol extracts ranged between 2.36 ± 0.01 to 2.89 ± 0.05 mg GAE/g. The results of total flavonoid contents of the seed extracts ranged from 19.22 ± 0.14 to 70.34 ± 0.62 mg CE/g. Furthermore, the absolute methanolic seed extracts were able to scavenge the DPPH assay than the aqueous methanol extracts. Also, as the concentration of the methanolic seed extracts increases, the results present an increase in the absorbance value of the reducing power assay (FRAP). The absolute methanol extracts of seeds of Persea americana showed the highest value of total phenols, flavonoids and most significant antioxidant activities. Therefore, this study demonstrated that methanolic extracts from avocado seeds are a good source of bioactive components that implement antioxidant properties.
Keywords: *Antioxidant activities, total phenols, total flavonoids, avocado seeds.*

INTRODUCTION
Free radicals are highly reactive and unstable molecules which are produced spontaneously by the body as a result of normal metabolism. Free radicals can accumulate in cells and harm other molecules like DNA, lipids, and proteins (Martemucci *et al*., 2022). This damage may raise the likelihood of developing cancer and other disorders. When there is an accumulation of excessive free radicals in the body, it generates a phenomenon known as oxidative stress. Excess free radicals can cause a variety of illnesses and cell damage (Tsatsakis *et al*., 2019). However, in small-moderate amounts, free radicals aid in the proper functioning of the body and the regulation of cell processes (Sharifi-Rad *et al*., 2020). Free radicals are majorly caused by external factors such as radiation, excessive smoke, industrial pollutants, and ozone. Antioxidants are essential for neutralizing the effects of free radicals and oxidants as well as reducing the risk of degenerative diseases (Rahman *et al*., 2022).
The avocado seed is a natural antioxidant with high nutritional content and bioactive substances such as fibre, phenolic compounds, vitamins C and E, and carotenoids that benefit human health (Siol & Sadowska, 2023). It has phytonutrients and antioxidants, such as vitamin C, that can strengthen immunity (Lyu *et al*., 2023) and have digestive benefits for treating ulcers and diarrhoea brought on by intestinal parasites. In addition to other medical uses, it is used to treat skin eruptions, dry skin, swelling brought on by inflammation, and other health conditions. Avocado seed contains phytochemical compounds with hydroxybenzoic acid that play antioxidant activity. Furthermore, avocado seeds, which include active compounds such as flavonoids, phenolics, tannins, and alkaloids, are the main source of antioxidant activity. Therefore, the objectives of this research were to examine the avocado seed extract's potential as a source of antioxidant activities, total phenol (TP), and total flavonoid (TF).

MATERIALS AND METHODS
Preparation of avocado seed extract
The fresh, dark avocado fruits were purchased from NIHORT Farm. Extract preparation starts at the sampling stage by separating the seed from the fruit pulp, peeling off the flesh and removing the pulp.

The seed was washed and cleaned with water, cut into pieces, dried in a place not exposed to direct sunlight, and then ground to powder and sieved to obtain fine particles. The seed powder was defatted with n-hexane in a soxhlet extractor and dried. Extracts were made by weighing 10 g of the powdered sample into 100 mL of solvents (100% methanol and 80% methanol) in different maceration containers. The mixture was stirred occasionally in the maceration container for 12 h at room temperature. It was then filtered using Whatman No 4 filter paper to separate the filtrate and residues. The residues were re-extracted with the same amount of 100% and 80% methanol as the solvent; re-extraction ended when the filtrate was clear. The filtrate was then evaporated using a rotary evaporator, dried, and weighed using an analytical scale.

Determination of total phenol and total flavonoid

Total phenol content was measured according to David *et al*. (2022) with minor modifications. The results were expressed as mg of gallic acid equivalents (GAE) per gram of sample ($R^2 = 0.9995$) using a spectrometer (T80 Series UV/Vis Double Beam Spectrophotometer, PG Instruments Ltd). The total flavonoid was determined by using the aluminium chloride method of Turco *et al*. (2016) with modifications. The results were expressed as mg of catechin equivalents (CE) per gram of sample ($R^2 = 0.9998$).

Antioxidant assay

The DPPH scavenging assay was performed according to Fadly *et al*. (2020) with minor modifications. The FRAP assay was estimated using the method of Vijayalakshmi & Ruckmani, (2016) with some modifications. A modified method by Elkhamlichi *et al*. (2017) was used to determine the total antioxidant capacity assay using the phosphomolybdenum method with modifications.

Statistical analysis

All analyses were done in duplicates, and data obtained from the results were processed and then analyzed statistically using SPSS (Statistical Package for Social Sciences).

RESULTS AND DISCUSSION

The results of total phenol and total flavonoid contents carried out *in vitro* were determined for 100% and 80% methanol extracts of seeds of *Persea americana* Mill are presented in Table 1. The total phenolic contents in different extracts expressed as mg gallic acid equivalents (GAE) per gram of extract, varied between 2.36 ± 0.01 to 2.89 ± 0.05 mg GAE/g. The highest phenolic contents were found in 100% methanol extracts (with 1 mg/mL extract concentration). Then, the total flavonoid contents values also tend to be at the same level as total phenolic contents. That is, the total flavonoid contents of 100% methanolic seed extracts were notably higher than 80% seed extracts. The results of total flavonoid contents determination of the examined seed extracts (in different extracts) ranged from 19.22 ± 0.14 to 70.34 ± 0.62 mg CE/g. The 100% methanolic seed extract had the highest value with 70.34 ± 0.62 (with 1 mg/mL extract concentration) which is in line with that reported by Folasade *et al*. (2016). Phytochemical substances such as phenols and flavonoids act as free radicals scavengers and serve as inhibitors to enzymatic reactions within the body (Mbinda & Musangi, 2019). Therefore, flavonoids which are considered a strong antioxidant found to be effective against a variety of ailments and other cardiovascular diseases, are actively present in various parts of avocado fruit.

Table 1: Total phenol and Total flavonoid contents of methanolic extracts of avocado seeds

Parameter	Results	
	100%	**80%**
Total phenol (mg GAE/g extract)	2.89 ± 0.05	2.36 ± 0.01
Total flavonoid (mg CE/g extract)	70.34 ± 0.62	19.22 ± 0.14

DPPH radical scavenging assay

The DPPH radical scavenging assay is shown in Fig.1. The absolute solvent extracts revealed stronger scavenging activity than the aqueous solvent extracts; also, as the concentration of the seed extracts increases at wavelength, λ = 517 nm, the activity increases. DPPH is an antioxidant assay that measures an antioxidant's ability to scavenge a stable radical. This stable free radical has an odd electron and absorbs strongly between 515 and 528 nm. When DPPH reacts with an antioxidant, it absorbs an electron from the antioxidant scavenger molecule, making the DPPH molecule more stable. At room temperature, this stable radical is decreased and decolourized from purple to pale yellow (Rahman *et al*., 2015). The 100% methanolic seed extracts showed great antioxidant activity, being able to scavenge more than 80%

of the DPPH radical assay at a concentration of 1000 µg/mL which displayed the highest activity than 80% methanolic seed extracts.

Ferric Reducing Antioxidant Power (FRAP)

The FRAP antioxidant assay is based on the reduction and inactivation of oxidation, and this can be described as redox reactions (which involve electron transfer between two species). The principle of reducing power assay is based on the ability to reduce ferric cyanide (Fe^{3+}) to form a ferrocyanide (Fe^{2+}) complex under low pH conditions in the presence of sample extract (Irshad *et al*., 2012). Fig. 1 presents the reducing abilities of the avocado extracts. The reducing power of seed extracts measured for the concentration from 0.25 to 1 mg/mL showed a general increase as the concentration of extracts gradually increased.

Total Antioxidant Capacity (TAC)

The TAC assay is presented in Fig 1. The phosphomolybdenum assay was used for total antioxidant capacity, the assay is based on the reduction of molybdenum (VI) to molybdenum (V) complex by antioxidant, which in turn forms a green solution. From the results, the 100% methanolic extracts have the highest TAC value at a concentration of 1000 µg/mL with 6.63 mg AAE/g, and the lowest was observed in 80% methanolic extracts at a concentration of 250 µg/mL with 1.14 mg AAE/g. Folasade *et al*. (2016) indicated that the total antioxidant capacity for the avocado seed extracts based on different extracting solvents showed the most effective antioxidant activity in the absolute solvents than the aqueous solvent. Furthermore, Alkhalaf *et al*. (2019) reported that avocado seed showed much greater total antioxidant capacity than pulp.

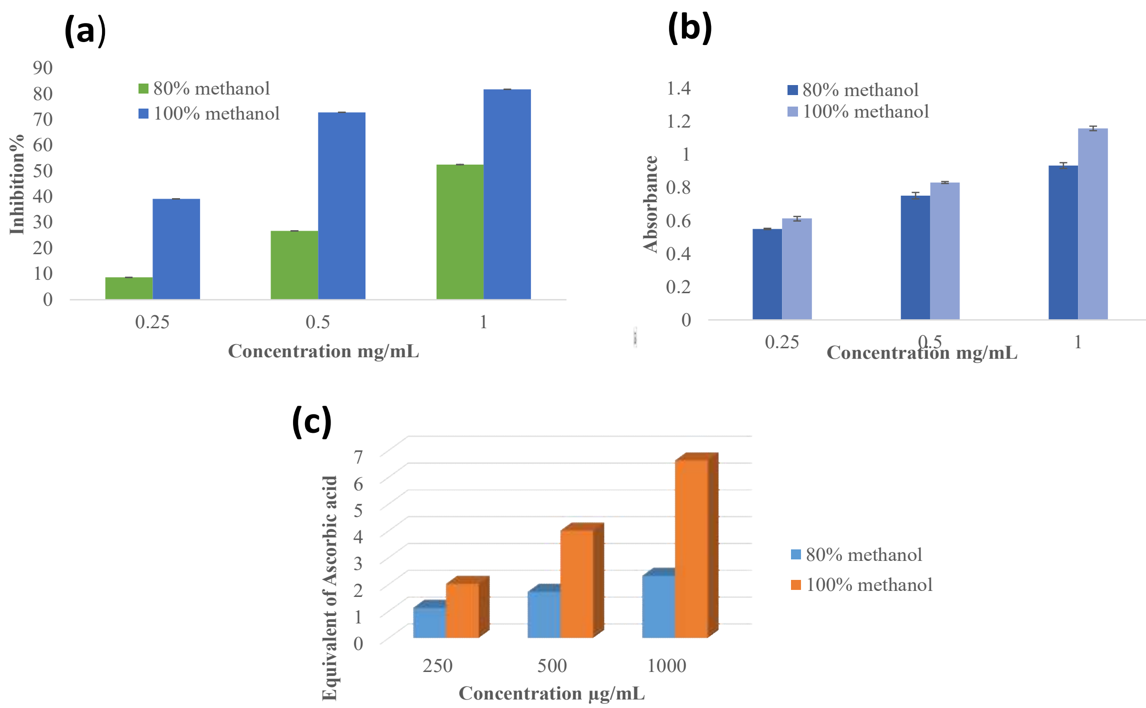

Figure 1: Antioxidant activities of methanol extract from *Persea americana* seeds using **(a)** DPPH assay **(b)** FRAP **(c)** TAC.

CONCLUSIONS

The three models' antioxidant potential (DPPH, FRAP, and TAC) examined in this study with methanolic seeds extracts followed the same trend as the total phenols and total flavonoids with 100% methanolic extracts being the highest in all and showed the highest antioxidant potential. Avocado seeds have significant polyphenol content, which may explain their high antioxidant activity. As a result, avocado fruit seed has been found as a source of phytochemicals that aid in antioxidant activity. More research should be done to develop the drying of avocado seed into tea bags for human consumption rather than being a by-product waste because it has antioxidant, anti-inflammatory, anti-ageing, and anti-cancer properties.

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USE OF LIBRARY BY RESEARCHERS IN AN HORTICULTURAL RESEARCH INSTITUTE

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ABSTRACT
The library is an important conduit of knowledge and information that gives birth to improvement in research and quality of life. Therefore, it has become imperative for research institutes to pay much attention to the provision of library services to their immediate patrons. However, there is a need to understand the library use patterns and material preferences of the researchers in order to efficiently provide these services. This article employed a collective case study method to study the use of library by researchers in horticultural research institute using the National Institute for Horticultural Research (NIHORT), Ibadan as a case study. The data used for the article was obtained from the daily statistics sheet kept by the library and a time frame between 2019 to 2023 was chosen. The study found that there was a high level of use of library among researchers in NIHORT, which is not abnormal for a research institute. The study also found that the researchers use more of books and journals than other library materials. The article concludes that researchers in NIHORT use the library as frequent as possible and they consult more of print materials. It is therefore recommended that the researchers should be introduced and encouraged to use electronic resources.
Keywords: *Horticultural research, Use of Library, Research institutes, Library resources, Researchers*

INTRODUCTION

A nation's agricultural, economic, scientific, and technological development can be guided in the right direction by agricultural research libraries. Examining how agricultural researchers, particularly those at the horticultural research institute, use libraries has become important at a time when the Federal Government of Nigeria is determined to increase agricultural productivity in the nation. A library is regarded as the hub of all research activities and a necessary component of an effective research system. It serves as a breeding ground for fresh concepts and ideas while also providing an account of earlier intellectual endeavors (Majid, Tamara, and Anwar, 1999). A science and technology institution's research capacity and sophistication can be gauged using the resources and facilities in the library (Gooch, 1994). The primary purpose of agricultural research libraries is to connect groups of students, professors, researchers, and scientists who are committed to exchanging knowledge and cooperating to solve agricultural and scientific problems and make use of available resources. Horticultural libraries may be defined as a collection of knowledge materials, especially books, journals and reports pertaining to horticulture. This collection may be a definite entity as in many agricultural research institutions, or within a larger library collection as in a university library (Aguolu, 2000). The library is essential to advancing scientific and technological research, which has numerous applications in agriculture and subsequently speeds up innovation. For the advancement of agriculture, the economy, society, and science, information is a vital resource.

The government has established a number of agricultural institutes, colleges, and universities over time, many of which have complementary agricultural libraries or collections. This has been done to advance agricultural research, teaching, and study. These institutions and their libraries produce and disseminate agricultural information or knowledge to government policymakers, researchers, teachers, students, farmers, and extension agents. According to Aguolu (200), agricultural data may be encoded or unencoded. The efficient utilization of libraries by researchers in horticultural research institutes plays a pivotal role in advancing scientific knowledge, fostering innovation, and promoting sustainable agricultural practices. However, despite the critical importance of libraries in supporting research endeavors, there is a noticeable gap in our understanding of how researchers in horticultural research institutes utilize library resources and services. This knowledge gap hinders the ability of these institutes to optimize their library facilities, tailor their collections, and enhance the overall research productivity of their staff. The expectations from agricultural libraries to play a major role in the dissemination of knowledge has necessitated a study to first determine the use of library by researchers in horticultural research institutes, using the National Institute for Horticultural Research (NIHORT), Ibadan as a case study.

Research Objectives

The major aim of the study is to examine the use of library by researchers in NIHORT. The specific objectives are to:

i. Examine the frequency of library use by researchers in NIHORT
ii. Investigate the type of library materials consulted by the researchers

Research Questions

i. How frequently do researchers at NIHORT use the library?
ii. What are the types of library materials consulted by researchers in NIHORT?

METHODOLOGY

The case study research design was employed for this study, while the collective case study method was preferred. This is because this method allows the researcher to study a group of people in a certain setting in order to explain their actions and behaviours in order to develop additional ideas and study questions that can be explored in future studies (Cherry, 2022). The population for the study consists of all researchers in the various departments of NIHORT who are users of the institute's library, irrespective of cadre. Only researchers who used the library within the specified period were used for the study. This article relied on data obtained from the daily statistics sheet of the library between year 2019 and 2023. The obtained data was analyzed and the results presented in charts using descriptive statistics.

RESULTS AND DISCUSSION

This study found that the use of library among NIHORT researchers is on the high side (fig. 1), which is expected of a research institute. However, it was observed that the institute library recorded the highest number of users in the year 2019. The study found that a good number of the researchers use the library on a daily basis, with a high number of them using the library at least once in a week. This is somewhat similar to the findings of Mugwisi (2014) that the majority of agricultural researchers in Zimbabwe use the library at least once a month, with those who use the library at least once a week coming closely behind. It however slightly negates the findings of Ezeala and Yusuff (2011) who found that researchers of agricultural research institutes in Nigeria use the library occasionally.

The study also found that the most preferred library materials by the researchers are books (fig 2-4) as they account for the highest number of library materials used monthly by the researchers. This may be an indication that the researchers prefer to seek knowledge from books as a primary source. The study also found journals to be the second preferred library material by the researchers in terms of frequency while reference materials were the least consulted materials. This is in consonance with the findings of Idiku et al. (2022) that print and book materials recorded 64% of library information sources consulted by users of an agricultural research library. It however contradicts the findings of Mugwisi (2014) who found that journals and government publications were the most consulted library materials by researchers in Zimbabwe agricultural research institutes.

CONCLUSION

Researchers are information seekers which makes it imperative for research libraries to provide replete necessary materials that are germane to the researchers in horticultural research institute. Although the study established that researchers use the library frequently and consulted more of books than other library materials, there is a need to sensitize the researchers about other materials and encourage them to use e-resources.

Based on this usage pattern, the institute should allocate enough funds to the library so that it can update its collection with new books and other materials. Additionally, access to cutting edge research resources, which are accessible on numerous local and worldwide internet databases, will motivate researchers to visit the library. This study therefore strongly suggests that libraries in horticultural research institutes should prioritize investments in e-resources, conduct frequent user training and sensitization programs to encourage researchers to use more e-resources for their research, and maximize the quest for knowledge as demonstrated in the use of library materials.

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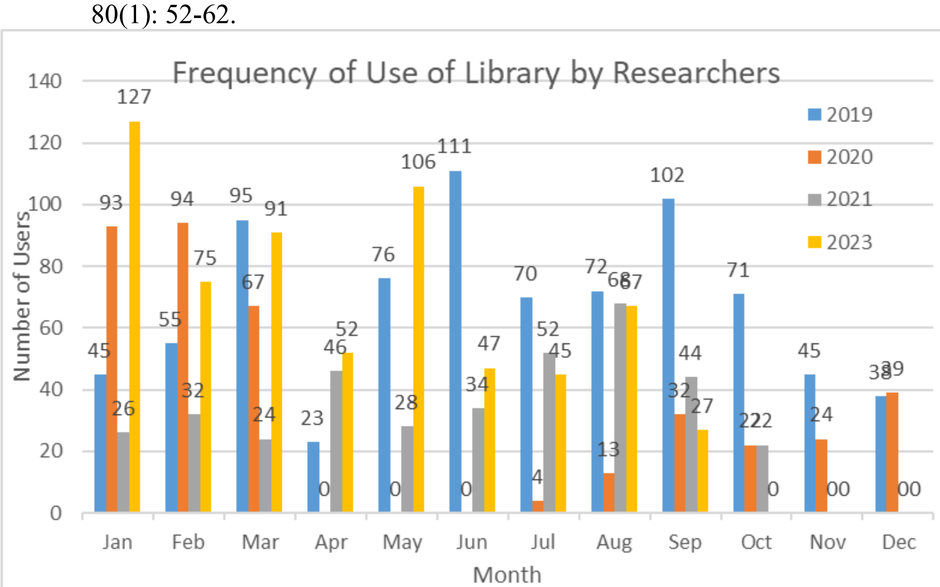

Figure 1: Frequency of use of library by researchers

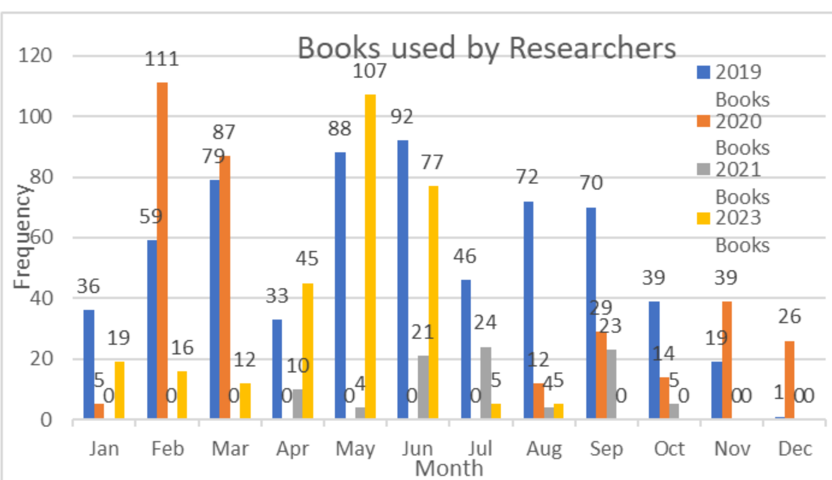

Figure 2: Frequency of use of books by researchers

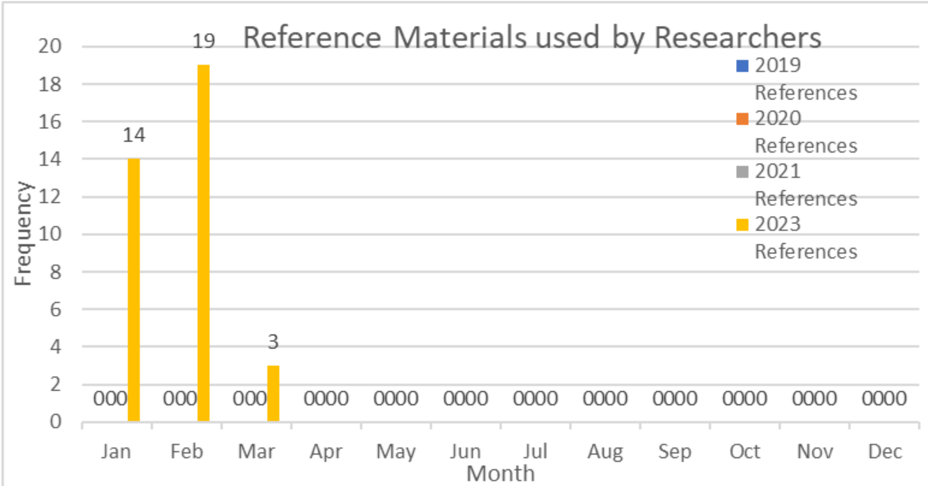

Figure 3: Frequency of use of reference materials by researchers

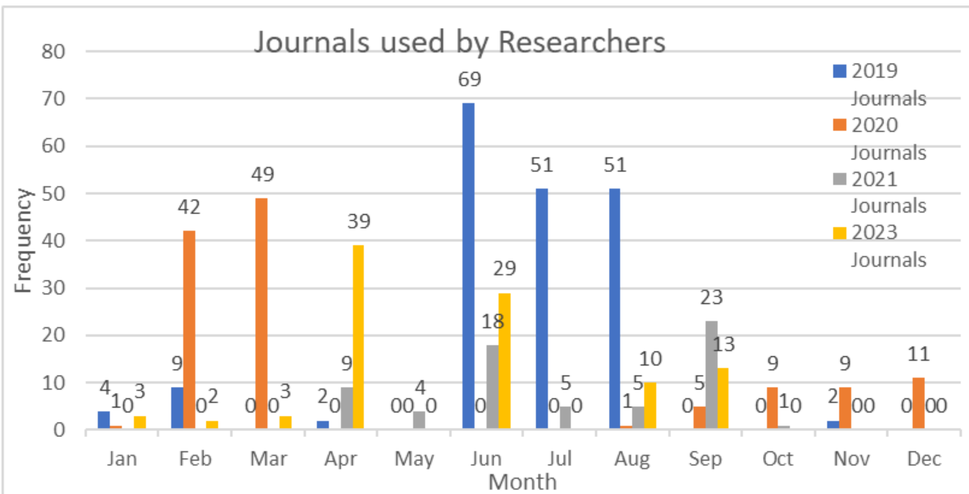

Figure 4: Frequency of use of journals by researchers

PHYSICO-CHEMICAL PROPERTIES OF THREE DIFFERENT *Cucurbita pepo* VARIETIES

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ABSTRACT

This study explores the diverse attributes of three Cucurbita pepo; pumpkin varieties; Casper white, Orangetti and Connecticut field cultivated in the National Horticultural Research Institute, Ibadan Nigeria, aiming to enhance awareness of their nutritional values. Pumpkin belonging to the Cucurbitaceae, are globally cultivated and have various applications based on their unique properties. The study reveals significant differences in colorimetric values, with all varieties tending towards darkness but lacking the typical bright orange hue due to carotenoid content variations. The research revealed that while all three varieties showed similar lightness values (L), the Orangetti variety exhibited the highest carotenoid content, contributing to its hue. Conversely, Casper White with its distinctive pale coloration, displayed the lowest carotenoid concentration. For Brix values, Orangetti was found to be the highest while the other two varieties (Casper white and Connecticut field) had lower Brix values, suggesting potential suitability for diabetic patients due to low sugar content. Additionally, Orangetti and Connecticut Field exhibit stronger DPPH antioxidant activity compared to Casper White, suggesting better potential for neutralizing free radicals. The study enhances understanding of these pumpkin nutritional and culinary potentials, and underscores the importance of considering these diverse pumpkin varieties in aiding informed consumer choices and further research.*

Keywords*: Pumpkin, Carotenoids, Color, Antioxidant activity, Awareness*

INTRODUCTION

Pumpkin (*Cucurbita pepo*) belongs to the family *Cucurbitaceae* and it is grown all over the world, with Cucurbita pepo, Cucurbita moschata, Cucurbita maxima being the most popular ones (Kulczyński *et al.*, 2020). The word pumpkin comes from the Greek word *pepon* meaning "large melon" (Dhiman *et al.*, 2009). They originated in Central America, playing roles in history, mythology, and cuisines worldwide (Kapek., 2022). Today, pumpkins are celebrated in fall festivals, Halloween traditions, and diverse culinary traditions (Kapek., 2022). They are considered among the top 10 vegetables worldwide (Balkaya *et al.*, 2010). Pumpkin (Cucurbita spp.) is one of the cucurbitacous fruit vegetables consumed and relished by most local people in Nigeria and in the sub-Saharan Africa. (Aruah *et al.*, 2012). According to Hussain Dar *et al*, pumpkins are rich in carbohydrates, thus making them a good source of calories. Additionally, it is abundant in ß-carotene, which gives pumpkins their distinctive yellow-orange color, making pumpkins a potential source of vitamin A which the body needs for healthy eyes, normal growth, and disease defense. It also contains a lot of fiber, lycopene, vitamin C, and vitamin E (Blessing *et al.*, 2011). Pumpkins are cultivated on over 3 million hectares worldwide, which yields over 27 million tons annually. China is the world's highest pumpkin producer with about 58% annual production (Hosen *et al,* 2021). The annual production of pumpkin has increased by over 5000 hectares compared to the past two decades according to a study by Wittstruck *et al*, 2020.

East African regions have lower pumpkin production projects due to their large reliance on other staple crops like rice, cassava, maize, sorghum and millet and this has led to lack of attention towards conserving plant genetic materials of other nutritious vegetables like pumpkin which has now resulted in decreased interest among small scale farmers in the production of pumpkin (Immaculate *et al.*, 2019). In Nigeria, a great number of the population are unaware of the nutritional benefits of Cucurbita, instead it is seen as a traditional food mostly for low income earners. This information gap may discourage high income earners and urban-dwellers from including this crop in their diet (Blessing *et al.*, 2011). This research aims to raise awareness of the nutritional values of three (3) different pumpkin varieties cultivated at the National Horticultural Research Institute, Ibadan, Nigeria. This knowledge can help increase awareness and encourage a wider population to include pumpkins in their diet.

A	B	C

Figure 1: Showing pumpkin varieties used A) Casper white B) Orangetti C) Connecticut field

METHODOLOGY

Source of material

Three pumpkin varieties of Cucurbita pepo used in this study were obtained from National Horticultural Research Institute. The pumpkin fruit was washed and peeled to remove the outer layer. The seeds were separated from the flesh and then the flesh was cut into smaller pieces and kept for further analysis.

Colour: Colour determination was carried out using a colourimeter (3NH NR60CP, Shenzhen, China) based on the CIE L*a*b* colour system.

Total carotenoid: The total carotenoid content of the pumpkins was determined using the method by De Carvalho *et al*, 2011.

DPPH Scavenging Activity: The antioxidant activity using DPPH was determined using the method by Baliyan *et al*, 2022.

Brix: Brix determination was carried out using a refractometer (PAL_1 Atago pocket refractometer).

RESULT AND DISCUSSION

Table 1: Shows the color values for three different *Cucurbita Pepo* varieties expressed using the L*a*b* color system.

Variety	L*	a*	b*	c*	Hue
Casper white	35.95 ± 0.48^{b}	1.92 ± 0.11^{a}	1.72 ± 0.74^{a}	2.61 ± 0.56^{a}	40.37 ± 11.34^{a}
Orangetti	36.23 ± 0.19^{b}	3.33 ± 0.45^{b}	2.54 ± 0.06^{ab}	4.20 ± 0.32^{b}	37.59 ± 4.64^{b}
Connecticut field	35.18 ± 0.19^{b}	4.44 ± 0.25^{c}	0.97 ± 0.16^{b}	4.55 ± 0.28^{b}	12.30 ± 1.40^{a}

Colour: The color values are an important parameter when trying to determine the visual quality of any fruit. The colorimetric values (L*, a*, and b*) are standard measurements in food science to understand the color of food products. L* values suggest lightness, with lower values tending towards darkness. The three pumpkin varieties showed no significant differences for L* values. The fact that all three pumpkin varieties displayed similar L* values, tending toward darkness, is intriguing. This result supports the assertion that these varieties lack the dominant orange hue commonly associated with high carotenoid content. Pongjanta *et al.* (2006) observed similar findings in pumpkin powder, emphasizing that not all pumpkin varieties will have the stereotypical bright orange hue. The a* values for all three varieties showed significant difference. The a* values were all positive and tends towards redness. Also, the three varieties were significantly different from each other. For the b* values, Connecticut field was significantly different from Casper white. However, there was no significant difference between Orangetti and Casper white and Connecticut field. For Chroma, variety Orangetti and Connecticut field had no significant difference while Casper white was significantly different. The hue angle values observed in this study were low and range between (12.30-40.37).

Table 2: Total carotenoid content, antioxidant activities and total soluble solid content of three (3) pumpkin varieties.

Variety	Total carotenoid(μg/g)	DPPH (%)	Total Soluble Solid (Brix (°))
Casper white	1.00±0.27^{a}	50.09±0.65^{b}	1.47±0.06^{a}
Orangetti	13.79±0.5^{c}	59.13±0.45^{a}	4.60±0.26^{b}
Connecticut field	8.79±0.16^{b}	59.52±0.91^{a}	2.00±0.43^{a}

Carotenoids: Carotenoid content of the pumpkin varieties observed in this study as showed in Table 2 indicate significant differences in all three varieties. However, highest total carotenoid content was observed in Orangetti as compared to other varieties. The Connecticut Field variety showcases a moderate level of carotenoids. Although this is lower than that of Orangetti, is considerably higher than Casper White's concentration, indicating a balanced carotenoid profile. Casper White variety has the lowest carotenoid content among the three. This low carotenoid presence is expected and consistent with its pale, almost white coloration, which often signifies reduced carotenoid concentrations. The carotenoid content of the pumpkin varieties ranged from 1.00-13.79 μg/g. The values obtained in this study compares favorably with those reported by Itle and Kabelka (2009) for Cucurbita pepo (1.9-14.7 μg/g) . Carotenoids bring extra benefits to foods, like antioxidants, anti-cancer properties, sun protection, heart health and reducing inflammation (Antonela Nincevic Grassino *et al*, 2023). High carotenoid levels can contribute to health benefits, given their antioxidant properties and their role as precursors to Vitamin A.

DPPH: From table 2, it was observed that the Orangetti and Connecticut Field varieties were not significantly different from each other. However, Casper White is significantly different from Orangetti and Connecticut field. Based on the results, Orangetti and Connecticut Field exhibit higher DPPH antioxidant activity compared to Casper White. This suggests that Orangetti and Connecticut Field may have a stronger capacity to neutralize free radicals, which are associated with oxidative stress and various health issues. The DPPH values of the pumpkin varieties in this study ranged from 50.09±0.65^{b} - 59.52±0.91^{a}. The values obtained in this study are lower than that of Lotfy *et al.* (2017).

Brix: A higher Brix value generally correlates with a sweeter taste in fruits and vegetables. The variation in Brix values among the three pumpkin varieties could have potential implications for consumer preference. Helyes *et al*. (2003) emphasized the importance of Brix measurements in determining the potential applications and consumer preference for fruits and vegetables. Findings from this research showed no significant difference in Brix value for Casper White and Connecticut. However, they were significantly different from Orangetti. It was also observed that all three varieties have low Brix values. This makes all varieties analyzed in this research ideal for diabetes patients.

CONCLUSION

In conclusion, the provided analysis sheds light on the varying physicochemical properties of different Cucurbita pepo varieties cultivated in the National Horticultural Research Institute, Ibadan, Nigeria. Building on the foundation laid by previous scholars, this study contributes to more understanding of the nutritional and culinary potentials of these pumpkins. Future research might delve deeper into other components like mineral content and texture.

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GENDER INVOLVEMENT IN SPICES PRODUCTION IN OYO AND KWARA STATES OF NIGERIA

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INTRODUCTION

Spices are a group of horticultural crops that are used primarily for enhancing taste, flavor and appeal of food and beverage. They are not usually cultivated like other horticultural crops and staples as they are mostly gathered from the wild in their natural habitats (Adelaja and Fasidi 2012). While some have been deliberately cultivated by resource-poor farmers they still remain largely neglected, under-utilized and under-estimated in spite of the several roles they are able to play in nutrition, health and in livelihood security of households. Some of these spices are perennial crops with sustainable high yields spanning several decades with the potential of high income generation for producing households; some have short life cycles that generate multiple harvests from the same unit of land. The rich agro-ecological diversity in Nigeria favors the production of different types of spices. The longer rainy season and fertile lands of the southern parts of Nigeria favors production of several indigenous and perennial spices that are adapted to forest conditions while the drier Northern parts of the country with semi-arid and dry humid features favor production of short duration and drought-tolerant spices. The production of spices is beneficial in several ways such as provision of employment; on-farm and off-farm, provision of income, nutrition security, household subsistence, individual and household wellbeing. As reported by Adewale and Oladeji (2022), gains accruable to thriving spices production includes ability to grow in marginal conditions, eradication of hunger and poverty as a result of multiple harvests and high incomes earned, job creation, environmental sustainability as well as improved food security and nutrition. As parts of research efforts to ensure that spices as crops that are already endangered do not continue to face the threat of extinction and ensure that households are able to obtain nutritious diets through adoption of more diversified and sustainable food production systems, the study was conducted to assess gender involvement in spices production in south western and north central zones in Nigeria with the following objectives:

1. Identify socio-economic characteristics of spices farmers;
2. Ascertain production patterns- types and varieties of spices cultivated in the zones,
3. Identify constraints associated with spices production;

METHODOLOGY

Multistage sampling technique was used to select respondents for this study. Oyo and Kwara states were selected at the first stage for their intensity of cultivatable and wild spices. The second stage involved a purposive selection of Local Government Areas (LGAs) that are renowned for spices production. Akinyele, Ona ara and Ido LGAs were selected from Oyo State while Asa LGA was selected from Kwara state. The third stage was a random selection of communities within the LGAs. The final stage involved a random selection of farmers involved in spices production; a total of sixty (60) farmers were purposively selected for the study. Descriptive statistics- percentages and frequency counts were used to assess gender involvement in spices production.

RESULTS AND DISCUSSION

Socio-demographic characteristics of spices farmers in Nigeria.

The results of socio-demographic characteristics on Table 1 include sex, marital status, religion, household size, educational attainment, main occupation and social network. The results showed that respondents were predominantly females as 60.0% were females while 40.0% were male. This signifies that spices production is largely female-oriented. This agrees with the assertion of Nakwe et al., (2018) that rural women despite their lack of skills are the main producers of secondary, neglected, under-utilized crops such as spices. Majority (71.7%) of respondents were married, 18.3% were single and 10.0% were widowed. Also, majority (73.3%) were of the Islamic faith while 26.7% practiced

Christianity. The farming system in the areas revealed a predominantly labor-intensive pattern as family size of majority (60.0%) of farmers was in the range 1 – 5 persons in the household, 33.3% had between 6 and 10 persons and only 6.7% had family size with more than 10 persons. As reported by Anyanwu (2013), large family size among farmers contributes to the household workforce to generate income and as insurance against old. The results also showed that majority (66.7%) had no formal education while 20.0% had primary education and 13.3% had attained secondary education. This result show that most of the farmers have basic education and therefore would be able to comprehend and adopt technologies that would enable them expand and earn more from spices production. Most respondents (81.7%) were farmers, 8.3% were artisans, 6.7% were civil servants and 3.3% were traders. Respondents belonged to different social groups- 61.7% were members of farmer association, 60.0% belonged to women groups, 55.0% belonged to cooperative societies and 51.6% were members of religious societies. Also, majority (66.7%) inherited their farmlands while 21.7% leased and 11.7% purchased the farmlands. Majority (55.0%) had less than 10 years' experience in spices farming while only 3.3% had more than forty years' experience. This shows that farmers have ample knowledge of spices production which is likely to translate into better production capabilities with repeated production activities. Family and hired labor were basically the types of labor used in the areas as majority (51.6%) used family source of labor and 35.0% used hired labor for spices production activities.

Table 1: Socio-demographic characteristics of respondents

Variables		**Frequency**	**Percentage**
Sex	Male	24	40.0
	Female	36	60.0
Marital status	Single	11	18.3
	Married	43	71.7
	Widowed	6	10.0
Religion	Christianity	16	26.7
	Islam	44	73.3
Household size	1 – 5	36	60.0
	6 – 10	20	33.3
	➢ 10	4	6.7
Educational	Non-formal	40	36.7
	Primary	12	16.7
	Secondary	8	13.3
Main occupation	Farming	49	81.7
	Artisan	5	8.3
	Civil service	4	6.7
	Trading	2	3.3
Social group	Farmers association	30	50.0
	Cooperative society	7	11.7
	Religious society	6	10.0
	Women group	7	11.7
Land acquisition	Inheritance	40	66.7
	Purchased	7	11.7
	Leased	13	21.7
Experience in spices	**< 10**	33	55.0
	11 – 20	4	6.6
	21 – 30	13	21.7
	31 – 40	8	13.3
	➢ 40	2	3.3
Labor source	Family	31	51.6
	Hired	21	35.0
	Both	8	13.3

Production Practices among Spice Farmers

A wide range of both indigenous and exotic spices are cultivated in the different localities. Turmeric and hot pepper were predominantly cultivated by 70.0% of the farmers. Ginger and lemon grass were cultivated by 66.7% and 63.4% respectively. Ethiopian pepper was cultivated by only 30.0% of farmers.

Similarly, locust bean, alligator pepper, clove and African nutmeg were cultivated by only 30.0%, 28.3%, and 3.3% respectively. Spices which used to exist only in the wild are now been cultivated by some farmers. While this shows that the zones are favorable for the production of diverse classes of agricultural crops -spices inclusive, it further reveals that with awareness and public enlightenment, knowledge gaps can be removed and spices production can be promoted. This confirms the position of Padulosi *et al*., 2013, that enlightenment and capacity build can enhance farmers production and utilization of neglected and under-utilized crops such as spices. Different types of farming systems were practiced; 8.3% of farmers practiced sole spices cultivation, while a very high proportion (91.6%) of farmers intercropped their spices with other crops. Majority (88.3%) intercropped spices with vegetables while some farmers planted cassava, yam, maize alongside these spices. Majority (50.0%) of farmers sold their spices in heaps, 38.3% sold in bags and 11.7% sold in baskets. While a few (8.3%) of farmers sell directly to consumers, majority sell spices beyond the farm gate to a host of buyers, 58.3% sell to wholesalers; 16.6% sell to retailers and agro-processors respectively, this minimizes transaction time and costs and as reported by Pingali et al., (2019); reduction in transaction time and costs improves market infrastructure and enhances income of agricultural households.

Table 2: Spices Production Practices

Variables		Frequency	Percentage
Spices produced	Turmeric	42	70.0
	Hot pepper	42	70.0
	Ginger	40	66.7
	Lemon grass	38	63.4
	Ethiopian pepper	18	30.0
	Locust bean	18	30.0
	Alligator pepper	17	28.3
	Clove	2	3.3
	African nutmeg	2	3.3
Type of cropping pattern	Sole	5	8.3
	Intercropping	49	91.6
Plant intercropped	Vegetables	53	88.3
	Cassava	3	5.0
	Yam	2	3.3
	Maize	2	3.3
	Others	4	6.7
Mode of sale	Heaps	30	50.0
	Bags	23	38.3
	Basket	7	11.7
Buyers	Retailers	10	16.6
	Wholesalers	35	58.3
	Agro-processors	10	16.6
	Consumers	5	8.3

Constraints to Spices Production

Constraints associated with spices production are presented in Table 3. The study shows that majority (70.0%) of respondents encountered the problem of pest and disease incidence as the most critical constraint. Incidence of pest and disease on farms limit production and is the major cause of yield loss and food insecurity. A large proportion (68.3%) of respondents had the problem of weather fluctuations such as drought, changing rainfall patterns with resultant decline in crop production, 65.0% complained of lack of credit facilities which supports the position of Peter-Onoh (2014) that without credit facilities, expanding agricultural production remains a huge challenge as purchasing inputs and use of modern technologies would remain difficult. Also, 53.3% of respondents complained of insufficiency of extension contact. Similarly, 53.3% of respondents were confronted with the menace of grazing animals; 51.6% of respondents had the problem of inadequate market information which confirms the position of Baliyan (2009) who positioned that lack of market information hinders the potentiality of large scale production of horticultural crops such as spices. While 48.3% of respondents were faced with the problem of insufficient market channels; the high cost of labor was the challenge of 46.6% of respondents. Also, 43.3% of respondents complained of theft of harvestable spices, while 41.6% complained of low market price. 40.0% were confronted with high transportation costs and 38.3% had the problem of glut. The least constraints to spices production were seeds and seedlings and the land tenure system. If these constraints associated with spices production are tackled, it will further promote spices production will enhance farmers income and wellbeing.

Table 3: Constraints to spices production

Constraints	Percentage (%)
Pest and disease incidence	70.0
Weather fluctuations	68.3
Lack of credit facilities	65.0
Insufficient extension contact	53.3
Grazing animals	53.3
Inadequate market information	51.6
Insufficient market channels	48.3
Labor cost	46.6
Theft	43.3
Low market price	41.6
High transportation costs	40.0
Glut	38.3
Seeds and seedlings	30.0
Land tenure	18.3

CONCLUSION AND RECOMMENDATION

The study revealed that a larger proportion of spices farmers are women, have large household size and are members of social organizations. A wide range of exotic spices were cultivated along with previously wild, semi-domesticated spices that are now been cultivated by a number of farmers. It further identified pest and disease incidence as the main limiting factor to increased production of spices which constitutes the primary cause of low quality spices and reduced yields. The land tenure in the area affords ease of land use that could promote large scale production of spices in the areas as seeds and seedlings are readily available. The study concludes that with improved access to extension services, increased enlightenment and capacity development farmers would take advantage of the several benefits of spices, include them largely in their production systems to enrich their income generating capacities, enhance biodiversity and household well-being.

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INTEGRATED NUTRIENT MANAGEMENT AND FERTILITY POTENTIALS IN MANGO PRODUCTION: CONSTRAINTS AND OPPORTUNITIES IN NASARAWA STATE, NIGERIA

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ABSTRACT
Integrated nutrient management (INM) refers to the maintenance of soil fertility and plant nutrient supply at optimum levels to sustain desired productivity using all sources of organic, inorganic and biological components in an integrated manner. There is however a dearth of information on practice of INM among mango farmers in producing areas. This study was conducted to ascertain current issues and challenges to INM use among mango farmers in Nasarawa state. The data collected from 66 mango farmers were analyzed; results indicated that majority (84.8%) were male, the average family size was 8 persons/household. A large proportion (59.1%) had less than two acres of mango farm and only 30.3% used grafted mango seedlings. A large proportion (37.9%) had less than 10 years' of experience in mango farming. Varieties of mango cultivated included Julie, Kent, Alphonso, Tommy Atkins, Saigon and Edward; Julie and Kent were cultivated by 84.8% and 59.1% of farmers respectively and were preferred for traits such as- marketability (78.8%), taste (63.6%), yield (42.4%) and size (28.8%). A greater proportion (53.0%) and (56.1%) of respondents did not apply fertilizer to their mango and were not aware of INM respectively. Constraints to mango production in order of importance were pest and disease infestation, insufficiency of credit facilities, inadequate market channels, bad roads and inadequate transportation system. It is recommended that the components and benefits of INM should be promoted among mango farmers to sustain higher yields, ensure yield stability while maintaining soil fertility and health.
***Keywords**: INM, Julie, Kent, Mango, Soil health*

INTRODUCTION

Mango has vast nutritional and economic importance to urban and rural households as the trees produce fruits with great diversity in size, form, color and quality. These fruits are put to diverse uses; ripe mango fruits are eaten raw and made into juices while unripe fruits are processed into pickles and chutney (Ali, Islam, Hassan *et al*., 2015). A key shortcoming to production of fruit trees is the steady decline of soil fertility which is usually further aggravated by continuous, long-term cultivation which results in soil nutrient mining. As most Nigerian soils are usually low in nutrient content as a result of total removal of crop residues from farm lands; other factors such as low fertilizer usage, inappropriate soil conservation and cropping systems contribute to the low nutrient content of the soils. The continuous use of chemical fertilizers especially NPK has impaired soil fertility and decreased soil factor productivity; therefore use of best horticultural techniques are required that will allow farmers have access; choose appropriate, efficient and cost-effective technologies for their enterprise; it is also important for farmers to participate in the development of the technologies and become knowledgeable about managing fertility in order to capture the diverse opportunities offered by the intervention.

There are many efforts in the form of researches and projects aimed at improving the livelihood of smallholder farmers to reverse the fertility status of soils which will increase productivity per unit area of land. Integrated nutrient management (INM) refers to a set of soil fertility management practices that necessarily include use of fertilizer and organic inputs combined with the knowledge on how to adapt these practices to local conditions with the aim of maximizing agronomic use efficiency of applied nutrients as well as improving crop productivity. It involves the use of chemical fertilizers in conjunction with organic manures, crop residues, bio-fertilizers and locally available resources in a cropping system. It further aims at reducing the uncontrolled use of chemical fertilizers, restore organic matter content in soils and increase nutrient use efficiency. INM also ensures the maintenance of the physical, chemical; and biological properties of soils and maintains the nutrient balance between supplied nutrient and nutrient removed by plants which aims at improving soil health and productivity on sustainable basis.

The goal of INM is to integrate the use of all natural and man-made sources of plant nutrients in order to ensure that crop production increases efficiently without compromising the soil productivity potentials of future generations. INM is thus crucial in sustainable agricultural productivity as it requires that natural resources be incorporated to generate increased output and incomes for farmers, (Dolker et al., 2017). In view of this, the study was conducted to ascertain constraints and opportunities associated with INM in mango production in Nasarawa state, Nigeria. Specifically, the study identified socio-demographic characteristics of mango farmers, characteristics of the mango production enterprise and constraints associated with mango production in the state.

METHODOLOGY

The study population comprised of mango farmers in Nasarawa state, Nigeria. Multi-stage sampling technique to select respondents. The first stage involved a purposive selection of Nasarawa state in the North-central zone of Nigeria for the intensity of mango production. The second stage involved a purposive selection of Local Government Areas (LGAs) in the state noted for mango production. Lafia, Kokona and Akwanga LGAs were selected. The third stage involved a random selection of communities within the LGAs- Akwaba community was selected from Lafia LGA; Maraba Kokona, Marke and Masauri kokona communities were selected from Kokokna LGA while Nongi, Endetu, Ubbe and Akwanga communities were selected from Akwanga LGA. The final stage involved a random selection of 66 respondents from the communities based on probability proportionate to size. Structured questionnaires were used to elicit information from citrus farmers in the selected communities. The information collected was statistically analyzed and results interpreted with frequencies, percentages and mean ranking.

RESULTS AND DISCUSSION

Personal Characteristics of Mango farmers

The personal attributes of mango farmers is shown in Table 1 It reveals that majority (84.4%) of mango farmers in Nasarawa state of Nigeria were male and only 15.2% were female signaling male dominance in mango production. Also, majority (68.2%) of the farmers were within the 19 and 41 age bracket revealing that most of these farmers are in the prime and active phase of their lives where they can give full and adequate attention to their livelihood security. While only 12.1% were single, majority (84.4%) were married. Marriage provides several benefits such as access to labor as married households usually have greater access to labor for agricultural activities than non-married households. The study further revealed that majority (60.6%) of respondents was Muslims practicing the Islamic religion. While only 18.2% had no formal education, 50.0% had basic education and 31.8% had tertiary education, this distribution reveals a largely literate population. With this varying literacy level, farmers are likely to adopt innovations such as INM faster than a largely illiterate population. Majority (71.2%) had more than 5 persons in their household signaling large household size; this might be attributed to polygamy as reported by Owoo (2018) which is the practice among Muslims in the northern part of Nigeria that encourages large household sizes coupled with the fact that children are considered as an essential part of the households work force as farm labor, to generate household income and as insurance in old age.

Table 1: Socio-Demographic Characteristics of Mango Farmers (n=66)

Variables	Categories	Frequency	Percent
Sex	Male	56	84.4
	Female	10	15.2
Age (Years)	<18	6	9.1
	18 – 41	45	68.2
	42 - 64	10	15.2
	65 and above	4	6.1
Marital status	Single	8	12.1
	Married	56	84.8
	Widowed	2	3.0
Religion	Islam	40	60.6
	Christianity	26	39.4
Educational attainment	Non formal	12	18.2
	Primary	20	30.3

	Secondary	13	19.7
	Tertiary	21	31.8
Household size	1 – 5	19	28.8
	6 – 10	32	48.5
	11 - 15	4	6.1
	16 – 20	8	12.1
	Above 20	3	4.5

Source: Field survey, 2022

Mango Production Characteristics

Production characteristics of mango farmers are shown in Table 2. It revealed that mango farmers in the state were predominantly smallholder farmers as majority (59.1%) of farmers had mango farms less than 2 acres. A large proportion (37.9%) of farmers have less than 10 years' experience in mango farming while about 33.3% had between 10 and 20 years' experience in mango farming. The findings of this study further revealed that only 30.3% establish their mango farms with grafted seedlings while majority (69.7%) use mango seedlings. This non-use of improved planting materials among Nigerian farmers reduces their yields with a resultant negative influence on their livelihoods. Mango varieties predominantly cultivated by farmers included Julie (84.8%), Kent (66.6%), Alphonso (57.6%) and Tommy Atkins (43.9%) with Julie and Kent been the most preferred. Framers revealed reasons for preference of these varieties to include marketability (78.8%), taste (63.6%), yield (42.4%) and size (28.8%). The mango orchard system is not common among farmers in Nasarawa state as majority (65.2%) practice intercropping mango with crops such as cassava, maize, beans and yam. The result of this study also showed that majority (53.0%) of farmers in Nasarawa state do not apply fertilizers to their mango trees; this could be attributed to the fact that fertilizer use in tree crop production is very low in Nigeria as farmers rely on native soil nutrients for the completion of the life cycle of the plants. Consequently, yields are sub-optimal and usually below world average. Also, majority (56.1%) of mango farmers in the state are not aware of INM fuelling the position of Cheraja et al., (2021), that INM is a recent and emerging strategy that results in higher yields, sustained productivity, improved soil health with environmental benefits.

Table 2: Mango Production Characteristics (n=66)

Variables	Categories	Frequency	Percentage
Farm size (acres)	Less than 2	39	59.1
	2 – 4	15	22.7
	4.1 – 6	4	6.1
	6.1 – 8	6	9.1
	Above 8	2	3.0
Mango farming (Number of years)	Less than 10	25	37.9
	10-20	22	33.3
	21-30	10	15.2
	31-40	2	3.0
	Above 40	7	10.6
Type of propagating material	Seedling	46	69.7
	Grafted seedling	3	30.3
Varieties cultivated*	Julie	56	84.8
	Kent	44	66.6
	Alphonso	38	57.6
	Tommy Atkins	29	43.9
	Saigon	12	18.2
	Edward	9	13.6
Preferred variety	Julie	56	84.8
	Kent	39	59.1
Reason for preference*	Marketability	52	78.8
	Taste	42	63.6
	Yield	28	42.4
	Size	19	28.8

Type of cropping pattern	Sole mango cropping	23	34.8
	Intercropping	43	65.2
Fertilizer application time	Never	35	53.0
	Once a year	9	13.6
	More than once	22	33.3
Awareness of INM	Yes	29	43.9
	No	37	56.1

Source: Field survey, 2022

Constraints to Mango Production

Several constraints challenge mango production in Nasarawa state as shown in Table 3. Pests and diseases infestation with 92.4% ranked first. This agrees with the findings of Ajayi and Nyishir (2006) that pest and disease incidence was the most challenging problem encountered by mango producing farmers in Nigeria. Lack of credit facilities and inadequate market channels ranked 2nd respectively with 90.9% while bad roads and inadequate transportation system ranked 4th respectively with 87.9%. This is in consonance with the position of Ibeawuchi et al., (2015) that Nigerian farmers are challenged by infrastructural constraints which include inadequate transportation systems and poor road networks. High post-harvest losses ranked 6th with 86.4% and fluctuating weather conditions ranked 7th with 84.8%. Inadequate storage facilities ranked 8th with 83.3% while insufficiency of labor and low market price ranked 9th respectively with 81.8%. Inadequacy of extension services, shortage of processing facilities and shortage of start-up / expansion capital ranked 11th respectively with 78.8%. Others are fruit theft and large number of middlemen..

Table 3: Constraints to Mango production (n=66)

Constraints	Percent	Rank
Pest and disease infestation	92.4	1st
Lack of credit facilities	90.9	2nd
Inadequate market channel	90.9	2nd
Bad roads	87.9	4th
Inadequate transportation system	87.9	4th
High post-harvest losses	86.4	6th
Fluctuating weather conditions	84.8	7th
Inadequate storage facilities	83.3	8th
Insufficient labor	81.8	9th
Low market price	81.8	9th
Inadequate extension contact	78.8	11th
Shortage of processing facilities	78.8	11th
Shortage of start-up capital	78.8	11th
Fruit theft	75.8	14th
Large number of middlemen	75.8	14th

Source: Field survey, 2022

CONCLUSION AND RECOMMENDATION

Based on the results obtained from this study, majority of mango farmers in the study area were male and a large proportion of these farmers had basic education. The study also showed that the farmers maintained a large household size which is an attribute of agrarian rural families as source of farm labor. The farmers are small holder farmers as small land holdings characterize their mango production enterprise and mango is planted as intercrop alongside other crops. The use of un-grafted mango seedlings characterized mango production in the study area as use of grafted seedlings is not common among mango farmers in Nasarawa state of Nigeria. A large proportion of farmers in the state are still not aware of integrated nutrient management as a strategy that will result in optimal yield of citrus, maintain and improve the physic-chemical properties and health of soils using different sources of plant nutrients.

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CURRENT ISSUES AND CHALLENGES IN INTEGRATED NUTRIENT MANAGEMENT FOR CITRUS PRODUCTION IN BENUE STATE, NIGERIA

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ABSTRACT
Citrus, the most important fruit crop based on international trade is mostly produced in Benue state, Nigeria. Quantities produced annually are however less than yield potential and are attributed to a range of factors including low soil fertility, lack of knowledge of nutrient sources and inappropriate use of fertilizers. Integrated nutrient management (INM) is a strategy that combines chemical fertilizers, organic manure and certain microbes for higher crop yields, sustained productivity and improved soil health. This study was conducted to ascertain current issues and challenges to INM among citrus farmers in Benue state. The data collected from 76 citrus farmers were analyzed. Results indicated that majority (71.1%) were male, the average family size was 8 persons/household. Majority (84.2%) had less than three acres of land and 77.6% used budded citrus seedlings. A large proportion (39.5%) had between 10 and 20 years' experience in citrus farming. Varieties of citrus cultivated included sweet orange, tangerine, tangelo, lemon, grape fruit, lime. Sweet orange was cultivated by majority (84.2%) of farmers and was preferred for traits such as-taste (52.6%), marketability (35.5%) and yield (21.1%). Majority (93.1%) and (86.8%) did not apply fertilizer on their citrus and were not aware of INM respectively. Inadequate extension contact (86.8%), funds for inputs such as fertilizers (85.5%) and storage facilities (84.2%) were prevailing constraints challenging citrus production in the study area. Consequently, it is important to promote the potentials of INM through extension services to farmers as well as the benefits inherent in nutrient sources other than chemical fertilizers.
Keywords: *Benue state, Extension service delivery, INM, Sweet orange*

INTRODUCTION

Citrus is a large group of fruits which includes oranges, limes, lemons, tangerines, and grapefruits and is one of the world's most important fruits. It is a highly nutrient-responsive perennial fruit crop by its avid nutrient-absorbing capacity (Srivastava, 2012). Nutrient management is of importance in production of fruit trees such as citrus in order to promote growth, quality and fruit yield. Productivity in citrus steadily declines over-time due to deficiency in secondary and micronutrients. As reported by Srivastava *et al*., 2008; citrus requires 16 essential elements for normal growth therefore sub-optimum production due to prevalence of nutrient constraints is well established in citrus production. Conventional farming system involves use of fertilizers to enhance soil nutrients and improve productivity. Chemical fertilizers are one of the most commonly applied inputs in citrus production. In addition to the high cost of acquisition, their continuous application hampers soil health, soil productivity, the environment, quality of produce and is deleterious to the health of humans who consume them (Tarai and Ghosh, 2016).

However, supplementing chemical fertilizers with organic sources of nutrients for large scale production for long periods is impractical as organic sources provide little amounts of essential nutrients and are required in very large quantities that might not be readily available. Maximum fruit yield and adequate tree volume is attainable through combined use of fertilizers. An integrated supply of nutrients from all possible sources is therefore needed to enhance yield and productivity of citrus. Integrated nutrient management is an approach which involves the combined use of inorganic, organic and biological sources of essential plant nutrients to sustain optimum crop yield and improve or maintain physic-chemical properties of soil. INM aims at meeting the social and economic needs of farmers without harming the natural resource base of agricultural production for future generations. According to Dolker et al., 2017, INM aims at generating higher output and incomes for farmers through an integrative use of all natural and man-made sources of plant nutrients that will ensure efficient increase in crop productivity without compromising the potentials of the soil for future generations. The study was conducted to ascertain issues and challenges in INM among citrus farmers in Benue state. Specifically, the study identified the socio-demographic characteristics of citrus farmers, the characteristics of their citrus enterprise and constraints associated with citrus production in the state.

METHODOLOGY

The study population comprised of citrus farmers in Benue state, Nigeria. Multi-stage sampling technique to select respondents. The first stage involved a purposive selection of Benue state in the North-central zone of Nigeria for its predominance in citrus production. The second stage involved a purposive selection of Local Government Areas (LGAs) in the state noted for citrus production. Gboko, Otukpo and Ushongo LGAs were selected. The third stage involved a random selection of communities within the LGAs- Mbaiyon, Nongou and Apkacher communities were selected from Gboko LGA; Otobi Akpa, Upu, Otobi Onobi and Amla Otobi communities were selected from Otukpo LGA while Tse alu and Alu Mbayem communities were selected from Ushongo LGA. The final stage involved a random selection of 76 respondents from the communities based on probability proportionate to size. Structured questionnaires were used to elicit information from citrus farmers in the selected communities. The information collected was statistically analyzed and results interpreted with frequencies, percentages and mean ranking.

RESULTS AND DISCUSSION

Socio-Economic Characteristics of Citrus farmers

Majority (71.1%) of respondents were male while 28.9% were female (Table 1) resonating the position of Obayelu et al., (2019) that the Nigerian agricultural landscape is male-dominated. Citrus farmers were largely in their active phase of life as majority (82.9%) of respondents was between 18 – 64 years age bracket. As also shown in Table 1, majority (76.3%) of respondents were married; this fuels the assertion that marriage is highly respected in rural communities. Majority (93.4%) of respondents practiced Islamic faith; this reveals Islam as the predominant religion in Benue state of Nigeria. While only (2.6%) of respondents did not have any formal education, a large proportion (68.4%) of respondents had basic education. With this level of educational attainment, citrus farmers would be able to understand and adopt innovations related to their enterprise such as integrated nutrient management (INM) with relative ease. The findings of this study also showed that a large proportion (60.5%) of respondents had between 6 and 10 persons in their households. This is representative of rural families who maintain large household sizes for on-farm and off-farm agricultural activities.

Table 1: Socio-Economic Characteristics of Citrus Farmers (n=76)

Variables	Categories	Frequency	Percent
Sex	Male	54	71.1
	Female	22	28.9
Age (Years)	<18	9	11.8
	18 – 41	40	52.6
	42 - 64	23	30.3
	65 and above	4	5.3
Marital status	Single	15	19.7
	Married	58	76.3
	Widowed	2	2.6
	Widowed	1	1.3
Religion	Islam	71	93.4
	Christianity	4	5.3
	Traditional	1	1.3
Educational attainment	Non formal	2	2.6
	Primary	7	9.2
	Secondary	45	59.2
	Tertiary	22	29.0
Household size	1 – 5	17	22.4
	6 – 10	46	60.5
	11 - 15	11	14.5
	16 – 20	2	2.6
	Above 20	0	0.0

Source: Field survey, 2022

Citrus Production Characteristics

Production characteristics of citrus farmers are shown in Table 2. Small holdings characterized citrus farming in Benue state as majority (84.2%) of respondents had citrus farms that were less than 3 acres where 2.7% of respondents had between 20 and 40 citrus trees while 30.3% of respondents had more than 80 trees. Also as shown in Table 2, a large proportion (39.5%) of respondents had citrus farming experience that spanned between 10 and 20 years. This indicates that respondents have acquired significant experience in citrus farming. Majority (86.8%) acquired their citrus farmlands through inheritance signifying that inheritance land tenure system is the predominant practice of land-holding in the state as it is in most rural communities. The study further revealed that majority (77.6%) established their citrus farms with budded citrus seedlings. Varieties of citrus produced in the state are- Sweet orange (86.8%), Valencia late (10.5%), Tangerine (9.2%) and Lemon (3.9%) with Sweet orange, Valencia late and Tangerine been the most preferred. Citrus farmers revealed that these varieties are preferred for traits such as taste (30.4%), marketability (78.8%), yield (42.4%) and size (28.8%). Citrus is intercropped by majority (77.6%) of farmers with cassava, beans, maize, yam, vegetables, maize, water melon and soya beans indicating that orchard system of citrus farming is not popular among farmers as only 22.4% practiced sole citrus cropping. A large proportion 39.5% and 34.2% sold their produce at the farm gate and on trees respectively, while only 14.5% and 13.2% of respondent sold their produce at rural and urban markets signaling farmers preference for using pick-up buyers than incurring transport costs of taking to markets as posited by Mayala amd Bamanyisa (2018). Fertilizer use is common among citrus farmers in the state as 59.2% of respondents applied fertilizers to the trees on a yearly basis while 9.2% of respondents applied fertilizers more than one a year; however, INM is still not a popular practice among citrus farmers in the state as majority (86.8%) were not aware of INM.

. **Table 2:** Citrus Production Characteristics (n=76)

Variables	Categories	Frequency	Percentage
Farm size (acres)	Less than 3	64	84.2
	3 – 6	10	13.2
	7 – 10	2	2.6
Number of trees	Less than 20	15	19.7
	20 – 40	18	23.7
	41 – 60	10	13.2
	61 – 80	10	13.2
	Above 80	23	30.3
Experience (Number of years)	Less than 10	18	23.7
	10 – 20	30	39.5
	21 – 30	14	18.4
	31 – 40	10	13.2
	Above 40	4	5.3
Land acquisition method*	Inheritance	66	86.8
	Purchase	9	11.8
	Lease	2	2.6
Type of propagating material	Seedling	17	22.4
	Budded seedling	59	77.6
Varieties cultivated*	Sweet orange	66	86.8
	Valencia late	8	10.5
	Tangerine	7	9.2
	Lemon	3	3.9
Preferred variety	Sweet orange	45	59.2
	Valencia late	11	14.5
	Tangerine	6	7.9
Reason for preference*	Taste	40	52.6
	Marketability	27	35.6
	Yield	16	21.1
	Size	9	11.8
	Aroma	6	7.9
	Storability	5	6.6
Point of sale	On trees	26	34.2
	Farm gate	30	39.5
	Rural market	11	14.5

	Urban market	10	13.2
Type of cropping pattern	Sole citrus cropping	17	22.4
	Intercropping	59	77.6
Fertilizer application time	Never	2	6.9
	Once a year	45	59.2
	More than once	7	9.2
Awareness of INM	Yes	10	13.2
	No	66	86.8

Source: Field survey, 2022

Constraints to Citrus Production

A number of barriers to optimum production of citrus were identified in Benue state (Table 3). Inadequate extension contact and insufficient funds to purchase inputs were the most predominant constraints with 86.8% and were ranked 1st. Lack of credit facilities was ranked 3rd with 85.5%. inadequate storage facilities ranked 4th with 84.2%. Pests and diseases infestation with 82.9% ranked 5th. As reported by Inienger and Udoh (2020), pest and disease incidence in citrus is particularly challenging as it easily spreads from tree to tree and eventually reduces productivity. This has a huge resultant effect on farmers livelihood and household income. Bad roads and shortage of start-up capital ranked 6th with 81.6% respectively. The inaccessibility of rural areas where large amounts of citrus are produced due to bad road network is a problem for citrus farmers as the fruits spoilage is common due to the long hours of travel spent along the bad roads. Unavailability of funds and lack of start-up capital for investment is a major constraint of citrus farmers in Nigeria. Inadequate processing facilities, lack of sufficient market information, inadequate marketing and low market price channels ranked 9th respectively with 80.3%. High post-harvest losses and inadequate transportation systems ranked 12th with 77.6% respectively. High tolls, glut, land use tenural arrangements and fruit theft were other constraints that challenged citrus production in Benue state.

Lack of credit facilities and inadequate market channels ranked 2nd respectively with 90.9% while bad roads and inadequate transportation system ranked 4th respectively with 87.9%. This is in consonance with the position of Ibeawuchi et al., (2015) that Nigerian farmers are challenged by infrastructural constraints which include inadequate transportation systems and poor road networks. High post-harvest losses ranked 6th with 86.4% and fluctuating weather conditions ranked 7th with 84.8%. Inadequate storage facilities ranked 8th with 83.3% while insufficiency of labor and low market price ranked 9th respectively with 81.8%. Inadequacy of extension services, shortage of processing facilities and shortage of start-up / expansion capital ranked 11th respectively with 78.8%. Others are fruit theft and large number of middlemen.

Table 3: Constraints to Citrus production (n=76)

Constraints	Percent	Rank
Inadequate extension contact	86.8	1st
Insufficiency of funds for inputs	86.8	1st
Lack of credit facilities	85.5	3rd
Inadequate storage facilities	84.2	4th
Pest and disease infestation	82.9	5th
Bad roads	81.6	6th
Inadequate marketing information	80.3	7th
Inadequate marketing channels	80.3	7th
High post-harvest losses	77.6	9th
Inadequate transportation systems	77.6	9th
Fluctuating weather conditions	77.6	9th
Low market price	77.6	9th
High tolls	76.3	13th
Glut	68.4	14th
Fruit theft	38.2	15th

Source: Field survey, 2022

CONCLUSION AND RECOMMENDATION

The results of the study showed that majority of citrus farmers in Benue state, Nigeria are male, with some level of formal educational attainment. Citrus in the state is mostly established with un-budded citrus seedlings with citrus largely planted as intercrop with other crops. Establishment of large orchards is encouraged as the orchard system is not popular in the state. Citrus production was challenged by a range of constraints such as inadequate extension services and contact with farmers, limited capital for inputs and access to credit facilities. Lack of developed and organized markets and value chains also challenged citrus production as inadequate marketing information, outlets for marketing, low market pricing, glut and high post-harvest losses were identified by farmers as constraints to citrus production in the state. Accordingly, capacity development activities and research-extension linkages should be promoted to enhance farmers' knowledge of benefits and components of integrated nutrient management and fertility resources in citrus production to improve production and productivity among farmers in Nigeria.

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EFFECT OF CHEMICAL AND BIOLOGICAL RIPENING AGENT ON BANANA (Musa spp)

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ABSTRACT
In recent days, artificial ripening techniques for fruits are widely used worldwide due to commercial value and consumer acceptability of attractive fruit color. This study was carried out to compare the use of biological and chemical ripening agents on the physical and chemical properties of Banana. The treatment included Apple, Avocado, Oilpalm fruits, Mango, (Biological agents) Calcium carbide and potash (Chemical agents) while the variety used (BITA 3) was obtained from Agricultural Development Programme (ADP) Benin City, Edo State Nigeria. All treatments were purchased from New Benin market, Benin City, Edo State. The experiment was conducted from April to June 2021. The experiment was laid out in a Completely Randomized Design (CRD) with three replications. Data were collected on physical and chemical properties of ripe banana. Results indicate thatthere was significant difference in both physical properties and Chemical composition of ripen banana except pulp percentage. Apple treated banana ripened within three dayspulp pH of 5.7, pulp to peel ratio of 0.1% and Chemical analysis was observedto be 12% and 2.1% for fat and zinc respectively. On the other hand calcium carbide treated banana ripened within 4 days, a pulp pH of 6.0, pulp to peel ratio of 0.1%and chemical analysis was observed to be 12% for fat, 1.3% for Zinc respectively. The study concluded that natural ripening agents especially Apple was better compared to artificial ripener like calcium carbide and Potash and they may be devoid of any Potential health risks.
***Keywords**: Banana, Carbide, Ripening, Agent, Chemical and Biological*

INTRODUCTION

Banana fruit of the genus Musa of the family Musae is one of the most important fruit crop in the world. The banana is grown in the tropics, and though it is widely consumed in those regions, it is valued worldwide for its flavour, nutritional value, and availability throughout the year. Dessert bananas are most commonly eaten fresh, though they may be fried or mashed and chilled in pies or puddings. They may also be used to flavor muffins, cakes, or breads. A ripe fruit contains as much as 22% of carbohydrate and is high in dietary fiber, potassium, manganese, and vitamin B6 and C (Ahmed *et al*., 2019). Bananas are climacteric fruits which are artificially ripened regularly. Ripening process of banana can be divided into three distinct phases namely the pre-climacteric or 'green life' stage, the climacteric and ripening stage and finally eat-ripe and senescence stage.During ripening process banana undergoes different physiological, biochemical, and organoleptic changes that lead to a soft and edible ripe fruit. Ripening is a biochemical process which involves a series of physiological changes in colour, aroma, flavor and texture. Once harvested it is highly perishable, with short shelf life leading to high post-harvest losses of about 20-50% dueto poor handling and quality deterioration (Ajayi and Mbah, 2007).
Ripening agents are substances which hasten the ripening process, and it comes in different forms. These include ethylene gas, ethephon, ethylene glycol, etherel and calcium carbide (Singal *et al*., 2012); African bush mango fruit (Irvingia gabonesis) and leaves, palm nut, cassia leaves, yellow pawpaw leaves, torch light battery, calcium carbide, potash and ash (Ajayi and Mbah, 2007). African mango fruits, calcium carbideand newbouldia leaves were also reported by Adewole and Duruji (2010). According to Singal *et al*., (2012), the commercial practice is to use these ripening agents to artificially ripen the fruits at the destination market before retailing. Ethylene gas is expensive to produce so low cost indigenous ripening technologies involving the use of hazardous materials are used (Singal *et al*., 2012; Ajayi and Mbah, 2007). The adverse potential of calcium carbide as a ripening agent has been established (Singal *et al*.,2012) while other chemical ripening agents like ethepon, etherel and ethylene glycol are also considered hazardous to health and they have to be used withinrecommended safe

limits (Hakim *et al*., 2012). The use of toxic and suspicious ripening agents is of great concern as the activities of human beings have been said to contribute to exposure of food materials to heavy metal contamination (Orisakwe *et al*., 2012). This present study was therefore carried out to compare the use of biological and chemical ripening agents on the physical and chemical properties of banana.

MATERIALS AND METHODS

Freshly harvested bunch of green but mature unripe banana (BITA 3) was bought from the improved banana varieties field collections of the Agricultural Development Programme (ADP), Benin City, Edo State. The ripening agents used were also bought from new Benin Market, Benin City and these were Calcium carbide, Potash, Apple, Mango, Avocado (Pear) and Oil palm fruits. The experiment was conducted (21st April to 30th April) 2021 at the Main Laboratory of the Faculty of Agriculture, University of Benin, Benin City, Nigeria. In a very clean and conducive environment with room temperature of 30^0C. The treatments *include;* Calcium carbide, Potash, Apple, Mango, Avocado, Oil palm fruits, Control under Open Air, and Control Under bag. The banana bunch was separated into hands with a sharp knife and each hand was made up of 12 banana fingers of approximately same size each. The weight of each banana hand made up of 12 fingers was taken using a sensitive electronic scale (Analytical weighing balance) on weighing, the banana handswere placed in black polythene bags. The calcium carbide and Potash were wrapped in polythene before being dropped into the black polythene bags containing bananas, the following treatments Apple, Mango, Avocado (Pear) and Oil Palm fruits were each placed respectively in polythene bags containing the banana. The control in bag was banana placed in black polythene bag without any ripening agent, while the last batch was control under open air, in which the bananas were not placed in black polythene bag. All the bags were tied up and stored on top of a table in the laboratory. The treatments were arranged in a completely randomized design (CRD) in 3 replicates.

Data Collection

Days to 50% ripening.

The days to 50% ripening was taken when about 6 out of the 12 fingers used for each experiment have ripened. Apple on day 3, Calcium carbide on day 3, while the untreated banana Control Open Air and Control under bag day 5 respectively, Avocado day 5, *Potash Day* 6. Oil palm day 6.

Days to full ripening (100%)

Apple day 4, calcium carbide day 5, potash day 6, Avocado day 6, *Mango Day* 7, ControlOpen Air and control bag day 7, oil palm fruit day 7.

Temperature in bags.

Each treatment, Apple 31^0C, Potash 31^0C, Control Open Air 30^0C, control under bag 32^0C, Mango 31^0C, Oil palm fruit 32^0C, Avocado 33^0C, Calcium carbide 32^0C.

Pulp to peel ratio

The division of weight of pulp to the weight of peel results in the pulp to peel ratio. Ripe banana was peeled using sharp edge knife. Then both pulp and peel were separated and individual weights were taken using a digital weight balance. Pulp to peel ratio is determined by using the formula given below.
Pulp to peel ratio =

Pulp percentage

The pulp percentage weight was *taken*, using the weight of Pulp all over the weight of peel and pulp which was then multiplied by 100.

pH of ripe fruit

The pH of the following fruits *was* recorded Calcium carbide and Mango had pH of 6 And 6 each. Potash and control open air 5.2 each. Oil palm 5.9 and control under bag was the least which is 5.1.

Laboratory Analysis

The physiochemical properties of the ripe bananas were determined according to the standard methods of AOAC (1990).

RESULT AND DISCUSSION

The effects of chemical and biological agents on physical properties of banana is showed in Table1. Result indicated that temperature reading ranges from 30^0C to 32^0C. Control Open Air Ripened at a temperature of 30^0C and Calcium carbide 32^0C there were changes in the pH of Calcium carbide and Mango with a pH of 6, Potash and control *o*pen air 5.2 each. Oil palm 5.9 and control under bag was observed to have the least of 5.1. These results were highly significant. The pulp topeel percentage ranges from 0.1- 2.2% respectively. Apple have 0.1% and Oil palm fruit treatment having 2.2%. Calcium carbide can induce ripening within 3 days and the fact that it is cheap makes it to be a popular ripening agent among banana marketers especially in the developing countries (Ajayi and Mbah, 2007).

Table 2 shows the effects of chemical and biological agents on chemical composition of ripe banana. The result shows that the use of biological and chemical agents greatly enhanced the ripening of banana. This result agrees with most research work in literature that ripening agents do accelerate ripening faster than when done naturally (Adewole and Duruji, 2010; Hakim *et al*, 2012 and Singal *et al*, 2012). This is also in agreement with Adewole and Duruji (2010) who observed a reduction in the protein content during ripening which may be due to reduction of nitrogen during ripening. However, it does not agree with Sen *et al* (2012) who stated that proteins increases during ripening. The differences in the protein values during ripening of bananas may be due to varietal differences (Mohapatra *et al*, 2010).

CONCLUSION.

Marketers are recommended to use biological ripening agents to ripen banana rather than chemical ripening agents because of the health hazards they cause.

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Table 1: Effects of chemical and biological ripening agents on physical properties of banana.

Treatments	Days to 50% ripening	Days to 100 % ripening	pH	Temperature	Pulp%	Pulp_P%
Ca. carbide	3.0	4.7	6	32	61.09	1
Potash	4.3	6.0	5 2	31	60.54	1.5
Apple	3.0	4.0	5 7	31	58.89	0.1
Avocado	5.3	6.7	4.7	31	60.05	1.5
Oil palm	6.3	7.7	5.9	31	63.45	2 2
Mango	4.6	7.7	6	31	62.14	1.2
Co_O. A	5.0	6.7	5.2	30	67.03	2.1
C_bag	6.0	7.0	5 1	31	61.37	1.5
LSD	1.4	1.7	0.25	0.8	ns	0.50

Table 2. Effect of chemical and biological Agents on chemical composition of ripebanana

Treatment	MC%	Ash%	Fat%	Fiber%	Protein%	Carbohydrate %	Zn	Cu	Mg
Ca.carbide	28.22	3.5	12	3.12	11	43	2.1	1.3	6.5
Potash	32	3	11 3	3 5	26.3	24	1.3	1	8.2
Apple	29.3	3.2	15	3.3	9	41	1.1	1	10 3
Avocado	26.2	3.4	18.4	3.2	16	33	3.9	1.5	6.5
Oil palm fruits	27	2.4	17.2	4 4	12.3	38	1	1	15
Mango	26	3.2	16.4	3.2	11.7	39	2.1	1.2	7.4
C_OA	28.3	3.3	13.2	3	18.1	34.4	1	1	11.3
Co_bag	25.3	4	14.3	3.4	14	39.2	1.2	1	8.4
LSD	1.4	0.2	1.2	0.4	0.874	1.7	0.14	0.06	0.63

GROWTH REPONSE OF SUNFLOWER (*Helianthus annuus* L.) VARIETIES AT VARYING INTRA-ROW SPACING IN SUDAN SAVANNA ECOLOGICAL ZONE OF NIGERIA

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ABSTRACT
This research was conducted to examine the growth and yield response of sunflower (Helianthus annuus L.) varieties to varying intra-row spacing in the Sudan savannah zone of Nigeria. The trial was conducted in two different locations, Kano University of Science and Technology (KUST) research farm and Binyaminu Usman Polytechnic (BUPOLY) Hadejia practical farm during 2019 raining season. Four varieties of sunflower (SSL803, SSL806, SSL807 and SSL809) were planted at varying intra-row spacing of 20, 30, 40, 50 and 60cm. Split plot design was adopted for the research, with variety allocated to the main plot while intra-row spacing to sub plots, treatments were replicated three times. Data were obtained on the plant growth and yield parameters. Data were subjected to statistical analysis of variance and mean differences separated using LSD at p=0.05. The result of the experiments shows that both variety and spacing revealed insignificant statistical difference in most of the growth characters assessed at both locations.
Key word: *Growth response, Sunflower, Varieties and Spacing*

INTRODUCTION

Sunflower (*Helianthus annuus* L.) belongs to the family (Compositae) Sunflower originated from Western North America; it is thought to have been domesticated around 1000 B.C. by Native Americans. Spanish explorers brought the sunflower to Europe in 1510. Sunflower is one of the most important oilseed crops containing high quality edible oil (Bakht *et al.,* 2010). Sunflower is currently the world's fourth largest oilseed crop (Rodriguez *et al.,* 2002). It is mainly used for oil production because of the high quantity of oil in the seeds (about 50%), (Severine *et al.,*2002). Sunflower seed was the third largest sources of vegetable oil worldwide, following cotton seed and soybean, sunflower oil is generally considered a premium oil because of its light colour, high level of unsaturated fatty acids and lack of linolenic acid, bland flavor an high smoke points, the primary fatty acids in the oil are oleic and linolenic (Typically 90 % unsaturated fatty acids), with the remainder consisting of palmatic and stearic saturated fatty acids (Anon.,1987). The economic importance of sunflower cannot be over emphasized as an important oilseed crop worldwide. The fresh green plants can be fed as silage or fodder to livestock. The seed which can be eaten raw or roasted contains 36 - 45% oil depending on the variety and can be used in salad, cooking oil, margarine, lubricant, paint vanishes and soap production. The decorticated seed cake is a good source of protein (35%) for livestock, especially when made from whole seed. The crop is also a good source of nutrition which is used in food preparation, feeding livestock and poultry (FAO, 2010).

Plant population based on row and plant spacing is a major part of agronomic practices leading to optimum productivity. Beg *et al.* (2003) found that high populations, from 80,000 to 100,000 plants, produced significantly higher yields. Agronomic practices in addition to high yielding varieties are the two most important items for higher productivity of the sunflower crop. Plant spacing is one of the most important agronomic practices that affect seed production and fatty acid composition of sunflower oils. It has been found to have positive influence on days to 50% flowering (Awais, *et al.,* 2013); stem diameter, head diameter, thousand seed weight, seed weight /plant and seed yield (Basha, 2000; *Ali, et al.,* 2014) as well as oleic and linoleic unsaturated fatty acids composition of oil (Ibrahim, 2012; Cucci, *et al.,2012*). On the other hand, it has been found to have negative influence on plant height (Ibrahim, 2012) and seed oil content (Faith, 2004; Ibrahim, 2012; Cucci, *et al.,2012)*. This work was conducted to evaluate growth and yield response of sunflower (*Helianthus annuus* L.) varieties to varying intra-row spacing in the Sudan savannah zone of Nigeria.

MATERIALS AND METHODS

The research was conducted at Bagauda research farm at Bagauda village, Kano state which lies between latitude 11 40'N and longitude 8 16' E and Binyaminu Usman Polytechnic Hadejia research farm, Hadejia town Jigawa state which lies between latitude 12 26' 59''E and longitude 10 02' 39'' E. Both locations were within the Sudan savannah ecological zone of Nigeria. The treatments consisted of variety SSL803, SSL806, SSL807 and SSL809 which were allocated to the main plots and intra-row spacing of 20, 30, 40, 50 and 60cm that were allocated to subplots. Split plot design was selected involving three replications, where each replication consists of four main plots each of 4.5m x 3m represented by 6 ridges. Five (5) selected plant samples were tagged for data collections on growth and yield characters at regular intervals and at harvest.

RESULTS AND DISCUSSIONS

The results of plant height, number of leaves and stem diameter at both locations were shown in Table 1 Plant height, number of leaves and stem diameter were not affected by variety and intra-row spacing at Hadejia, while at Bagauda, the plant height and stem diameter were significantly affected by both variety and intra row spacing, while the number of leaves was not significantly affected. Table 2 shows the results of Leaf area/plant, dry weight and days to 550% flowering and showed that none on the parameters were significantly affected by both the variety and the intra-row spacing in either of the locations, while only days to 50% flowering was significantly affected by variety at Bagauda. Results of Crop growth rate as affected by variety and intra-row spacing at both locations and sampling periods at 4th and 7th weeks after sowing, (Table 3) shows that spacing did not affect CGR significantly at both locations. However, the results shows that CGR was significantly affected by variety at 4th week after sowing at both locations, while at 7th week after sowing, CGR was not significantly affected by sunflower varieties. The interaction between variety and intra-row spacing showed non-significant statistical difference on all the characters assessed in either of the locations.

CONCLUSION

This study examined the growth and yield of sunflower as affected by variety and spacing at Bagauda and Hadejia locations. Based on the findings effects of variety and spacing on most of the characters assessed were not statistically significant at both locations, this implies that the differences observed were just by chance. Hence any of the varieties tested can perform very well in the experimental sites with good management.

Table 1: Effect of Variety and Intra-raw spacing on Growth Parameters of Sunflower (*Helianthus annuus* L.) at Bagauda and Hadejia in 2019 wet season

TREATMENT	BAGAUDA			HADEJIA		
	Plt Ht	NL	SD	Plt Ht	NL	SD
Variety						
SSL 803	167.44ab	32.20a	3.17ab	116.94a	32.40a	2.99a
SSL 806	153.99b	32.33a	2.88b	149.43a	32.20a	2.97a
SSL 807	185.39a	32.33a	3.44a	168.05a	34.00a	3.20a
SSL 809	185.29a	34.13a	3.30ab	161.27a	34.80a	3.09a
S.E±	6.05	1.40	0.10	7.54	1.30	0.16
Significance	**	NS	**	NS	NS	NS
Inter-row spacing (cm)						
	175.24a	33.92a	3.16ab	170.02a	35.33a	3.10a
20	180.95a	34.58a	3.28ab	164.17a	33.75a	3.16a
30	185.55a	31.92a	3.44a	164.39a	33.42a	3.19a
40	153.69b	30.67a	2.98b	159.32a	32.92a	3.15a
50	169.71ab	32.67a	3.13b	149.22a	31.33a	2.72a
60	5.41	1.25	0.09	6.74	1.17	0.16
S.E±						
Significance	**	NS	**	NS	NS	NS
Interaction (VxSP)	NS	NS	NS	NS	NS	NS

Table 2: Effect of Variety and Intra-raw spacing on Leaf Area/Plant, Dry weight and Days to 50% flowering of Sunflower (*H. annuus* L.) at Bagauda and Hadejia

TREATMENT	BAGAUDA			HADEJIA		
	LA	DW	D to 50% F	LA	DW	D to 50% F
Variety						
SSL 803	5236.9a	104.00a	54.33a	3146.8a	95.82a	61.47a
SSL 806	5298.0a	139.47a	54.87a	2510.5a	104.69a	60.93a
SSL 807	5928.4a	138.51a	52.87a	3576.3a	97.51a	61.60a
SSL 809	6239.5a	208.73a	52.73a	3247.3a	107.79a	61.33a
S.E±	389.26	34.66	0.42	262.71	16.64	0.41
Significance	NS	NS	**	NS	NS	NS
Inter-row spacing (cm)						
	5639.7a	181.85a	53.17a	3527.5a	109.62ab	60.33b
20	6059.1a	139.13a	53.50a	3211.3ab	112.54ab	61.33ab
30	5865.5a	145.94a	53.67a	3223.4ab	127.45a	61.33ab
40	5101.3a	111.75a	54.33a	3025.6ab	92.33ab	61.50ab
50	5713.1a	159.71a	53.83a	26.13.4b	65.33b	62.17a
60	348.02	30.99	0.38	234.88	14.87	0.37
S.E±						
Significance	NS	NS	NS	NS	NS	NS
Interaction						
(VxSP)	NS	NS	NS	NS	NS	NS

Table 3: Effect of Variety and Intra-raw spacing on Growth of Sunflower (*H. annuus L.*) at Bagauda and Hadejia

TREATMENT	BAGAUDA		HADEJIA	
	4WAS	7WAS	4WAS	7WAS
Variety				
SSL 803	4.01b	31.77a	2.77b	28.75a
SSL 806	4.09b	44.10a	2.56b	30.92a
SSL 807	4.06b	41.69a	3.58a	27.73a
SSL 809	6.59a	53.64a	3.11a	31.79a
S.E±	0.65	8.46	0.26	5.19
Significance	*	NS	*	NS
Inter-row spacing (cm)				
	4.11a	48.69a	3.58a	31.76ab
20	5.06a	40.30a	2.99ab	33.56ab
30	5.04a	41.92a	3.21ab	37.79a
40	3.97a	36.19a	2.52b	27.41ab
50	5.24a	46.90a	2.72b	18.48b
60	0.58	7.56	0.23	4.64
S.E±	NS	NS	NS	NS
Significance				
Interaction (VxSP)	NS	NS	NS	NS

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EVALUATION OF WEED SUPPRESSIVE ABILITY OF FLUTED-PUMPKIN *TELFAIRIA OCCIDENTALIS* HOOK F. ACCESSIONS

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ABSTRACT
Crop cultivars with enhanced weed suppressive abilities could play a key role in Integrated Weed Management (IWM) strategy. A field experiment was conducted at the National Horticultural Research Institute, Ibadan to evaluate the Weed Suppressive Abilities (WSA) of fluted-pumpkin Telfairia occidentalis Hook F. accessions. Thirty-eight accessions from all the major fluted-pumpkin production areas in Nigeria were evaluated. The experiment was laid out in Randomised Complete Block Design with three replications. Data were collected on weed species composition, weed density, weed biomass, weed ground cover and fluted-pumpkin canopy cover. Results indicated that 57% of the weed species were broadleaves, 33.3% were grasses while 9.1% were sedges. Results also indicated significant differences in weed density, weed biomass, weed ground cover, and fluted-pumpkin canopy cover ($p < 0.05$). Accession 38 had the lowest weed density, weed biomass and weed ground cover. The result suggested that the accessions with high canopy cover could suppress weeds and hence reduce weed completion with fluted-pumpkin.
Keywords: *Accession, Fluted-pumpkin, weed density, weed biomass, canopy-cover.*

INTRODUCTION

Fluted pumpkin (*Telfairia occidentalis*), commonly known as iroko or ugu in Yoruba and Igbo languages respectively in Nigeria is an important vegetable crop belonging to the plant family Cucurbitaceae. (Prota, 2006). It is a nutritious vegetable of tropical West Africa widely cultivated for its leafy shoots and immature edible seeds (Akoroda, 1990). The leaves are rich in iron and used to cure anaemia while also being high in protein content (Okoli and Mgbeoku, 1983). Weed competition is a major limiting factor to its production as weed competition with the crop adversely affects the crop. Although fluted pumpkin is a poor competitor with weeds, the variation in its genetic composition could play an important role in integrated weed management. Weed competitiveness comprises of the major elements namely Weed Tolerance (WT) and Weed Suppressive Ability (WSA). Weed Tolerance is the ability of a crop to maintain high yields in the presence of weeds while weed suppressive ability is the ability to suppress weed growth (Rodenburg *et al* 2009). The major objective of this paper therefore is to evaluate the Weed Suppressive Ability of fluted-pumpkin accessions.

MATERIALS AND METHODS

The field trial was conducted around vegetable nursery building of the National Horticultural Research Institute headquarters, Ibadan in the 2022 cropping season between March and November. The experimental site was slashed, ploughed and harrowed with tractor-mounted implements. The plot size was 2 m by 2 m (4 m^2) with 38 fluted-pumpkin accessions. The seedlings were transplanted at a spacing of 1 m x 0.5 m, making a population of 20,000 plants ha^{-1}. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. At 4 weeks After Transplanting (WAT), inorganic fertilizer (NPK 20:10:10) mixed with organic fertilizer (poultry manure) was applied at 100 and 300 kg ha^{-1} respectively to supply the necessary nutrients to the plants as the site has been in use for planting fluted-pumpkin over many years. Staking was also done at 4 WAT using teraga or table method and the crop was trailed appropriately using rope. Weed removal was done at intervals of 4, 8, 12 weeks after transplanting when crop canopy had been fully formed, and prior to pod harvesting. Data were collected on weed species composition, weed density, weed biomass, weed ground cover and fluted-pumpkin canopy cover. Weed species composition, density, and biomass were obtained from two 50 cm x 50 cm quadrats randomly thrown in the diagonal transects of each plot. Weeds within each quadrat were counted and cut with sharp knife, sorted by species, and bulked together to form a sample. The samples collected were oven-dried at a temperature of 80^0C for 48 hours to obtain weed biomass. Weed ground cover and fluted-pumpkin canopy cover were obtained using the Line Intercept Method (LIM) used in vegetation assessment (Coulloudon *et. a*l. (1999). Statistical analysis of the data collected was performed using GenStat release 4.23 Discovery Edition Statistical software package. Means were separated using Least Significant Difference (LSD) at 5 percent probability level.

RESULTS

Nineteen weed species were frequently (more than 10%) observed in the plots. The most dominant ones were *Cleome viscosa, Mitracarpus villosus, Euphorbia heterophyla, Commelina benghalensis, Peuraria phaseoloides, Panicum maximum, Paspalum scrobiculatum and Tridax procumbens.* Of the weed species observed, 57.1% were broadleaves, compared to grasses and sedges which were 33.3 and 9.5% respectively. This observation corroborates the findings of Olorunmaiye *et al*. 2010 that broadleaves are dominant in vegetable fields. Weed density differed significantly among the accessions at 4, 8, and 12 WAT (table 1).

Table 1: Weed suppressive ability of fluted-pumpkin *Telfairia occidentalis* Hook F. accessions

Accession no.	Weed density (m^{-2})			Weed biomass ($g\ m^{-2}$)			Pumpkin canopy cover (%)	Weed cover (%)
	4 WAT	8 WAT	12 WAT	4 WAT	8 WAT	12 WAT		
AC1	126.7	272.0	213.3	70.0	109.1	209.3	79.0	21.0
AC2	78.7	353.0	282.7	50.3	184.3	370.3	81.0	19.0
AC3	65.3	242.7	201.3	62.3	108.7	264.5	79.7	20.3
AC4	81.3	197.3	92.0	55.9	87.6	466.9	81.3	18.7
AC5	129.3	278.7	46.7	39.6	141.9	189.5	83.0	17.0
AC6	72.0	333.3	420.0	55.6	189.2	574.4	0.0	100.0
AC7	68.0	378.7	328.0	64.0	220.4	740.8	0.0	100.0
AC8	40.0	434.7	416.0	61.1	293.7	812.8	0.0	100.0
AC9	89.3	278.7	150.7	46.7	110.1	282.8	41.0	59.0
AC10	120.0	408.0	362.7	46.5	198.5	253.6	83.3	16.7
AC11	73.3	150.7	202.7	66.3	64.0	321.5	80.0	20.0
AC12	81.3	402.7	420.0	43.2	216.4	858.5	20.3	79.7
AC13	65.3	342.7	409.3	57.9	237.9	653.9	68.3	31.7
AC14	44.0	332.0	36.0	35.6	120.4	170.0	89.3	10.7
AC15	142.7	436.0	317.3	67.9	103.5	258.8	64.0	36.0
AC16	69.3	206.7	453.3	80.1	101.6	411.6	30.7	60.3
AC17	88.0	129.3	138.7	57.2	52.9	194.3	53.3	46.7
AC18	66.7	221.3	89.3	51.2	82.0	251.2	64.0	36.0
AC19	60.0	260.0	189.3	51.3	136.9	296.9	74.3	25.7
AC20	44.0	394.7	250.7	33.7	318.8	390.7	54.7	45.3
AC21	41.3	440.0	596.0	33.1	180.7	788.3	46.7	53.3
AC22	66.7	444.0	630.7	63.9	255.1	720.4	0.0	100.0
AC23	38.7	107.3	73.3	71.6	182.0	164.3	34.7	65.3
AC24	93.3	296.0	677.3	48.5	200.5	996.5	43.7	56.3
AC25	64.0	385.3	753.3	55.3	367.2	712.9	0.0	100.0
AC26	69.3	406.7	402.7	42.3	183.3	763.9	0.0	100.0
AC27	110.7	200.0	278.7	29.5	129.6	302.8	79.3	20.7
AC28	105.3	185.3	228.0	36.8	57.7	92.4	0.0	100.0
AC29	125.3	401.3	696.0	70.5	276.0	1,085.3	0.0	100.0
AC30	86.7	350.7	328.0	58.9	133.7	321.5	76.3	23.7
AC31	65.3	137.3	76.0	68.0	189.7	188.5	84.3	15.7
AC32	92.0	352.0	624.0	53.6	193.7	821.9	0.0	100.0
AC33	73.3	234.7	753.3	46.4	140.3	753.3	0.0	100.0
AC34	78.7	164.0	36.0	52.3	54.7	13.6	83.7	16.3
AC35	93.3	421.3	385.3	56.0	144.4	726.4	0.0	100.0
AC36	76.0	400.0	832.0	50.0	184.7	808.3	0.0	100.0
AC37	94.7	352.0	382.7	25.1	226.3	876.3	45.3	54.7
AC38	90.7	88.0	20.0	45.3	27.9	15.1	93.7	6.3
LSD (0.05)	30.96	23.58	47.57	33.27	24.88	92.82	9.9	9.9
P (0.05)	**	**	**	NS	**	**	**	**

WAT-Weeks after transplanting. LSD- Least Significant Difference, **Significant P at 0.05, NS Not significant

At 2 WAT, accession 15 had the highest weed density which is significantly similar to that obtained in accession 1, 5, 10, 27, and 28. The lowest weed density was obtained in accession 38. At 8 WAT, the highest weed density was obtained in accession 22 while the lowest was obtained in accession 38. At 12 WAT, the highest weed density was obtained in accession 32 and it differed significantly from all other accessions (LSD = 47) while the lowest weed density was obtained in accession 38. Weed biomass also differed significantly among the accessions at 8 and 12 WAT but did not differ at 4 WAT. At 8 WAT, the highest weed biomass (367.2 g m^{-2}) was obtained in accession 25 which is significantly higher than those obtained in all other accessions. Accessions 8, 22, and 29 had similar weed biomass (293, 255, and 276 g m^{-2} respectively). At 12 WAT, accession 29 had the highest weed biomass while accession 38 had the lowest. By implication, accession 38 is the most superior accession in weed suppression while accession 25 is the weakest accession in weed suppression. The differences in the variation in weed suppressive abilities of the accessions could be attributed to the differences in the weed and fluted-pumpkin's canopy cover (Table 1).

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RESIDUAL EFFECTS OF DIFFERENT ORGANIC MANURE (COWDUNG AND BIOCHAR) ON THE EARLY GROWTH OF *PTEROCARPUS SOYAUXII*

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ABSTRACT
The aspect of organic amendments often overlooked was the residual release of nutrients which improve soil productivity. This research was to investigate the residual effect of different organic manure (biochar and cow dung) on the early growth of Pterocarpus soyauxii seedlings. Fifteen treatments were applied and replicated four times. Collar diameter, height and number of leaves were data collected per plant at 3weeks for 18 weeks. Result obtained for collar diameter and number of leaves reveals the residual effect of application of biochar (B11 and B12) which has the highest number of 4.83mm and 58.25mm when compared with control of 3.85mm and 44.25mm respectively. Length of height shows the highest at (B+C4) of 29.62cm when compared with the control 20.75cm. There was no significant correlation among the growth parameters but there was a significant correlation between the use of both cow dung and biochar to improve plant and soil quality.
Keywords: *Pterocarpus soyauxii, treatment, residual effect, organic manure, growth parameters.*

INTRODUCTION
The maintenance of soil productivity is a significant barrier to tropical agriculture. Typically, crop cultivation is rotated across fields so that it can rely solely on fertile soils for a few years while not using fertilizers (Akande *et al.,* 2010). However, this cannot be sustained to meet increased demand of an increasing population. Erosion and poor soil fertility in tropical soils have detrimental effects in deteriorating the nutrient status and changing the population of soil organisms (Atijegbe *et al.,* 2014). However, nutrients contained in manures are released more slowly and are stored for a longer time in the soil ensuring longer residual effects, improved root development and higher crop yields (Abou El Magd *et al*., 2005, Yang *et al.,* 2015). *Pterocarpus soyauxii* belongs to the family *Fabaceae- Papilionoideae*, is a tree 27-34 m tall with bole length up to 17 m, girth up to 3.3 m with an undivided stem. The English name include (redwood, large fruited camwood, Gabon padouk, barwood, African padouk, African coral wood) (Orwa *et al.,* 2009). Pterocarpus is a genus with approximately 60 species, 20 of which may be found in African nations like Nigeria, Cameroon, Sierra Leone, and Equatorial Guinea.

Organic matter improves the physical and chemical characteristics of soil and prolongs the release of nutrients. The Organic fertilizers/manure like, cow dung on the other hand is readily available in rural areas of the country since most of the rural farmers rearing cattle for fattening, production of milk, and for ploughing their agricultural fields. Moreover, farmers around the nation are becoming aware and embrace the usage of organic manure, which is readily available, toxic-free, and inexpensive (Thakur *et al.,* 2021). Biochar is produced from biomass by pyrolysis, the thermal decomposition of biomass in absence or limited oxygen (Bridgewater *et al.,* 2003). Biochar is very porous material (George *et al.,* 2012) and thus it decreases soil bulk density and simultaneously increases water holding capacity (Brewer *et al.,* 2012). Several research works have been conducted on the complementary effect of organic manure and chemical fertilizers on different tree species, little information is available on the effect of cowdung and biochar on soil properties, nutrient uptake and growth of *Pterocarpous soyauxii*. The primary aim of this research is to investigate the residual impact of various organic manures (biochar and cowdung) on the early growth of *Pterocarpus soyauxii.*

MATERIALS AND METHODS
The experiment was carried out at the Trees Improvement Section Screen house of Forestry Research Institute of Nigeria, Jericho Ibadan, located on Longitude 3° 9'E and Latitude 07° 25'N. The annual temperature ranges from 25.4^0C-31.6^0C with a mean rainfall of about 1300-1500mm and average relative humidity of about 79.4% (FRIN Meteorological station). River sand was collected at the Asanmagbe

river bank in Forestry Research Institute of Nigeria. The soil was washed and sterilized at 200°C for one hour. The sterilized soil was bagged in 3kg polyethylene bags. Organic manure was then added and allowed to decompose for 3weeks before the seedlings was transplanted. The seed was sourced from the seed section Sustainable Forest Management Department, Forestry Research Institute of Nigeria. The study was carried out in a Completely Randomized Design (CRD) with 15 treatments replicated 4times. The experiment consists of B+C (10t/ha+90kgN, 135kgN and 180kgN), B+C (20t/ha + 90kgN, 135kgN and 180kgN), B+C (30t/ha + 90kgN, 135kgN and 180kgN), Biochar (20t/ha, 30t/ha), Cowdung (90kgN, 135kgN and 180kgN) and control. Viable seedlings transplanted were of uniform age of two months after transplanting and data were collected for 18weeks on plant height (cm), collar diameter (mm) and number of leaves at 3weeks intervals. The seedlings were further transplanted to the field for further research. All data obtained were subjected to statistical analysis using Genstat Statistical Software and were subjected to Analysis of Variance. Means were separated using Duncan's Multiple Range Test (Duncan, 1995) at 5% probability level.

Table 1: Physico-chemical properties of the sterilized river sand

Parameters	Value
Soil pH	6.36
Organic Carbon (O.C) %	2.97
Organic Matter (O.M) %	5.12
Potassium (K)mg/kg	0.08
Total Nitrogen (N) g/kg	0.30
Calcium (Ca) cmol/kg	7.50
Magnessium (Mg)cmol/kg	3.20
Sodium (Na)cmol/kg	2.4
Phosphorus (P)mg/kg	39.9
Manganese (Mn)mg/kg	59.0
Copper (Cu)mg/kg	114.0
Zinc (Zn)mg/kg	7.5
Iron (Fe)mg/kg	3.3
Sand	84.5
Clay	11.0
Silt	4.50
Textural Class	sandy soil

Table 2: Chemical analysis of the organic amendment used (biochar and cowdung)

Parameters (%)	Biochar	Cowdung
Available P	0.877	0.1380
Total N	1.370	1.180
Calcium	2.600	0.588
Magnesium	3.785	0.661
Potassium	2.650	2.810
Sodium	1.140	0.840
Manganese	0.033	0.023
Iron	0.903	1.333
Copper	0.006	0.018
Zinc	0.042	0.003
Carbon	86.41	

Table 3: Residual effects of organic manure on the Height (H) of *Pterocarpus soyauxii*

	Weeks after Transplanting (WAT)					
Treatment	(3)H	(6)H	(9)H	(12)H	(15)H	(18)H
B+C1	6.95a	8.75bc	11.62ab	13.38a	18.10a	20.88a
B+C2	7.15ab	9.75a-c	12.75ab	15.88a	18.25a	21.75a
B+C3	9.25a	11.63a	15.12a	18.12a	23.0a	27.88a
B+C4	8.875a	11.25ab	13.12ab	17.75a	22.25a	29.62a
B+C5	6.88a	9.13a-c	10.88ab	14.12a	16.88a	21.38a
B+C6	5.75b	7.88c	9.75b	11.50a	14.75a	17.51a
B+C7	7.25ab	9.93a-c	11.88ab	14.88a	19.01a	20.88a
B+C8	9.13a	10.78ab	13.25ab	15.50a	19.38a	21.75a
B+C9	6.63ab	9.25a-c	11.25ab	12.88a	16.38a	18.62a
B10	7.63ab	10.05a-c	11.88ab	14.01a	18.25a	21.38a
B11	9.58a	10.50ab	13.50ab	15.12a	18.88a	22.62a
C12	7.88ab	9.88a-c	13.12ab	15.88a	21.5a	26.62a
C13	7.50ab	9.25a-c	12.07ab	14.88a	18.75a	21.15a
C14	6.62ab	9.01bc	12.12ab	13.62a	18.12a	23.10a
CTL15	7.25ab	8.925bc	10.51b	12.88a	17.10a	20.75a

There was significant difference among treatments from 3-9 WAT (HI to H3). At 3, 6 and 9WAT B+C3 was significantly different from B+C6 and the plots that receives no treatment (control CLT 15). However, at 12-18WAT, no significant differences were observed among the treatment used. The highest plant height was observed at B+C4 with a mean value of 29.62cm when compared with control (20.75cm) while B+C1 recorded the least mean value of 20.88cm.

Table 4: Residual effects of organic manure on the Collar Diameter (D) of *Pterocarpus soyauxii*

	Weeks after Transplanting (WAT)					
Treatment	(3)D	(6)D	(9)D	(12)D	(15)D	(18)D
B+C1	1.92a	2.10a	2.36ab	2.55a	3.34ab	3.98ab
B+C2	1.71a	2.07a	2.30ab	2.48a	3.26ab	3.99ab
B+C3	2.12a	2.28a	2.53ab	2.75a	3.85a	4.22ab
B+C4	1.59a	2.06a	2.36ab	2.54a	3.81a	4.51ab
B+C5	1.94a	1.98ab	2.25ab	2.42a	3.33ab	4.41ab
B+C6	1.72a	2.14a	2.26ab	2.24a	2.98b	3.49b
B+C7	1.802a	1.528b	2.12ab	2.42a	3.48ab	4.31ab
B+C8	1.64a	2.15b	2.40ab	2.64a	3.24ab	4.02ab
B+C9	1.58a	2.01ab	2.22ab	2.37a	3.56ab	4.06ab
B10	1.88a	2.21a	2.43ab	2.48a	3.55ab	4.27ab
B11	1.59a	1.96ab	2.48ab	2.65a	3.71ab	4.83ab
B12	1.89a	1.84ab	2.32ab	2.645a	3.47ab	3.95ab
C13	1.55a	1.82ab	1.99b	2.21a	3.47ab	4.18ab
C14	1.748a	1.95ab	2.31ab	2.51a	3.48ab	4.32a
CTL15	1.97a	2.08a	2.38ab	2.53a	3.03b	3.85ab

There were no significant differences among the weeks after transplanting (WAT) except at week 15 and 18. At 15WAT, residual application of B+C3 and B+C4 with mean value 3.85mm and 3.81mm were significantly correlated than B+C6 which had the least performance with mean value 2.98mm when compared with control (3.02mm). At 18WAT residual application of B+C14 was significantly higher than B+C6 and the highest diameter was observed at B11 with a mean value of (4.83mm) while the least was recorded with B+C6 (3.49mm) respectively.

Table 5: Residual effects of organic manure on the Number of Leaves (NL) of *Pterocarpus soyauxii*

	Weeks after Transplanting (WAT)					
Treatment NL	(3) NL	(6) NL	(9) NL	(12) NL	(15) NL	(18)
B+C1	12.25a	15.25a	27.50a	30.25a	38.50a	44.25a
B+C2	11.50a	16.75a	28.25a	32.75a	40.00a	45.75a
B+C3	13.02a	18.75a	28.75a	34.01a	46.75a	45.01a
B+C4	13.01a	19.02a	28.25a	32.51a	49.01a	65.51a
B+C5	12. 25a	18.01a	20.05a	30.0a	45.75a	52.50a
B+C6	10.75a	14.25a	21.01a	27.01a	39.51a	36.51a
B+C7	13.02a	19.51a	27.52a	31.75a	42.25a	47.75a
B+C8	13.75a	17.75a	26.01a	33.25a	41.75a	51.02a
B+C9	11.25a	15.75a	24.25a	27.75a	39.25a	53.51a
B10	12.25a	16.75a	28.02a	30.25a	41.01a	47.02a
B11	12.03a	15.25a	23.51a	28.75a	40.03a	52.01a
B12	14.25a	16.50a	28.02a	30.51a	47.25a	58.25a
C13	12.52a	17.51a	26.25a	32.25a	48.25a	56.75a
C14	11.25a	14.02a	24.75a	29.25a	43.50a	55.01a
CTL15	11.75a	14.5a	24.0a	28.0a	36.0a	44.25a

There were no significant differences among the treatment. At 18WAT the highest mean value of number of leaves was 51.3 while at 3WAT has the lowest mean value was 12.3. At 18WAT (B12) has the highest number of number of leaves of 58.25 while compared with control of 44.25.

DISCUSSION

The experimental soil was sandy soil and the pH was slightly acidic. The total nitrogen (N) and available phosphorus (P) content were high when compared with the critical value of 0.15% for N and 0.85mg/kg for available P (Ayodele and Agboola 1985) obtained for soil in south western Nigeria. Using the critical level of 0.16cmol/kg exchangeable Potassium (K) was low (Agboola and Ayodele 1987) and increase in N content in soils amended with cow dung and biochar suggests the ability of these amendments to supply N because of their fairly high N content. The results also suggest increased mineralization of river soil N was due to the priming effect after application of these amendments as a result of enhanced growth of soil microorganisms (Munda *et al.,* 2018). The adsorption of phosphorus in soil is pH dependent. With the increase in soil pH, solubility of P will also increase when biochar is added (Schneider 2012). The micronutrients (Cu, Mn, Fe and Zn) ranges from medium to high conforming with Ayele *et al.,* (2013). The medium to high values of these micronutrients may be due to long period of fallow of the land which has not been under cultivation for many years, according to Nigeria Country Profile (1997), the Country's soils are found to be of medium to high potentials.

It has also been suggested that organic amendments particularly biochar have considerable potential for soil improvement because of its unique physical, chemical, and biological properties and their interactions with soil and plant communities (Lehmann *et al.,* 2011; Amlinger *et al.,* 2007; Elad *et al.,* 2011). Fertilizer requirement of species, differ and such effort must be made to identify the appropriate fertilizer preferences of any species. Although some studies have reported only a limited effect of biochar and other organic amendments on plant growth (Lehmann *et al.,* 2011; Jones *et al.,* 2012), a number of others, using a range of plant species, have reported similar results (Ahmad *et al.,* 2014; Husk and Major 2011; Elad *et al.,* 2011). Our findings, however, suggested that cow dung played only a minor role in the increment of the growth variables, while biochar had significant effect on the growth of *Pterocarpus soyauxii* as a result of a longer time it takes to decompose and remains in the soil.

CONCLUSION

Combined use of organic amendments had shown a positive effect on soil condition and the growth response. A significant growth response (height) was found, where combined biochar/cow dung were applied. It also shows that there is positive response of biochar on collar diameter and number of leaves when applied solely. Therefore, the use of both cow dung and biochar to improve plant and soil quality can be recommended.

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ASSESSMENT OF YOUTH INVOLVEMENT IN PLANTAIN VALUE CHAIN IN OYE LOCAL GOVERNMENT, EKITI STATE, NIGERIA

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ABSTRACT
Agriculture has the potential to offer numerous productive employment opportunities for young people, provided there is an increase in investment and a favorable legal and policy environment. The plantain value chain involves the production, processing, transporting, marketing, and post-production of this horticultural crop, hence, the study aimed to assess the involvement of youth in all these processes in Oye local government, Ekiti state, Nigeria. Multi-stage sampling technique was used to arrive at the total of one hundred (100) youths. Data were collected using a well-structured questionnaire and was analyzed using descriptive statistics. The study reveals that the majority (62.0%) of the youth falls between the age of 25 and 44 years and about 58.0% were male. The study found that youth were moderately involved in plantain value chain, they make use of plantain production, processing, or marketing as a side hustle or secondary job. Also, it was observed that many of the respondents were educated which was concluded to be a major cause for the moderate and partial involvement of youth in Plantain value-chain. To encourage youths to participate more in active farming there is a need to encourage incentives that could make commercial agriculture enticing.
Keywords: *Plantain, Non- Agricultural, Agriculture, Horticulture, Young people*

INTRODUCTION

As reported by the Food and Agriculture Organization in 2021, Agriculture is the foundation of Nigeria's economy, contributing 22.35% to the GDP and serving as the main source of livelihood for most Nigerians, despite the presence of oil. The agriculture sector is made up of four sub-sectors which are: - Crop Production, Livestock, Forestry, and Fishing. Unfortunately, Nigeria's agricultural sector is bedeviled with several challenges such as lack of access to markets and credits, low level of technology especially mechanization, inadequate post-harvest infrastructure (storage, processing, transport), low uptake of research findings by stakeholders, and limited availability of improved technological packages especially planting materials and certified seeds (Ministry of Agriculture, 2007). This has made agriculture unattractive and non-lucrative, resulting in declining youth participation in agriculture (Muhammad-Lawal, Omotoesho, & Falola, 2009). According to Aphunu & Atoma (2010), in Nigeria, the farming population is aging. They noted that it is practically impossible for this aged generation dominating the agricultural sector to deliver the expected productivity required to meet the food demands of the growing population.

The National Policy on Youth Development in Nigeria states that individuals aged between 18 and 35 are considered youth (African Union). Most of these youth, both male and female, reside in rural areas where there are limited opportunities for productive employment (Allen., et al. 2016). However, because of their youth, resourcefulness, and entrepreneurial nature, they have a lot of untapped potential to revolutionize the agricultural industry. (Betcherman., et al. 2015). It is worth noting that Nigeria has one of the largest youth populations globally, with a staggering 13.9 million unemployed young Nigerians as of the second quarter of 2020. Unfortunately, this unemployment rate is on the rise in tandem with the growth in the youth population (NBS, 2020). According to the National Bureau of Statistics (NBS), Nigeria's youth population stands at 40 million, with only 14.7 million of them in full-time employment, and another 11.2 million without jobs. Agriculture has the potential to offer numerous productive employment opportunities for young people, provided there is an increase in investment and a favorable legal and policy environment. Nevertheless, the youth seem to be turning away from farming in search of more lucrative and business-oriented occupations (Girard, 2016).

Engaging more young people in the agricultural sector is one of the approaches to addressing the unemployment crisis among African youth. While most of the world's food is produced by (aging) smallholder farmers in developing countries, older farmers are less likely to adopt the new technologies needed to sustainably increase agricultural productivity and feed the growing world population while protecting the environment. Hence, we need to re-engage youth in agriculture. Plantain is a highly significant horticultural crop, ranking among the top ten food security crops that nourish people worldwide (USDA, 2012). It has long been a staple food for both rural and urban communities. Plantain is a versatile ingredient in the kitchen and serves as a primary ingredient in many popular delicacies and snacks. (Aina et al, 2012). The plantain value chain involves the production, processing, transporting, marketing, and post-production of this horticultural crop, all of these stages have employed different categories of persons in Nigeria and, therefore, have the capacity to solve the problem of unemployment, which is why this study aims to assess the involvement of youth in all these processes, to know how involved the youths are in Oye Local Government of Ekiti state. Ekiti State being among one of the plantain-producing States in Nigeria. In view of these, the objectives of the study were to:

1. Identify the socioeconomic characteristics of the youth in the study area;
2. Describe the major involvement of the youth in the plantain value chain;
3. Identify the non-agricultural business practiced by the youth of the study area;

METHODOLOGY

The study was conducted in Oye Local Government Area of Ekiti state. It was carved out from the defunct Ekiti North Local Government on 17 May 1989. Oye Local Government is bounded by Ilejemeje Local Government to the North, Irepodun/Ifelodun to the South, Ikole local Government to the East, and Ido/Osi Local Government to the West. A Multi-stage sampling technique was used to arrive at a total of one hundred (100) youths from two of the fifteen districts Oye and Ilupeju Ekiti which was purposively sampled based on 10%. Followed by random sampling of the communities in the two districts and finally by random sampling of a total of fifty youths in each of the two districts. It should be noted that the youth group in each community was identified through the village head. Descriptive statistics (mean, frequency, pie-charts, bar-charts and percentage distribution) were used to analyze the data.

RESULT AND DISCUSSION

Respondents' Socioeconomic characteristics

The result in Table 1 revealed that the majority (57.0%) of respondents are in the range of 35-44 years category. Thirty one percent are younger adults under 35 years, while only 12% are older, 45-54 years bracket. This indicates a relatively youthful sample, with most respondents in their mid-30s to early 40s. Looking at gender, there is a fairly even split between males (58.0%) and females (42.0%). This result is supported by the study carried out by (Tijani et al., 2009; Ekunwe &Ajayi in 2010), who found that Men were more involved in Plantain production, although considering that the differences were not so much we can infer that women are now getting involved in the value chain. For religious belief, an overwhelming majority (78%) identified as Christian, with far fewer identifying as Muslim (21%) or holding Traditional beliefs (1%). Ayinde et al., also reported that there were more Christians involved in the plantain value chain. Occupation-wise, civil service is the most common job (34.0%), followed by farming (30.0%), teaching (15.0%), trading (10.0%), and unemployment (11.0%). The prevalence of civil service jobs is high which can be associated with the presence of a tertiary institution in the Local Government, while farming and trading suggest some rural inhabitants are also represented. Only a few are unemployed from the sample which implies that they are involved in one activity or the other. In all, the respondents are relatively educated. Finally, a strong majority (76.0%) identified as indigenous to the area, versus 24.0% non-indigenous.

Table 1: Percentage Distribution of Socio-Demographic Characteristics of Respondents

VARIABLE		FREQUENCY	PERCENTAGE
Age	< 25 – 34 Years	31	31.0%
	35-44Years	57	57.0%
	45-54Year	12	12.0%
Sex	Male	58	58.0%
	Female	42	42.0%
Religious Belief	Christianity	78	78.0%
	Islam/ Traditional	21/ 01	21.0%/ 1.0%
Primary Occupation	Civil Servant/ Teaching	15/34	15.0%/ 34.0%
	Trading/ Farming	10/ 30	10.0%/30.0%
	Unemployed	11	11.0%
Educational Qualification	No formal education/ ND/NCE	02/ 40	2.0%/ 40.0%
	HND/ B.SC	23/35	23.0%/ 35.0%
Are you an indigene?	Yes/ No	76/24	76.0% / 24.0%

Source: Field Survey, 2023

Involvement of Youth in the Plantain Value Chain

The results in Table 2 revealed the involvement of the respondents in the plantain value chain. Regarding the production activities, the majority (63.0%) of the respondents were rarely involved in sucker production while 52.0% of the respondents were involved in plantain production. This is in agreement with the result obtained by Ayinde et al., (2022) and Akinyemi et al., (2010) where there was low involvement in plantain production. This can be as a result of the stress related to the production of plantain and their suckers. This imbalance raises sustainability concerns, as replanting is crucial for maintaining productivity over time. Also, regarding the processing, it was split into Flour, Chips, and fried plantain products. Findings revealed that more than half (60.0%) of the respondents were highly involved in the processing of plantain into flour, 32.0% of the respondents were involved in the processing into chips while 78.0% of the respondents were involved in the processing into fried plantain (Dodo), this result on processing negates the finding of Ayinde et al., in 2022 that observed that only 23% of the population were highly involved in plantain processing. Fifty seven percent of the respondents were highly involved in the distribution process of plantain, this result supports the finding of Adeoye et al., 2012 which identifies a lot of intermediaries in the transport or distribution of plantain. This points to potential opportunities for enhancing youth skills and engagement in additional plantain value-added products that have strong market demand. Regarding the marketing of the plantain, the result reveals that 43.0% of the respondents were highly involved in wholesale, 46.0% were moderately involved as retailers and 55.0% were rarely involved as consumers. This implies that respondents' participation further down the value chain in transportation, small-scale vending, and retail is less pronounced.

Table 2: Percentage Distribution of the Respondents on their Involvement in the Plantain Value Chain

Activities	Rarely Involved	Moderately Involved	Highly Involved	Mean
Production activities				
Sucker Production	63(63.0%)	21(21.0%)	16(16.0%)	0.950
Fruit Production	32(32.0%)	16(16.0%)	52(52.0%)	0.800
Processing into:				
Flour	40(40.0%)	10(10.0%)	50(50.0%)	0.960
Chips	68(68.0%)	10(10.0%)	22(22.0%)	0.540
Dodo	22(22.0%)	30(30.0%)	48(48.0%)	0.740
Distribution	10(10.0%)	33(33.0%)	57(57.0%)	1.470
Marketing				
Wholesales	16(16.0%)	41(41.0%)	43(43.0%)	1.270
Retail	32(32.0%)	46(46.0%)	22(22.0%)	0.900
Consumption	55(55.0%)	(0.5%)	45(45.0%)	0.900

Source: Field Survey,2023

Non-Agriculture Business Practiced

Table 3 is on the percentage distribution of the respondents on non-agriculture business practices, the findings revealed that the majority (77.0%) of respondents were not involved in businesses like tailoring and driving, 54.0% were highly involved in teaching while 46.0% were highly involved in trading. From the findings, it could be seen that most of the respondents have other businesses they engage in apart from farming which can help their income and livelihood sustainability as youths. This is supported by Daudu et al., (2023) who noted that youth would rather be involved in other activities than solely on farming.

Table 3: Percentage Distribution of the Respondents on Non-Agriculture Business Practiced

Non- agriculture Business	Rarely Involved	Moderately Involved	Highly Involved	Mean
Trading	11(11.0%)	43(43.0%)	46(46.0%)	1.320
Bike Riding	44(44.0%)	34(34.0%)	22(22.0%)	0.780
Mechanic	45(45.0%)	44(44.0%)	11(11.0%)	1.390
Tailoring	77(77.0%)	23(23.0%)	-	0.230
Driving	77(77.0%)	20(20.0%)	03(3.0%)	1.400
Teaching	3(3.0%)	43(43.0%)	54(54.0%)	1.400

Source: Field Survey, 2023

CONCLUSION AND RECOMMENDATION

From the study, we concluded that many of the youths were moderately involved in one plantain value chain or the other, however, it is not the sole or primary business of the youths in Oye Local Government. Many use plantain production, processing, or marketing as a side hustle or secondary job, while others as a subsistence form of agriculture. Also, it was observed that many of the respondents were at least educated which can be a major cause for the moderate and partial involvement, as youth in recent times would prefer to work in offices and other Jobs than farming which was also seen in the number of respondents that are employed into the civil service, as many youth sees farming as strenuous. This can also be linked to the increase in the number of respondents that participate in transporting and marketing the plantain in the value chain. It is obvious that there are a number of opportunities in the plantain value chain that has not been utilized, to encourage youths to participate more in active farming there is a need to encourage incentives that make commercial agriculture enticing as the population currently involved in farming are aged and this is not sustainable considering the increasing population of the country as well as ensuring food security.

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IMPACT OF GAS FLARING ON COCOA SOIL FERTILITY IN NDOKWA LOCAL GOVERNMENT OF DELTA STATE

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ABSTRACT
Gas flaring is common in the Niger Delta region of Nigeria to dispose of associated gas. Gas flaring is the burning of natural associated gas and other petroleum hydrocarbons at flare stacks during oil field operations and the basic components include methane, ethane, propane, iso-butane, n-butane, iso-pentane, n-pentane, n-hexane, CO_2, H_2S, He, and N_2 and soot etc. The threat to human, fauna and flora life posed by pollution due to gas flaring cannot be over-emphasized. Soil samples was collected from cocoa farms close to gas flare stack at Asemoku community in Ndokwa local government Area of Delta state at varying distances from the flow stations at a depth of 0-30cm using hand auger. Soil samples was collected at distance of 100m, 300m, 500m, 700m and control in cocoa farm away from the flow station. Soil samples were analyzed using standard laboratory procedures. The soil pH, a useful indicator of nutrient availability, presence of heavy metals in soils, the pH values ranged from 4.0 to 6.2.
Keywords: *Cocoa, hydrocarbon, gas, flaring, metals soils*

INTRODUCTION
Nigeria produces about 290,163*MT* (Statista., 2023 and in the first quarter of 2022, she earns some N22.89bn from exporting raw cocoa beans and other cocoa products (National Bureau of Statistic, 2022). The output of Nigeria cocoa beans for three years; 2014/15 to 2016/17 was about 620,000 metric tons and Niger Delta oil and gas producing states accounted for 546,822 metric tons which is about 88% as revealed by Cocoa Value Chain Assessment Report of the Foundation for Partnership Initiative in the Niger Delta (Aljazirah., 2019). Gas flaring is common in the Niger Delta region of Nigeria to dispose of associated gas (Akpojivi *et al*., 2005). Gas flaring is the burning of natural associated gas and other petroleum hydrocarbons at flare stacks during oil field operations and the basic components include methane, ethane, propane, iso-butane, n-butane, iso-pentane, n-pentane, n-hexane, CO_2, H_2S, He, and N_2 and soot etc. The threat to human, fauna and flora life posed by pollution due to gas flaring cannot be over-emphasized. These acid gases are carried downward as acid deposition (wet and dry depositions) onto cocoa vegetation, soil, and water bodies in communities close to the flare sites. This work was carried out in Ndokwa LGA, to study the impact of gas flaring on the fertility of cocoa soils.

MATERIAL AND METHODS
Soil samples was collected from cocoa farms close to gas flare stack at Asemoku community in Ndokwa local government Area of Delta state at varying distances from the flow stations at a depth of 0-30cm using hand auger. Soil samples was collected at distance of 100m, 300 m, 500m, 700m and control in cocoa farm away from the flow station. Soil samples were analyzed using standard laboratory procedures.

RESULTS AND DISCUSSION
Table 1: physical properties of cocoa growing soils in gas flared areas in delta state

S/n	Sand %	Clay %	Silt %
1	79.52	9.2	11.28
2	77.52	7.2	15.28
3	35.52	13.2	51.28
4	45.52	23.2	31.28
5	77.52	11.2	11.28
6	73.52	13.2	13.28

The physical properties of soil analysis is presented in tables 1 above and table 2 below. The textural classes of the soil samples is sandy-loam, and well suitable for cocoa cultivation. The soil pH, a useful indicator of nutrient availability, presence of heavy metals in soils, the pH values ranged from 4.0 to 6.2.

Table 2: Physical properties and pH of cocoa growing soils in gas flared areas in the Niger Delta

S/n	Distance (m)	pH	Temp. (O^{o}C)	Moisture (%)
1	100	4.0	60	16
2	300	4.2	48	27
3	500	4.4	34	32
4	700	5.7	30	30
5	control	6.2	30	45

The pH values increased away from the gas flare site along the cocoa plantation this is due to the deposits of acidic gas from gas flaring during oil and gas production and acid rains around cocoa farms close to flow station. the effect acid rain on vegetation and crops results in the decline of productivity and growth of some major food crops in the region such as; cassava, maize, plantain and cash crops like rubber, cocoa and oil-palm has also been documented. The recommended pH is 5.5-6.5 for cocoa growing soils, however cocoa has thrived in some lower pH soils of 4.5-5.5. The percentage moisture contents increased away from the gas flaring point, the soils of the cocoa plantation closer to the flare stack drys faster, this is certainly as a result of the continuous heat generated by continuous burning of petroleum gases (CO_2, H_2S, He, and N_2 and soot) etc.

Table 3: Chemical properties of cocoa growing soils in gas flared areas in the Niger Delta

S/n	Ca Cmol/kg	Mg Cmol/kg	K Cmol/kg	Org C %	N **%**	P mg/kg
1	2.45	1.18	0.12	1.32	0.09	1.27
2	1.15	2.97	0.26	1.76	0.21	2.86
3	2.15	2.34	0.24	2.60	0.18	2.40
4	4.67	2..63	0.36	4.60	0.90	1.64
5	2.86	1.52	0.24	0.80	0.06	4.32
6	3.43	1.82	0.22	1.08	0.06	8.52

The results of the chemical analysis is presented in table 3. Nitrogen content was adequate at sampling points closer to the flow station but wasn't up to the critical value of 0.09% at 700m and control which are further away from the flare points. This also confirm the present of nitrogen gas during gas flaring. The available P was inadequate across all sampling locations and far below the critical value of 10mg/kg recommended by Egbe (1989) as shown in table 4

Table 4: Critical levels of some soil properties for cocoa cultivation by Egbe (1989)

N %	P Mg/kg	K Cmol/kg	Ca Cmol/kg	Mg Cmol/kg	Zn Mg/kg	OM %	pH
0.09	10.0	0.3	5.0	0.8	2.80	3.0	5.5

The K content was also inadequate except at sampling point 5 and all samples was inadequate for Ca in the study area. Gas flaring could alter soil quality parameters including physio-chemicals and microbial characteristics as seen in table 2. it has been reported that temperature, bulk density decreases with distance from flaring sites while CEC, organic matter and moisture contents increases away from gas flare stations as seen in our reports in tables 2 and 3.

Table 5: Heavy metals in cocoa soils in gas flared areas in the Niger Delta

Soil S/n	Pb cmol/kg	Cr cmol/kg	Ni cmol/kg	Cd cmol/kg	Cu cmol/kg	Zn cmol/kg
1	54.25	-	-	22.45	15.75	33.45
2	42.25	-	-	17.25	43.00	20.25
3	39.50	-	-	15.25	18.00	36.45
4	30.25	-	-	11.50	26.50	27.75
5	18.50	-	-	7.25	38.00	23.25
6	9.25	-	-	10.25	35.75	18.25

CONCLUSION

Heavy metal pollution has been reported in cocoa soils but focus was on the use of agrochemical. The possible heavy metal contamination of cocoa soils due to (oil and gas) flaring is presented in table 5. Cadmium is a component of refined products of petroleum as an impurity (Buekers, 2007). The range of Pb, Cd, Cu and Zn contents around flaring sites in the study areas is presented in table 5. It can be observed that the values decreased away from the gas flaring points with exception of Zn at sample point 3. The cadmium values in cocoa farms around gas flare areas was higher in all samples far above the critical safety level for cadmium by various authorities (0.8mg/kg WHO, 1996, 0.76mg/kg, Commentuijn *et al.* (1997), 0.5mg/kg (Saadia *et al*., 2016). It is important to stress that excessive levels of cadmium in soil (>1 mg/kg) presently found in samples is due to closeness of such farms to some gas flaring and other petroleum contamination of the areas and may largely be as a result of emissions (Oversteyns.,1992). Cu and Zn values were lower in samples but the range suggest a build up above the permissible or critical levels and probably a clean up process going on the area. There is need to expand the study to other areas and monitor cocoa production closely in the Niger Delta since majority of cocoa beans comes from the Niger Delta region.

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NUTRIENT DYNAMICS SOILS AND LEAVES SAMPLES OF COFFEE PLOTS AT COCOA RESEARCH INSTITUTE OF NIGERIA

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ABSTRACT
Coffee production has social and economic impact locally and internationally as about two (2) billion cups of coffee is consumed worldwide on a daily basis (British Coffee Association., 2021), coffee is second only to petroleum in the world trade (Famaye, 2019). Adequate soil nutrition is essential in modern coffee production to increase yield therefore, agricultural practices in coffee plantations should preserve the soil fertility, which is the wealth of the growers. Healthy soils are the foundation of agriculture and indeed civilization itself. There are strong indications of soil nutrient deficiency across coffee plantations irrespective of age. The soils reaction was slightly acidic to neutral, ranges from 5.20 to 7.15 and the soil pH across the plantations was within the critical levels of coffee cultivation which is 5.5 to 7.0 (Robusta) and 4.5 to 5.5 (Arabica) as reported by Daniel et al (2015). The N values are moderately adequate for coffee with few inadequacies but the P and K values are all inadequate across plantations thus limiting yield as well as income to farmers. Similar research across coffee plantations nationwide should be carried out with a view of developing data base for coffee cultivation. The use of organic (coffee waste) or inorganic fertilizers and rehabilitation of the coffee plantations used for this study is strongly recommended.
Key words*: Coffee, soil, nutrients, yield, critical.*

INTRODUCTION

Coffee production has social and economic impact locally and internationally as about two (2) billion cups of coffee is consumed worldwide on a daily basis (British Coffee Association., 2021), coffee is second only to petroleum in the world trade (Famaye, 2019). Adequate soil nutrition is essential in modern coffee production to increase yield therefore, agricultural practices in coffee plantations should preserve the soil fertility, which is the wealth of the growers. Healthy soils are the foundation of agriculture and indeed civilization itself (Joel *et al*., 2010). Plant roots grow and absorb water and nutrients according to the physical, chemical and biological properties of the soil which in turn affects yield of crops among other factors. It was based on the assumption that the plant itself is used as a soil nutrient extractor and, within certain limits, there is a relationship between the supplies of nutrients, either from the soil or the fertilizer, and leaf nutrient contents; increases in leaf nutrient content are related to higher yields, and decreases to lower yields (Bataglia *et al*., 2004). Leaf analysis is an efficient way to monitor the health and nutrient status of plants which play a vital role on the quality and yield of coffee berries (Joel *et al*., 2010).

Since most of the coffee plots in the Institute were established over two decades ago, the nutritional reservoir in the soil might be insufficient to completely meet the nutrients demand; it is therefore necessary to evaluate the nutrient status of the soils. Soil nutrient status is proportional to the yield and quality of plants and production can be drastically reduced in poor soils if limiting factors are not quickly detected and promptly corrected.

MATERIALS AND METHODS

The experiment was conducted at Cocoa Research Institute of Nigeria Ibadan, Nigeria (Lat 07°10¹ and Long 03°51¹E) and altitude 124m above sea level with average daily temperature of about 30°C. Ibadan is located in the forest ecological zone with a bimodal rainfall pattern and a mean annual rainfall of 1300mm. Soil samples was taken from two different soil depths (top at 0-20cm and subsoil 20-40cm) using soil auger. The composite soil sample was processed through 2mm sieve and analyzed using standard laboratory procedures. The soil pH was measured in 1:1 soil-water ratio, the particle size was determined by Bouyoucos hydrometer method (Bouyoucos,1951). Available P was by Bray P1(Bray and

Kurtz 1945) Leaf samples was collect from the 3rd and 4th leaf on the branches of coffee trees and was processed and analyzed following standard laboratory processes.

RESULTS AND DISCUSSION

Physical properties of soil under coffee plantations

Table1: presents the summary of the physical properties of the soil at the (0 – 20) cm and (20-40) cm soil depth under coffee plantations. Results showed that the physical properties of the soil under different coffee plantations varied. The soils of the plantation varied in their sand, silt and clay content, nevertheless, the textural class is generally sandy loam**.** The soils reaction was slightly acidic to neutral, ranges from 5.20 to 7.15 and the soil pH across the plantations was within the critical levels of coffee cultivation which is 5.5 to 7.0 (Robusta) and 4.5 to 5.5 (Arabica) as reported by Daniel et al (2015).

Chemical properties of the soil and leaf under coffee plantations at CRIN, Ibadan

Table.2 presents the summary of the chemical properties of the soil at the (0 – 20) cm and (20-40) cm soil depth under coffee plantation. Results showed that the chemical properties of the soil under different coffee plantations also vary. The N content in samples 1 and 2, CRIN demonstration plot top and subsoil was adequate and above 0.09%, similar results was obtained in zone 5 coffee germplasm plot and samples 7 and 8. But samples 3,4,9 and 10 were below the nitrogen level required for coffee production. This trend shows a continuous depletion of soil nutrients across the plantations. The K contents are grossly inadequate across coffee plantations both top and subsoil, it ranges from 0.154 cmol/kg to 0.352cmol/kg against the minimum critical value of 4.5cmol/kg (Daniel *et al.,* 2015). These inadequacies maybe related to the removal of nutrients due to harvesting over two decades. The P content was also very low across plantations, with the highest value of 11.76mg/kg and the least value of 1.46mg/kg against the recommended critical value of 30mg/kg for coffee production confirming the high levels of nutrient depletion across the coffee plots as a result of nutrient mining majorly through harvest of berries and this also confirm the non usage of fertilizers in the coffee research plots for over two decades which definitely affects yields.

Coffee leaf analysis

Table 3 presents the results of the coffee leaf analysis which shows varying degrees of deficiency. The % N contents in the leaves was lower in most samples except samples 5 and 6, others are below the critical range of 2.5-3% irrespective of the age of the plantation. The N values ranged from 2.013 to 2.835 % N showing similarity of low N with the soil samples. The K content was also inadequate except for samples 3and 4 with 2.443% K and 2.299% K values compared to the critical range of 2.1 o 2.6%K recommended by Abayneh *et al*., (2015, FAO undated). The Ca and Mg content of the leaf samples was found to be below the critical range of 0.75-1-5 and 0.25-0.40% for all leaves samples while Na values for all leaf samples was adequate for coffee as seen in table 4.

Table1: Soil physical properties under coffee plantation

	pH	Sand	Silt	Clay
S/N		%	%	%
1	6.65	87.80	4.80	19.40
2	6.60	91.80	4.80	3.40
3	7.15	81.80	6.80	11.40
4	7.10	75.80	8.80	15.40
5	5.85	71.80	8.80	19.40
6	5.20	71.80	16.80	11.40
7	5.30	63.80	10.80	25.40
8	5.30	61.80	16.80	21.40
9	5.40	71.80	10.80	17.40
10	5.45	65.80	18.80	15.40

Table 2: Chemical properties of soil under coffee plantation

Ca Cmol/kg	Mg Cmol/kg	Exchangeable Bases K Cmol/kg	Na Cmol/kg	Total N %	Total Org C %	Av. P P mg/kg
2.96	0.713	0.308	0.35	0.113	1.370	11.76
2.45	0.67	0.264	0.28	0.109	0.841	2.61
1.69	0.66	0.352	0.385	0.076	0.535	1.46
6.4	1.164	0.176	0.315	0.034	0.189	3.98
0.76	0.66	0.198	0.42	0.196	0.368	3.05
1.16	0.46	0.220	0.25	0.408	0.256	2.52
0.69	0.50	0.308	0.46	1.201	0.975	2.92
1.97	0.49	0.176	0.28	0.053	0.306	2.74
1.65	0.50	0.242	0.35	0.029	0.445	7.38
1.84	0.53	0.154	0.32	0.045	0.395	4.2

Table 3: chemical properties of coffee leaf samples

Plants S/Code	Total N %	Total P %	Total K %	Total Na %	Total Ca %	Total Mg %
1	2.013	399.976	2.061	0.258	0.728	0.123
2	2.187	291.591	1.580	0.194	0.584	0.104
3	2.457	79.431	2.443	0.292	0.572	0.121
4	2.489	147.662	2.299	0.251	0.434	0.129
5	2.835	125.376	1.555	0.231	0.579	0.123
6	2.731	136.548	1.802	0.197	0.343	0.084

Table 4: Nutrient Optimum range for coffee leaf samples

Nutrient Optimum range	Values %
N (Nitrogen)	2.5 - 3.0
P (Phosphorus)	0.15- 0.2
K (Potassium)	2.1 - 2.6
Na (Sodium)	< 0.05
Ca (Calcium)	0.75 - 1.5
Mg (magnesium)	0.25 -0.40

Source: Abayneh *et al*., 2015

CONCLUSION AND RECOMMENDATIONS

The soil and plant nutrients analysis of coffee plantations across the institute headquarters is far revealing. There are strong indications of soil nutrient deficiency across coffee plantations irrespective of age. The soils reaction was slightly acidic to neutral, ranges from 5.20 to 7.15 and the soil pH across the plantations was within the critical levels of coffee cultivation which is 5.5 to 7.0 (Robusta) and 4.5 to 5.5 (Arabica) as reported by Daniel *et al* (2015). The N values are moderately adequate for coffee with few inadequacies but the P and K values are all inadequate across plantations. The leaf samples show similar deficiencies for N, K, Ca, Mg in the study areas. Similar research across coffee plantations should be carried out with a view of developing data base for coffee cultivation. The use of organic or inorganic fertilizers and rehabilitation of these coffee plantation is strongly recommended.

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VARIETAL TRIALS OF TOMATO (*Lycopersicon esculentum Mill.*) IN SOUTHWESTERN NIGERIA.

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ABSTRACT
Tomato (Lycopersicon esculentum Mill.) is one of the most important vegetables worldwide. This experiment was conducted at National Horticultural Research Institute (NIHORT), fifteen cultivars of tomatoes were sown in planting trays in the nursery on February 14th, 2014. The seedlings were transplanted on the 24th of March 2014 onto a plot of 9m^2. Plant to plant distance was 50cm apart with RCBD experimental design replicated three times. Data collected were seed germination percentage, seedling survival, seedling height, number of leaves per seedling, height at maturity, stem girth, number of branches, day to first fruiting and number of fruits (yield) per plant and weight of fruit per plant, fruit pH. The result of the establishment count after two weeks of transplanting to the field showed that AVTO 1303 had 97.62 % while Star 9063, UC82 B(BB), UC 82 B(SA) and ROMA VF (BB) had 60% germination. STAR 9064 and RIO GRANDE (SA) had slow growth rate at 7WAP (Plant height 3.25 cm, 5.5cm; Stem diameter 0.12 cm, 0.13 cm; Number of Leaves 1.75, 1.75,). The cultivars Star 9064, Rio Grande (BB), Rio Grande (SA), and UC 82 B were late flowering.
Keywords: *Tomato, varieties, yield, pH, fruit quality*

INTRODUCTION

Tomato (*Lycopersicon esculentum Mill.*) is one of the most important vegetables worldwide. Tomato belongs to the Solanaceae family. World tomato production in 2001 was about 105 million tons of fresh fruit from an estimated 3.9 million ha. It is a relatively short duration crop and gives a high yield, it is economically attractive and the area under cultivation is increasing daily. It is an important source of vitamins and an important cash crop for small holders and medium scale commercial farmers (Krishna *et al.,* 2022). Tomatoes contribute to a healthy, well-balanced diet. They are rich in minerals, vitamins, essential amino acids, sugars, and dietary fibres. Tomato contains much vitamin B and C, iron, and phosphorus (Oladokun *et al.,* 2022) fruits are consumed fresh in salads or cooked in sauces, soup and meat or fish dishes. They can be processed into purées, juices, and ketchup. Canned and dried tomatoes are economically important processed products.

Three different types of tomato plants can be distinguished: tall or indeterminate type; semi-bush or semi-indeterminate type; bush or determinate type. The tall varieties are the best choice for a long harvest period. They keep growing after flowering. This feature is called indeterminate. However, under tropical conditions, diseases and insect attacks will stop growth. The plants generally have more foliage. This will keep the temperature lower within the crop and the fruits grow in the shade of the leaves. Because they are covered, the sun does not damage the fruits and they ripen more slowly. Slower ripening and a high leaf/fruit ratio improve the taste of the fruits and in particular the sweetness (Almansa *et. al* 2011). `The tall types must be staked, caged, or trellised. Short types usually support themselves and need no staking. Under severe weather conditions such as heavy rain however, staking may be advisable. Determinate types stop growing after flowering. They require less labour, so they are popular for commercial cultivation. They have a relatively concentrated fruit set which lasts only two or three weeks, and the fruits ripen much faster than those from indeterminate types.

Tomatoes are normally transplanted, because much better results are gained when seedlings are raised in a nursery (Chiomento *et al.,* 2020). Two methods of raising seedling in nurseries can be used: sowing in seedbed; sowing in seedling tray. Smaller quantities of seed are needed, the seedlings can be selected for growth and health before planting in the field, the plantlets can be well protected, and the planting distance is more regular than after sowing directly in the field. The objective of this research was to test the viability, yield, and adaptability of the tomato cultivars to different agro ecologies in Nigeria.

MATERIALS AND METHODS

Fifteen cultivars of tomatoes were sown in planting trays in the nursery on February 14th, 2014. The seedlings were transplanted on the 24th of March 2014, to the experimental field in NIHORT onto a plot of $9m^2$. Plant to plant distance was 50cm apart. Data collected were seed germination percentage, seedling survival, seedling height, number of leaves per seedling, height at maturity, stem girth, number of branches, day to first fruiting and number of fruits (yield) per plant and weight of fruit per plant. The pH of the fresh fruit samples was determined using One gram of sample homogenized in 1ml of distilled water and 1ml of de-ionized water of pH 7.0. The pH of the juice was recorded using an electronic pH meter. The pH meter was standardized using a buffer solution of pH, the method described by Rangana (1979).

RESULTS AND DISCUSSION

Germination in the nursery: 15 cultivars of tomatoes were planted, after 3 days all other cultivars except Bro Portinari, Brs Nagar, Brs Kiara, Brs Montese and Brs Couto germinated. However, after 5 days, Brs Couto, Brs Montese and Brs Kiara germinated. All the 13 cultivars that germinated were transplanted to the field on the 24th of March 2014. The establishment count after two weeks of transplanting to the field showed that AVTO 1303 had 97.62 % while Star 9063, UC82 B(BB), UC 82 B(SA) and ROMA VF (BB) had 60% respectively (Table 2). However, Brs Couto, Brs Montese and Brs Kiara did not survive. These can be due to some factor that was identified by Ma *et a*l., (2023)

Vegetative growth of cultivars: The vegetative growth for the different cultivars was highly significant (p=0.05%). However, STAR 9064 and RIO GRANDE (SA) had slow growth rate at 7WAP (Plant height 3.25 cm, 5.5cm; Stem diameter 0.12 cm, 0.13 cm; Number of Leaves 1.75, 1.75,) respectively (Table 1). Significantly higher plant height was observed with AVTO 1303.

Reproductive parameters of cultivars: The cultivars Star 9064, Rio Grande (BB), Rio Grande (SA), and UC 82 B were late flowering as shown in Table 2 indicating average number of flowers per plant. This affected the days to first fruiting and fruiting in the different cultivars. For average fruit weight per plant, UC82 B(BB) 61.46g, AVTO 1303 65.72g and Ibadan Local 60.67g is significant (Table 2). The fruit weight obtained in this study is higher than the fruit weight per plant reported by Nwosu *et al.,* (2018) who obtained as low as 2.72g fruit weight.

Fruit Quality: The pH of the fresh tomato fruits from ten varieties was in the range of 4.1 to 5.9 (Table 2). UC (SA) had the highest pH of 5.9 while Star 9063 had the lowest pH of 4.1. The pH of most varieties fall within suitable pH range for tomato processing. Tomato pH ranges from 4.3 to 4.9 according to Aboagye-Nuamah *et al*., (2018)

CONCLUSION

The study has shown that significant differences exist in the morphological properties of the ten tomato varieties The pH of the fresh fruit meet the recommended level of desirable traits for industrial tomato processing.

Table 1: Vegetative parameter for Tomato cultivars

	7WAP			9WAP			
Cultivar	Plant height (cm)	Stem diameter (cm)	No of Leaves	Plant height (cm)	Stem diameter (cm)	No of Leaves	No of branches
Star 9063	26.00	0.68	10.75	43.75	0.70	19.75	4.50
Star 9064	3.25	0.12	1.75	6.50	0.18	2.50	0.00
Star 9062	18.75	0.50	8.50	34.50	0.60	19.50	3.75
Rio (BB)	13.25	0.35	7.00	22.00	0.50	9.25	0.25
Rio (SA)	5.50	0.13	1.75	10.75	0.25	3.50	0.00
UC(BB)	25.75	0.60	6.25	42.00	0.63	19.00	2.50
UC(SA)	15.25	0.53	6.50	24.75	0.58	9.25	0.50
Roma (BB)	25.00	0.70	8.75	42.25	0.80	21.25	4.25
Avto 1303	40.95	0.73	18.75	60.75	0.78	29.75	5.50
Ibadan Local	30.77	0.58	15.00	50.57	0.93	25.20	5.00
LSD (0.05)	8.77	0.03	3.86	10.10	0.18	7.19	1.61

WAP- Weeks after Planting

Table 2: Yield parameters of ten accessions of Tomato

Cultivar	% establishment	Days to first fruiting	pH	AFW (g)	AFN	AFD (cm)	AFL (cm)
Star 9063	60	62	4.1	58.40	7	11.65	12.50
Star 9064	50	79	4.2	32.08	2	12.35	14.90
Star 9062	50	73	4.2	53.31	2	11.70	12.55
Rio (BB)	45	73	4.7	57.45	1	8.20	7.20
Rio (SA)	60	75	4.7	61.49	2	14.75	14.85
UC(BB)	60	67	4.7	20.47	2	2.20	2.25
UC(SA)	45	80	5.9	21.26	2	8.50	7.50
Roma (BB)	60	80	4.6	42.97	2	12.40	13.50
Avto1303	97.62	57	4.5	15.72	22	10.77	11.63
1badan Local	42.86	61	4.5	60.67	8	9.16	10.67
LSD (0.05)	0.99	0.86	0.84	0.82	0.99	0.81	0.87

AFW- Average fruit weight per plant, AFN- Average Fruit number per plant, AFD- Average Fruit Diameter, AFL- Average Fruit length

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PRELIMINARY CHARACTERIZATION OF TELFAIRIA OCCIDENTALIS HOOK F. (FLUTED PUMPKIN; CUCURBITACEOUS) ACCESSIONS IN SOUTH WEST NIGERIA FOR YIELD IMPROVEMENT.

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ABSTRACT
Telfairia occidentalis (Hooks F.) is king of leafy vegetable and an economically important cash crop. The variability among the accessions was studied by characterizing their agronomic and yield traits. The 38 accessions used were collected from different geopolitical zones in Nigeria. The experiment was performed in a randomized complete block design with three replications. Mean square values due to accessions were highly significant (p >0.01) for all the traits studied. Acession38 gave the highest female leaf area at 437.80cm2. AC39, AC14, AC1 and AC38 recorded early days to flowering at 80.33, 86.67, 91.33 and 92.33 respectively. Early days to pod set was observed in AC14, AC38 and AC1 at 106.31, 106.33, and 116.67 respectively. AC38 had maximum number for female percentage ratio at 96.67%. AC10 and AC38 had maximum pod lengths at 72.75cm and 64.65cm respectively. AC10 and AC38 had maximum pod widths at 84.50cm and 72.90cm respectively. Greater number of pod weight was observed in AC38 and AC14 at 63.80g and 45.13g. AC38, AC 14 and AC3 recorded higher number of pod yield per plot at 9.5, 8.67 and 7.0 respectively. Based on the evaluated traits, promising lines; AC38 AC14 and AC 10 can be deployed as progenitors to develop early maturing, high yielding Telfairia occidentalis varieties adaptable to south western Nigeria. This information is vital for conservation of different genetic materials and initiation of improvement programme for Telfairia occidentalis in western Nigeria
Keywords: *Telfairia occidentalis, accessions, characterization, leaf area, internode, pod length, pod width, pod weight*

INTRODUCTION

Fluted pumpkin (*Telfairia occidentalis* Hook. F.), named after the famous Irish naturalist, botanist and plant collector Charles Telfair is a member of the family cucurbitaceae and order Telfaireae. (Compleat botanica, 2004; Jeffrey, 1980). The two main species in the genus are Telfairia occidentalis (Hook (F) and Telfairia pedata (Smith ex sim World Agro Forestry Centre, 2004). Botanically, it has a creeping growth habit and its vines spreads across the ground to produce an efficient cover to the ground against erosion and produces large fruits with many large seeds ((Horsfall and Spiff, 2005; Ajayi et al., 2004; Purseqlove, 1997). It is a dioecious plant with male and female flowers borne on different plants (Boualem *et al*., 2015). Male plants start flowering earlier at means of 129 days compared with 150 days after planting for female plant and over a longer period of 59 days versus 17 days for females plant (Fayeum *et al.,* 2016a; Akoroda, 1990). There are more than 300 open male flowers to single opened female flowers and male flowers open in the evening. About 10 – 15% of given female population do not flower in the first year of planting and abortion of fruit is high (Fayeum et al., 2016a). Plant may set up to six fruits but usually one large and one or two medium sized fruits are eventually carried to maturity. (Ajayi *et al.,* 2016; Akoroda and Adejoro, 1990).

Telfairia is indigenous to Nigeria. It is commonly cultivated in the South Eastern part of Nigeria (Akoroda, 1990). Studies conducted by Schippers, 2002 show that its cultivation is gradually gaining prominence in the South Western part of the country. It serves as food for millions of people in the world and is widely grown in tropical wet coastal areas of West Africa, principally in Benin, Cameroon, Ghana, Nigeria and Sierra Leone (Odiaka *et al*., 2008; Okoli and Mgbeogwu, 1983; Akoroda, 1990). Also, it is grown in Florida as summer vegetable (Ajayi *et al.,* 2007; Uguru and Onovo, 2011). The leaf is used for preparing delicacy like “Edikang Ikong” and Ubo abak soups. The leaves of the plant are very much sought after by sheep and goats hence could be used as fodder (Boualem *et al*., 2015; Akoroda *et al*., 1990). Chukwudi and Agbo, 2014 reported that fluted pumpkin is an important vegetable supplement in the carbohydrate dominated staple food chain of West Africa. It is very rich in iron and protein and is used to cure anemia. A low dose of 400 mg/kg body weight fluted pumpkin seed oil improved sperm count and testicular histology in rat (Akang *et al.*, 2010). The seeds are enriched in amino acids (94.9%) which contains higher levels of essential amino acids than soya bean with 93.7%. (Odiaka *et al.,* 2008; Esuoso *et al.,* 1998).

Despite being a very important vegetable crop well known for its rich source of protein, vitamins, mineral, oil, medicinal value, economically cash crop and means of livelihood of many rural communities (Chukwudi and Agbo, 2014; Odiaka *et al.,* 2008; Ajayi *et al.*, 2007; Okafor, 1983), report from the regional stakeholder workshop for West Africa held in 2010, in Cotonou, Benin categorized fluted pumpkin among the neglected and underutilized plant species with the potential to play key role in supporting rural livelihoods and in alleviating food insecurity. However, research findings have revealed there are scanty data or information on phenotypic and genetic identification of existing accessions of this orphan crop which would be beneficial to increase food security. There is also a problem in differentiating existing accession from one another due to wide genetic variations among them which is essential for the long term success in breeding programme and maximizing the exploration of germplasm resources (Chukwurah and Uguru, 2010; Balaj *et al.,* 2002). There is insufficient knowledge of genetic relationship among these accessions which would aid in selecting promising and desirable progenitors for future breeding programme. The success of any crop breeding programme largely depends on studying the availability of huge genetic variability and possible genetic progress that might arise among accessions (Nwangburuka *et al.,* 2014). Therefore, it was on this basis that this study was conducted to identify, and differentiate existing accessions and to select promising and high yielding accessions for crop improvement programme.

MATERIALS AND METHODS

The study was conducted in 2022 wet growing season at the Research Farm of National Horticultural Research Institute, Ibadan (Latitude 7º24’26”N, and longitude 3º50’43”E; 191 meters above sea level) Ibadan has bimodal rainfall distribution, which peaks in June/July followed by a two weeks break in August. This distribution creates two cropping season generally categorized as early and late. The early rain occurs between late March/April and end of July while the late rain occurs from August/September to November (Olaniyan *et al* 2001). Total number of 38 accessions of Telfairia occidentalis were collected from different geopolitical zones of Nigeria. Seeds of each accessions were raised in trays containing sterilized sawdust for two weeks in the screen house and watered four times in a week. Two weeks old telfairia seedlings were transplanted to the field during early rainfall. The experiment was laid out in randomized complete block design with 3 replications. The plot size was 2m x 2m and plant spacing of; 1m inter spacing and 50cm intra spacing making a population of 20,000 plants per hectare. Weeding and all other agronomic practices and farm hygiene were carried out as at when due.

DATA COLLECTION

Data were collected on agronomic traits as follows: Internode length (cm), Petiole length (cm), Male leaf area (cm2), Female leaf area (cm2), Male days to flowering, Female days to flowering, Days to pod set, Pod length (cm), Pod width (cm), Fresh pod weight (grams) and Number of pod yield per plot based on the International Plant Genetic Resource Institute (IPGRI, 1995) descriptors for Telfairia. The data were subjected to statistical analysis, means were separated using the Least Significant Difference (LSD) (Ajayi *et al.,* 2007).

RESULTS

The primary aim of this study was to characterize the existing levels and patterns of phenotypic diversity among the accessions of Telfairia Occidentalis. The information about the existing diversity is an essential prerequisite for the success of any breeding program and provide a good opportunity for the selection of accessions with desirable quantitative traits, such as high leaf yield, pod size and shape, and acceptable to consumers. Table 1 shows the mean square value for all the traits studied. It revealed that mean square values due to accessions were highly significant ($p > 0.01$) for all the traits studied which includes internode length, petiole length, male leaf area, female leaf area, male days to flowering, female days to flowering, days to pod set, pod length, pod width, pod weight and number of pod yield per plot. The mean performance of the accessions of telfairia occidentalis indicates considerable variation was observed among the accessions studied. Maximum internode length was recorded for AC21 at 19.15cm while AC16 had minimum internode length at 7.95cm. For the petiole length, AC38 had the highest

petiole length at 18.36cm but AC1 had least petiole length at 6.65cm. The trait female leaf area was identified for AC38 at 437.80cm2 while a minimum of 68.55cm2 for AC26. AC38 recorded maximum mean value for male leaf area at 227.55cm2 but AC26 displayed minimum male leaf area at 37.50cm2.
In the determination of days to first flowering, for male days to flowering, it was observed that AC39, AC14 and AC38 had early number days to first lowering at 73.33, 79.00 and 81.31 respectively while AC21 had late number of days to first flowering at 127.50. For female days to flowering, AC39, AC14, AC1 and AC38 recorded early days to flowering at 80.33, 86.67, 91.33 and 92.33 respectively but AC21 had late days to flowering at 141.50. Days to pod set was moderately lower for AC14, AC 38 and AC1 at 106.31, 106.33, and 116.67 respectively while AC4 recorded maximum days to pod set at 129.00. For the percentage male to female ratio, AC38 had maximum number for female ratio and minimum number for male ratio while AC35 had maximum number for male ratio but minimum number for female ratio. AC10 and AC38 had high level of pod length at 72.75cm and 64.65cm respectively but AC23 had lower pod length at 23.12cm. Again, AC10 and AC38 had maximum pod width at 84.50cm and 72.90cm respectively while AC23 had minimum pod width at 16.97cm. Greater number of pod weight was observed in AC38 and AC14 at 63.80g and 45.13g but AC20 had lower pod weight at 4.0g. A greater number of pod yield per plot was witnessed in AC38, AC 14, and AC3 at 9.5, 8.67 and 7.0 respectively but AC20 and AC10 recorded lower number of pod yield per plot at 1.5 and 1.0 respectively.

DISCUSSION

All the morphological traits showed highly significant ($P \leq 0.01$) variations indicating the presence of sufficient amount of genetic variability among the Telfairia occidentalis accessions for all the studied traits. This was evident by the outcome of the ANOVA. (Chukwudi *et al.,* 2016; Ogar and Asiegbu, 2005; Ajayi *et al.,* 2007 reported sufficient genetic variation in Telfairia occidentalis which warrant selection and hybridization among this specie for development of superior genotypes. Similar variability was reported by Rego *et al.,* (2015b); Akoroda and Adejoro (1990) which showed that traits evaluated had highly significant differences for almost all the genotypes studied indicating a wide range of variability among the genotypes evaluated and that breeders should select such genotypes to develop superior varieties. All the traits studied which includes Internode length, petiole length, male leaf area, female leaf area, male days to flowering, female days to flowering, days to pod set, pod length, pod width, pod weight and number of pod yield per plot varied significantly at ($P \leq 0.01$. Maximum internode length was recorded for AC21 at 19.15cm. AC38 had the highest petiole length (These results confirmed the studies carried out by Odiaka and Akoroda (2009). Maximum average female leaf area of 437.80cm2 was identified for AC38 and a minimum of 68.55cm2 for AC26). AC38 recorded maximum male leaf area 227.55cm2. (Fayeum *et al.,* 2016b; Akoroda *et al*., 2006).
AC14 and AC38 had early number days to male first flowering at 73.33, 79.00 and 81.31 respectively. AC21 had late number of days to male first flowering at 127.50. AC39, AC14, AC1. AC38 recorded early days to female flowering at 80.33, 86.67, 91.33 and 92.33 respectively similar results were reported by (Ogwu *et al*., 2017; Fayeum *et al.*, 2016a ; Ajayi *et al.,* 2004). AC21 had late days to female flowering at 141.50 similar results were reported by (Chukwudi and Agbo, 2016; Aremu and Adewale, 2012). AC38 had maximum number for female ratio and minimum number for male ratio while AC35 had maximum number for male ratio but minimum number for female ratio (Ezenwata *et al.*, 2019; Adeyemo and Tijani, 2018; Grumet et al., 2011). AC14, AC 38 and AC1 had early days to pod set at 106.31, 106.33, and 116.67 respectively but AC4 had maximum days to pod set at 129.00 (Akoroda and Adejoro, 1990; Uchechukwu *et al.,* 2017). AC10 and AC38 had maximum pod length at 72.75cm and 64.65cm respectively but AC23 had lower pod length at 23.12cm. AC10 and AC38 had maximum pod width at 84.50cm and 72.90cm respectively while AC23 had minimum pod width at 16.97cm. Greater number of pod weight was observed for AC38 and AC14 at 63.80g and 45.13g. AC20 had lower pod weight at 4.0g (Odiaka *et al*. 2008). A greater number of pod yield per plot was witnessed for AC38, AC 14, and AC3 at 9.5, 8.67 and 7.0 respectively. AC20 and AC10 recorded lower pod yield per plot at 1.5 and 1.0 respectively (Fayeun *et al.*, 2016; Nyaka *et al.,* l 2005; Ajayi *et al*., 2004)

CONCLUSION AND RECOMMENDATION

1. The genetic variations that existed among the studied accessions were evident in the morphological traits measured and yield obtained
2. Accession AC38 and AC14 due to its distinguishing high leaf yielding in the is recommended for further genetic/crop improvement programme

3. Accession AC1 and AC38 with early days to pod sets are recommended to be included in hybrid breeding programme for crop improvement
4. The highest fruit yield/plot obtained for AC38 and AC14 are recommended for further genetic/crop improvement programme
5. AC38 and AC14 with highest average fruit weight are also recommended for further genetic/crop improvement programme

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Table 1: mean square of traits evaluated in 38 accessions of *Telfairia occidentalis*

Source Variance	DF	Internode length (cm)	Petiole Length (cm)	Female leaf Area (cm)^2	Male leaf Area(cm)^2	Female Days to First Flowering	Male Days to First Flowering	Female Ratio	Male Ratio	Days To Pod set	Pod Length	Pod Width	Pod per plot (g)
Block	2	1.62	2.15	57243.03	171.71	273.12	237.08	143.01	68.82	205.85	5.17	10.63	918.38
Accessions	37	21.03**	31.76**	31960.05**	9132.97**	994.03**	888.90**	1225.10**	1104.82**	1792.51**	196.33**	364.36**	9974.10**
Error	73	0.68	1.45	2926.19	548.57	189.08	166.71	151.34	141.59	167.26	43.81	52.61	169.95

Table 2: Mean performance of morphological traits studied on 38 accessions of *Telfairia Occidentalis*

Acc code	Internode length	Petiole Length	Female Leaf area	Male Leaf Area	Male 1st day to flowering	Female 1st day to flowering	Male ratio	Female ratio	Days to Pod set	Pod length	Pod width	Pod weight	No of Pod yield per plot
Acc1	13.93de	6.65j	364.89bac	182.21bdc	82.67gh	91.33gih	56.67fdeg	43.33gefh	146.67a	52.18fecdh	66.84bcd	20.86hegdf	4.33dfe
Acc2	14.43cde	7.93ihj	336.35bdc	168.56edc	122.67ba	132.6bdac	53.33feg	46.67gefhd	136.00bdac	50.84gfecdh	63.35fbecd	12.50hlgkjmi	3.00hgfe
Acc3	12.50fg	11.48feg	278.10fbedc	165.68edc	86.67ba	113.67egfh	33.31jih	66.67bcd	123.00dc	46.13gfedh	57.47fecdg	25.73ed	7.00bc
Acc4	10.65ijk	9.90fhg	307.56bedc	160.63ed	119.00ba	128.00bdac	50.00fhg	50.00gefcd	129.00bdac	53.19fecd	60.5fecdg	22.05egdf	5.00dce
Acc5	10.55ijk	8.70ih	256.85fedg	190.25ghi	126.00a	134.00bac	50.56fhg	60.00fde	145.00ba	54.18bed	58.48fecdg	18.20hegdjfi	5.00dce
Acc9	10.60ijk	9.00ih	227.78fehg	155.55ed	114.00bac	127.50bdac	60.00fdc	40.00gefhi	132.50bdac	42.26gh	51.70fg	16.50hegjki	4.00dgfe
Acc10	12.15fgh	9.83fhg	154.13ikhj	154.13ikhj	108.50bdac	115.50edfc	85.00ba	15.00j	128.00bdac	72.75a	84.5a	11.85hlkjmi	1.50ih
Acc11	11.55fgi	9.22ih	361.11bac	155.71ed	86.67egfh	92.33gih	60.02fde	40.00gefhi		56.24bcd	64.44becd	21.33hegdf	4.00dgfe
Acc13	12.43fg	13.38de	321.94bdc	158.90ed	126.67a	141.00a	70.00bdec	30.00gjhi	146.00ba	57.71bc	69.16bc	14.83hlgkjfi	3.00ihgfe
Acc14	10.71ijk	7.57ij	363.08bac	112.62gf	79.00gh	86.67ih	16.67jk	83.33a	121.33d	48.80gfecdh	58.24fecdg	45.13b	8.66a
Acc15	10.466ijk	8.27ihj	309.40bdc	165.61edc	120.67ba	127.67bdac	73.33bdac	26.67jhi	131.33bdac	48.67gfecdh	53.58feg	12.10hlkjmi	3.0ihgfe
Acc16	7.95m	9.60hg	99.40k	64.82jhi	97.50egdfc	103.50ebdfc	85.00ba	15.00j	127.50bdac	56.75bcd	56.75fedg	6.75lkm	1.50ihgfe
Acc17	11.60ghi	13.05de	96.60k	96.40k	107.00ebda	116.00bac	50.00fhg	50.00gefcd	132.50bdac	42.00h	66.00bcd	26.20ed	5.00dce
Acc18	14.68cd	14.25d	366.30ba	366.29ba	115.38bac	128.67bdac	63.34fdec	36.67gefcd	134.33bdac	52.89gfecd	67.08bcd	17.13hegjfi	3.33hgfe
Acc19	10.85hij	13.70d	338.06bdc	177.83bdc	90.00egdfh	102.33egifh	70.00bdac	30.00gjhi	128.00bdac	55.33becd	60.50fecdg	36.30cb	3.67gfe
Acc20	14.44cde	13.43de	281.80fbedc	172.21dc	115.67bac	121.33ebdac	90.00a	10.0j	128.67bdac	52.00gfecdh	64.40becd	4.0m	1.00 i
Acc21	19.15a	17.83ba	322.77bdc	130.39ed	127.50a	141.50a	80.00bac	20.00ji	146.00ba	55.50bced	16.97i	9.55lkjm	1.50ih
Acc22	15.60bc	12.50de	97.82k	90.50gh	124.50ba	136.00bac	80.00bac	20.00ji	143.00bac	49.00fecdh	39.42h	9.70lkjmi	2.00ihg
Acc23	9.38lk	9.12ih	155.13ikhj	64.55jhi	113.00bac	126.50bdac	46.67fihg	53.33efcd	138.00bdac	23.12i	50.96hg	5.63lm	4.33dfe
Acc24	15.77bc	16.3bc	289.58fbedc	174.84bdc	116.00bac	126.20bdac	60.00fde	40.00gefhi	132.00bdac	42.87gfh	60.50fecdg	8.70lkjm	2.50ihgf
Acc25	15.67bc	14.15d	193.17ihjg	132.32ef	119.50ba	130.25bdac	70.00bdec	30.00jhi	136.50bdac	44.93gfeh	57.93fecdg	9.10lkjm	2.17ihg
Acc26	10.44ijk	7.40ij	68.55k	37.55j	122.50ba	134.67bac	50.00fhg	50.00gefcd	146a	51.90gfecdh	56.70fedg	20.65hegdf	5.00dce
Acc27	16.80b	14.45dc	366.27ba	366.27ba	122.00ba	134.67bac	50.00fgh	50.00gefcd	140.67ac	50.07gfecdh	57.93fecdg	19.40hegdfi	5.00dce
Acc29	10.55ijk	12.60de	206.64fihg	55.15jhi	88.50egdfh	130.00bac	50.00fgh	50.00gefcd	130.00bda	54.60bed	56.70fedg	22.4oedf	5.00dce
Acc30	9.65jkl	8.42ih	305.22bedc	227.68a	119.67ba	126.67bdac	63.66fdec	36.67gfhi	134.67bda	46.00gfedh	55.95fedg	10.33lkjmi	3.67gfe
Acc32	16.05b	17.50ba	360.80bac	211.00ba	125.50a	138.00ba	50.00fgh	50.00gefcd	141.00bdac	51.50gfecdh	55.95fedg	17.50hegjfi	3.00ihgfe
Acc34	10.58ijk	9.88fhg	277.52fedcg	52.04ji	83.67gfh	94.33gifh	30.00ji	70.00bc	125.33bdc	50.28gfecdh	61.72fbecdg	27.77cd	7.00bc
Acc35	10.80ij	11.70fe	118.46ikj	118.46kj	104.00ebdfc	111.00egdf	90.00a	10.00j	133.00bdac	50.75gfecdh	56.35fedg	17.50hegjfi	4.00dgfe
Acc37	9.03ml	9.00ih	108.98kj	108.98kj	119.50ba	130.50bdac	40.00ihg	60.00ecd	41.00e	47.50gfecdh	57.08fedg	22.10egdf	6.0dc
Acc38	13.10ef	18.37a	437.80a	223.55a	81.33gh	92.33gih	3.33k	96.67a	121.33d	64.65ba	72.91ba	63.80a	9.67a
Acc39	10.88hij	11.68fe	338.62bdc	150.95ed	73.33h	80.33i	63.33fdec	36.67fhi	40.67e	53.67fecd	66.33cd	20.70hegdf	3.67gfe

Mean with the same alphabets within the Column are not significant different at 5% probability level from one another

EFFECT OF GROUNDNUT OIL IN PROTECTING STORED COWPEA *(Vigna Unguiculata* L. Walps*)* FROM ATTACK BY COWPEA WEEVIL (*Callosobruchus Maculatus*)

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ABSTRACT
This study was carried out to determine the effect of groundnut oil in protecting stored cowpea (Vigna unguiculata L. Walps) from attack by Callosobruchus maculatus. The experiment was laid out in completely randomized design (CRD) replicated three times with five treatments admixed with 100g cowpea seed; 0 (T_1), 3.5 (T_2), 4.0 (T_3), 4.5 (T4) and 5.0 ml (T5). Data were collected on adult mortality, oviposition, progeny, seed damage and weight loss. The recorded data were analyzed using analysis of variance and the treatment means were compared by Fisher's least significant difference (F-LSD) at 5% probability level. The results showed that there were significant differences between the treatments ($P \leq 0.05$). Cowpea treated with 4.5 and 5.0 ml recorded 100% insects' mortality at 72 and 96h while 4ml exerted 100% mortality at 48h. oviposition was completely inhibited in cowpea treated with 4, 4.5 and 5ml oil. While progeny emergence was suppressed in 3.5, 4.0, 4.5 and 5.0ml dishes. The result shows that least weight loss and seed damage was observed in cowpea treated with groundnut oil compared to other control. Based on this study it was recommended that groundnut oil can be used to protect cowpea from damage caused by C. maculatus infestation as it has no documented health risk compared with the use of pesticide.
Keyword: *Groundnut oil, Cowpea, Cowpea weevil and Toxicity*

INTRODUCTION

Cowpea (*Vigna unguiculata* L. Walps) as a pulse is commonly stored as staple for man and animals due to its high protein content especially in tropical and subtropical regions where it complements the expensive animal protein source in human diet. It also as livestock feed to make silage and hay (Diouf, 2011). Enormous losses of between 20-50% have been reported on stored cowpea due to attack by cowpea weevil (*Callosobruchus maculatus*) and sometimes the loss could be 100% (Abulude *et al*., 2007). It is used as human food. According to Peace (2015) who reported that, more than 5.4 million of dried cowpeas are produced worldwide, with Africa producing nearly 5.2 million. Nigeria, the largest producer and consumer, accounts for 61% production in Africa and 58 % worldwide.

Cowpea production is affected by insect pests and disease infestations which lead to economic losses. Insect damage is the major constraint to cowpea grain production in most cowpea producing nations (Singh *et al*., 1978). The cowpea weevil, *Callosobruchus maculatus* (F.) (*Coleoptera: Bruchidae*), is a cosmopolitan field-to-store pest ranked as the principal post-harvest pest of cowpea in the tropics (Caswel, 1981). It causes substantial quantitative and qualitative losses manifested by seed perforation and reductions in weight, market value and germination ability of seeds (Oluwafemi, 2012). Apart from direct damage to grains, losses also occur as a result of contamination with insect faecal material, nitrogenous waste (frass) and exuviae (Udo, 2000) thus making it unfit for human consumption.

Concerted efforts have been made by farmers and governmental agencies to control and or reduce infestation and attack of stored cowpea by the bean weevil. Insect pest control in stored produce relies heavily on the use of fumigants and residual contact insecticides. The implications of these are serious problems of toxic residues, health and environment hazards, development of insect strains resistant to insecticides, increasing cost of application and erratic supply of safer chemicals in the developing countries due to foreign exchange constraints (Obeng-Ofori *et al*., 1997). The need to find materials that effectively protect stored produce, that are readily available, affordable, relatively less poisonous and less detrimental to the environment had stimulated interest in the development of alternative control strategies and re-evaluation of traditional botanical pest control agents (Talukder and Howse, 1995). Resource poor farmers in developing countries use different materials to protect stored grains against pest infestation by mixing grains with protectants made up of plant products. Plant derived pesticides are effective against many pests as antifeedants, repellents or toxicants and are less hazardous (Obeng-Ofori, 1997).

Groundnut extracts have been found to be effective against many economically important insect pests, groundnut products are broad spectrum in activity and are known to affect over 300 species of insects as well as mites, nematodes, fungi, bacteria and few viruses, and groundnut products are harmless to mammals and most beneficial arthropods, biodegradable and appear less likely to build up genetic resistance in target pests (Obeng-Ofori, 1997). In spite of the highly positive benefits derived from the use of the groundnut products, their utilization as pesticide is limited in Africa (Obeng-Ofori, 1997). In this study, laboratory bioassays were used to evaluate the efficacy of groundnut oil for the control of cowpea beetle *Callosobruchus maculatus* in stored cowpea.

MATERIALS AND METHODS

Experimental Site

The study was conducted between the month of December, 2019 and January, 2020 at the Department of Crop Production and Horticulture laboratory, Modibbo Adama University of Technology Yola, (Latitude 9^0 and 11^0N and longitude 12^0 and 20^1E)

Treatment and Experimental Design

The experiment consisted of five treatments; at 0 (No application), 3.5, 4.0 ml, 4.5 and 5.0 ml of groundnut oil / 100g cowpea seed laid out in a Completely Randomized Design (CRD), replicated three times. Each of the containers with the cowpea grains were treated with groundnut oil by mixing thoroughly to ensure adequate contact and twenty adult insects were introduced into each treatment. Each treatment was replicated three times while the control had no groundnut oil added to it.

Source of Materials

Insect culture

Collosobruchus maculatus was obtained from an infested stock of grains from the Jimeta grain market, Adamawa State, Nigeria and cultured in the Crop Production and Horticultural Laboratory, Modibbo Adama University of Technology Yola, Nigeria with culture conditions being 28 ± 2ºC temperature and 66% relative humidity respectively. After seven days of oviposition, the parent adults were discarded and the emerging progeny was used for the various bioassays.

Grain samples and groundnut oil

Grain and oil samples were obtained from Jimeta main market, Adamawa State, Nigeria. The grains were cleaned to remove impurities and any hidden infestation. Fifty grams of the grain samples were placed into 200 ml glass jar and covered with white muslin cloth held in place with rubber bands to which each of the treatment was added.

Twenty-five unsexed newly emerged adult *C. maculatus* were introduced into each jar containing 100g cowpea seed admixed with five different concentrations; 0 (T_1), 3.5 (T_2), 4.0 (T_3), 4.5 (T4) and 5.0 ml of the groundnut oil. A control experiment comprising untreated seeds was also set up. The experiment was arranged in the laboratory at room temperature, laid out in a Completely Randomized Design and replicated three times. The *C. maculatus* adult mortality was recorded for four days at every 24 hours Dead insects were removed, counted and recorded to calculate percentage adult mortality at each observation (Adesina et al, 2022). After 96 hour of *C. maculatus* infestation all living and dead insects were removed, number of eggs laid on treated and control seeds were counted using a hand lens and the jars with treated seeds and control were kept undisturbed in the laboratory for adult emergence (Adesina et al., 2022). The number of adults emerged from the treated cowpea was counted and recorded at 14, 21 and 28 days after treatment. Percentage seed damage was determined by counting damaged seeds with adult emergence holes on the surface of the stored seeds, 28 days after infestation (Adesina and Mobolade-Adesina 2020). While percentage weight loss was collected after sieving the treated and control dishes of insects and frass through a 3 mm sieve (Idoko and Adesina 2013) and the stored seeds reweighed.

Data Collection and Analysis

Data collected on adult mortality, number of eggs laid, adult emergence, seed damage and weight loss were subjected to one-way analysis of variance (ANOVA) and significant treatment means were compared by using Duncan New Multiple Range Test (DNMRT) at the 5% level of significance (P< 0.05).

RESULTS

Effect of Groundnut Oil on Mortality of *C. maculatus* at different Time (Hours) after Treatment

Table 1 shows the effect of groundnut oil on mortality of *C. maculatus* at different hours after treatment. From the result there were highly significant differences (P≤0.01) among the treatment all through the different time after treatment. At 24 hours, the result showed that 0 ml has no mortality with 0.00 while 4.5 ml recorded highest percentage mortality (19.33%). Similar trend was observed at 48 hwith 95% (20) mortality recorded as the highest number of insect mortality. At 72 and 96 h cowpea treated with 4.0, 4.5 and 5.0 ml have the highest insect mortality of 20.00 (95%). insect mortality.

Effect of Groundnut Oil on Oviposition of *C. maculatus* after Treatment to stored cowpea

Table 2 shows that groundnut oil has significant oviposition suppression on *C. maculatus*. Cowpea in the control dish (0 ml) recorded the highest number of eggs laid (24.67), distantly followed by 3.5 ml which produce 0.67 eggs laid compared to other treatments (4.0 4.5 and 5.0 ml) that completely inhibited oviposition.

Effect of Groundnut Oil on *C. maculatus* Progeny Emergence

Table 3 shows that the different dosage of groundnut oil significantly suppressed *C. maculatus* progeny emergence. Across the storage duration, highest number of progeny emergence was noticed from cowpea in the control dish. While, cowpea treated with 3.5, 4.0, 4.5 and 5.0ml of groundnut oil completely inhibited progeny emergence.

Effect of Groundnut Oil on Weight loss and Level Damage Caused by *C. maculatus* to Stored Cowpea

Result in Table 4 shows the effect of groundnut oil on weight loss level of damage caused by *C. maculatus* to stored cowpea 28 days after treatment. . The result revealed that, at 28 days of storage, cowpea treated with 4.5 ml recorded the lowest weight loss (0.97g) compared with untreated control that suffered the heaviest weight loss (4.07g). Similar trend was observed in terms of percentage seed damage, *C. maculatus* inflicted the highest percentage damage on cowpea in the untreated control dishes (48.29%) compared to the significant almost zero percentage damage recorded in the treated cowpea (0.09-0.55%).

CONCLUSION

The study shows that at 4.5 mls proved to be more effective in protecting stored cowpea as it significantly evoked higher percentage insect mortality, inhibited oviposition, adult emergence, percentage seed damage and weight loss compared to other treatments. and with less reduction in This is an indication that groundnut oil could reduce the infestation of stored cowpea grains against *C. maculatus* infestation. In light of the foregoing, adoption of groundnut oil as stored cowpea grains protectant as environmental friendly substitute to the use of chemical (pesticide) by resource poor farmrer

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Table 1: Effect Groundnut oil on Mortality of *C. maculatus* at different time (hours) after treatment

	Mean mortality at different hours after treatment			
Cultivars	24	48	72	96
0ml	0.00	0.00	0.00	0.00
3.5mls	17.33	18.00	19.33	19.33
4.0mls	18.67	19.33	20.00	20.00
4.5mls	19.33	20.00	20.00	20.00
5.0mls	17.33	18.69	20.00	20.00
Mean				
P<f	0.001	0.001	0.001	0.001
LSD	2.486	1.329	0.939	0.939

Key : P<f = Probability of F

Table 2: Effect Groundnut oil on Oviposition of *Callobruchus maculatus* in Days

Treatment	Oviposition
0ml	24.67
3.5mls	0.67
4.0mls	0.00
4.5mls	0.00
5.0mls	0.00
Mean	
P<f	0.002
LSD	5.571

Key: P<f = Probability of F

Table 3: Effect of Groundnut Oil on Progeny caused by *C. maculatus* to Stored Cowpea after Treatment

Treatments	Mean progeny at different days after treatment		
	14	21	28
0ml	23.0	38.0	77.33

3.5mls	0.00	0.00	0.00
4.0mls	0.00	0.00	0.00
4.5mls	0.00	0.00	0.00
5.0mls	0.00	0.00	0.00
Mean			
P<f	0.001	0.001	0.001
LSD	6.143	2.153	5.231

Key : P<f = Probability of F

Table 4: Effect of groundnut oil on weight loss and level damage caused by *C. maculatus* to stored cowpea.

Treatment	Weight loss	% Damage
0ml	4.07	48.29
3.5mls	2.23	0.55
4.0mls	1.57	0.18
4.5mls	0.97	0.09
5.0mls	1.77	0.27
Mean		
P<f	0.002	0.001
LSD	5.571	1.228

Key: P<f = Probability of F

RESPONSE OF LEAF VEGETABLE (*Corchorus olitorius*) TO NITROGEN FERTILIZER IN OGBOMOSO

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ABSTRACT
Poor soil fertility, particularly inadequate N, may limit the cultivation of Corchorus olitorius. This study was conducted to determine the effects of N to maximize C. olitorius production in Ogbomoso between June and August 2023. The treatments were 0, 30, 60, 90, 120, 150 and 180 kg N/ha, laid out in a Randomized Complete Block Design replicated thrice at the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso, Nigeria. Data on growth (plant height, number of leaves, stem diameter and number of branches) and yield (shoot biomass, leaf biomass and leaf/shoot ratio) were subjected to Analysis of Variance and treatment means differences were compared using $LSD_{0.05}$. Nitrogen applied at 90 kg N/ha had the highest number of leaves (268), branches (18), stem diameter (9.67 mm) and plant height (89.8 cm) while the control had the lowest number of leaves (110), branches (18) and diameter (6.17 mm), while180 kg N/ha had the lowest plant height (66 cm) at 7 weeks after transplanting. The 60 kg N/ha produced the highest quantity of shoot (8,833 kg/ha) and leaf biomass (2,506 kg/ha) while the control had the lowest shoot value (4,667 kg/ha) and leaf biomass (1,408.7 kg/ha). Regression analysis revealed that leaf yield increased linearly with nitrogen rate until diminishing return sets in. In conclusion, the application of N at 60 kg/ha was adequate for the growth and yield of corchorus in the study area.
Keywords: *Jute mallow, nitrogen, growth, shoot and leaf biomass.*

INTRODUCTION

Corchorus olitorius known commonly as 'fruited jute', 'bush okra' or 'jute mallow' is a common tropical leafy vegetable found in Africa, Asia and some parts of the Middle East and Latin America (Odofin *et al.,* 2011). It has succulent leaves which soften rapidly with cooking, and thickens into a viscous mucilaginous soup which can be eaten with starchy foods (Adediran *et al.,* 2015). The edible portion of the plant, the leaf, is mucilaginous like okra. Corchorus is nutrient-rich and contains dietary fiber, protein, iron, calcium, thiamin, riboflavin, niacin, and folate. Vitamin C, E and β-carotene, Galactose, galacturonic acid, and rhamnose are also present (Fondio and Grubben, 2004; Ndiovu and Afolayan, 2008). The cultivation of *C. olitorius* faces various challenges, including inadequate nutrient supply from the soil. To meet the growing demand for this crop and improve its yield, farmers often rely on the application of fertilizers, with nitrogen being a key nutrient in plant growth and development.

Nitrogen is an essential nutrient for plant growth and development, influencing processes such as photosynthesis, protein synthesis, and overall plant vigor (Taiz and Zeiger, 2010). Several studies have been conducted to investigate the effects of nitrogenous fertilizers on the growth and yield of various crops, including vegetables (Pandey *et al*., 2019; Xu *et al*., 2018). Olaniyi, and Ajibola (2008) observed that, application of N, P and K significantly increased the plant height, number of leaves, fresh shoots, dry matter yield of *Corchorus olitorius* above the control (no fertilizer). However, the response of *C. olitorius* to nitrogen fertilization remains relatively underexplored. Understanding the location specific requirements and rates of this crop will help optimize fertilizer application and contribute to sustainable agricultural practices; therefore, the objective of this study was to determine the effects of varying rates of N-fertilizer on the growth and biomass production of *Corchorus olitorius*.

MATERIALS AND METHODS

The study was conducted at the Teaching and Research Farm, Ladoke Akintola University of Technology (LAUTECH), Ogbomoso, Oyo State, Nigeria, during the 2023 growing season. The land was cleared of bushes and beds measuring 1 × 1 m with 1 m spacing between beds were made. Two weeks old Corchorus seedlings were transplanted at two plants per hill at plant spacing of 0.5 × 0.5 m to make a population of 80,000 plants/ha. Manual weeding was carried as and when due. The experiment was laid out in a Randomized Complete Block Design (RCBD) replicated three times. Urea (45% N) was used to supply nitrogen at 30, 60, 90, 120, 150 and 180 kg N/ha. Beds without any soil amendments (Control treatment) were included for comparison. Fertilizer was applied a week after transplanting in split dosage with application of 60 kg N/ha and the balance for the treatments above 60 kg N/ha applied at two weeks after transplanting. Data on plant height, stem diameter, number of leaves, number of branches were collected on five randomly selected tagged plants from three weeks after transplanting (WAT). At seven weeks after transplanting, the plants were harvested and fresh shoot and leaf biomass were obtained using sensitive weighing balance. Data were subjected to analysis of variance (ANOVA) and treatment means compared and significant mean differences were separated with LSD at $p < 0.05$.

RESULTS

Application of 90 kg N/ha resulted to significantly more leaves than the control at 5 and 7 weeks after transplanting (WAT), it also had significantly more leaves than all the other treatments, while the control had significantly lowest number of leaves compared to other treatments (Table 1). It was observed that 150 kg N/ha rate resulted to the tallest plant at 5 WAT while it was 90 kg N/ha that gave the significantly tallest plant compared to the control at 7 WAT. The 180 kg N/ha rate resulted to significantly shortest plants at both periods of observation (Table 2). Application of 120 kg N/ha gave the highest stem diameter at 5 WAT (Table 3), while the 90 kg N/ha rate resulted to significantly highest stem diameter than the control at 7 WAT. However, treatments at 180 kg N/ha and Control had significantly lowest stem diameter at 5 and 7 WAT r. The 60 kg N/ha treatment had the highest number of plant branches at 5 WAT while 90 kg N/ha had significantly highest number of branches at 7 WAT (Table 4). The 180 kg N/ha and 0 kg N/ha treatments had significantly least plant branches at 5 WAT and 7 WAT.

It was observed that the 60 kg N/ha had significantly highest shoot biomass (8,833 kg/ha) while it was lowest for the control (4,667 kg/ha) (Table 5). There was no significant difference between the leaf/shoot ratios at all the fertilizer rates. The highest leaf biomass was observed at 60 kg N/ha (Fig 1) while it was lowest for the control. Leaf biomass declined at rates above 60 kg N/ha. The leaf biomass response curve indicated that the increase in leaf biomass was linear with increase in fertilizer rates until diminishing return sets in after 60 kg N/ha rate.

Table 1: Effects of nitrogen fertilizer rates on the number of leaves of *Corchorus olitorius*

Fertilizer rate (kgN/ha)	Weeks after transplanting	
	5	7
0	51	110
30	66	168
60	69	174
90	70	268
120	66	200
150	67	199
180	50	148
$LSD_{0.05}$	20.2	64.6

$LSD_{0.05}$ =LSD at 5% probability level.

Table 2: Effects of nitrogen fertilizer rates on plant height (cm) of *Corchorus olitorius*

Fertilizer rate (kgN/ha)	Weeks after transplanting

	5	7
0	39.2	77.8
30	37.6	79.5
60	38.6	80.3
90	38.7	89.8
120	39.5	87.3
150	39.9	82.6
180	25.6	66.0
$LSD_{0.05}$	10.9	18.5

$LSD_{0.05}$ =LSD at 5% probability level.

Table 3: Effects of nitrogen fertilizer rates on the stem diameter (mm) of *Corchorus olitorius*

Fertilizer rate (kgN/ha)	Weeks after transplanting	
	5	7
0	2.93	6.17
30	3.97	8.20
60	4.17	8.50
90	4.20	9.67
120	4.33	9.13
150	4.13	8.83
180	2.67	7.13
$LSD_{0.05}$	1.25	2.08

$LSD_{0.05}$ =LSD at 5% probability level.

Table 4: Effects of nitrogen fertilizer rates on the number of branches of *Corchorus olitorius*

Fertilizer rate (kgN/ha)	Weeks after planting	
	5	7
0	8.7	10.2
30	11.2	15.9
60	11.3	16.0
90	10.6	18.3
120	10.2	15.7
150	10.0	14.3
180	6.7	14.1
$LSD_{0.05}$	2.2	4.3

$LSD_{0.05}$ =LSD at 5% probability level.

Table 5: Effects of nitrogen fertilizer rates on shoot biomass (SB), (kg/ha) and leaf to shoot ratio of *Corchorus olitorius*

Fertilizer rate (kg N/ha)	SB	LB/SB
0	4667	0.3
30	5000	0.29
60	8833	0.28
90	8000	0.27
120	7000	0.3
150	8000	0.3
180	6500	0.28
$LSD_{0.05}$	3778	0.06

$LSD_{0.05}$ =LSD at 5% probability level.

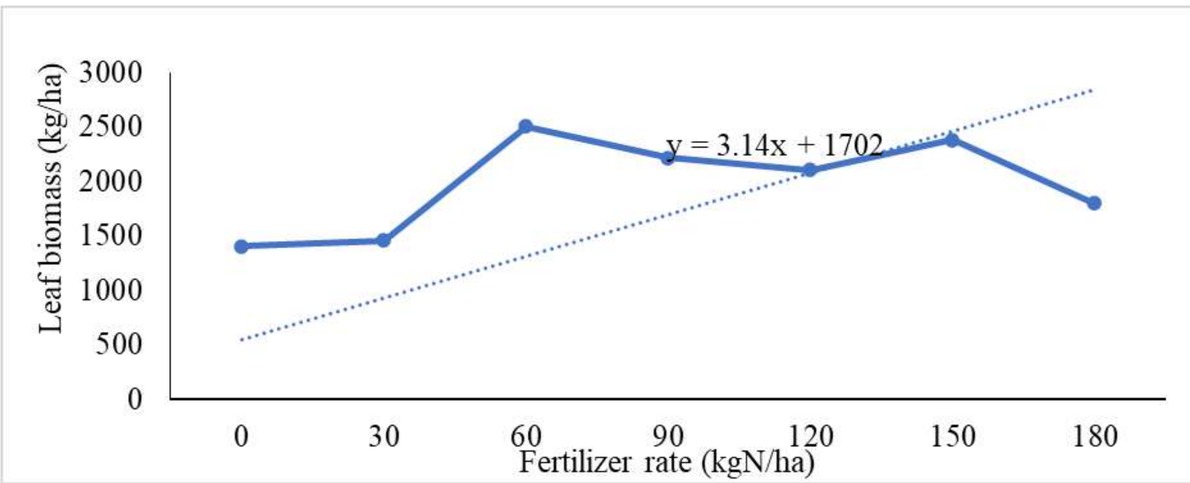

Figure 1: Effects of fertilizer rates on the leaf biomass of *Corchorus olitorius*

DISCUSSION

There were significant variations in the response of *C. olitorius* in growth parameters to varying rates of N application. Nitrogen rates higher than 90 kg N/ha reduced the growth parameters. It shows that excess nitrogen can interfere with the uptake of other essential nutrients, such as potassium and calcium, potentially leading to deficiencies in these elements which can further affect the overall health and quality of the crop (Albomoz, 2016). These findings were in agreement with observation of Tovihoudji *et al*. (2015) that the application of N at rate above 100 kg N/ha of urea, did not enhance the growth of *C. olitorius*.

Nitrogen rates had significant influence on the Cochorus fresh shoot and leaf biomass with 60 kg N/ha producing the highest shoot and leaf weights. Beyond this rate, there was decline in shoot and leaf biomass produced. This indicates that the optimum N rate for the economic yield of *C. olitorius* in the study area had been reached. Isah, *et al*. (2012) reported that N fertilizer application levels on leafy vegetables had a positive influence on the yield of leaf and shoot production. However, Olaleye *et al*. (2008), reported that nitrogen applied at a 50 kg N/ha rate to Corchorus cultivated under cocoa plantation soils rich in organic matter had the highest shoot and leaf biomass production. Also, Olaniyi and Ajibola (2008) reported that 45 kg N/ha rate had the highest shoot and leaf yield for oniyaya variety of *C. olitorius*. The differences in the N rates observed could be due to the varieties of Corchorus cultivated and the inherent soil fertility status.

The decline in performance of *C. olitorius* beyond 60 kg N/ha could be related to the plant's luxury consumption. This observation agreed with the report of Mbia *et al*. (2020), who noted that increasing application of N to Corchorus increases the yield until diminishing returns at over 90 kg N/ha. In conclusion, application of 60 kg N/ha was optimum for improved economic yield of Corchorus in the study area.

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AGE DISTRIBUTION AND MARKETING OF OGBONO (*Irvingia gabonensis* var wombolo) TREE KERNEL YIELDS: A CROSS SECTIONAL VIEW AS A PRE AND POST RETIREMENT BENEFIT SUPPORT IN OKIGWE SOUTH EASTERN NIGERIA.

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ABSTRACT
A cross sectional growth, fruit and extracted kernel yields parameters were taken on existing Ogbono trees in orchards of Mbato, out station of NIHORT Okigwe, Imo State, South east Nigeria. The study was done during the 2023 fruiting season of Ogbono tree. The main purpose was to compare the monthly and annual pension of level 6 -13 retired NIHORT staff to one tree kernel yield money value in a year. Result showed that a middle aged Ogbono tree kernel gave net profit range of #57,000 -66,000, about twice federal minimum wage and then three times (#17,000 monthly pension) or one quarter the #204,000, per annum minimum pension alert of a level-6 retired NIHORT staff. Recommendation was made for one to plant today (not tomorrow) stands of Ogbono trees as a backup benefit for retirement in these days of unbearable high cost of living.
***Keywords**: Age, Benefit, Kernel yields, Marketing, Ogbono, Retirement support*

INTRODUCTION

Ogbono seed kernel tree (*Irvingia gabonensis* var wombolu) has various local names that includes Dika bread tree,Oro-apon, Bush mango ,African mango and wild mango is included by UNESCO as a multipurpose fruit tree which by indebt research, traced its origin to humid low land rainforest of central African and West Africa characterized with Ultisols (Okafor,1983, Mbagwu,1992, Nzekwe,1995 ,Van Dyke,1997,Reguengo,*et al*,2023). Presently, it is called African wild Apple (Okpara *et al*, 2021). This may not be unconnected with recent findings that *I. gabonensis* fruits pulps or peels that lie waste on farms and homestead as a local bye products in the course of seed kernel extractions has found use in winery and food/diet supplement industries.Thus the arrays among other products by Amazon of African mango Bio-Lipo dietary liquid extract(Amazon Com.Inc.,2023). The seed of the fruit consists of a hard shell, an outer brown testa (hull) and inside, the kernel, composed of two white cotyledons (National Research Council, 2006). The kernels, rich in fat (myristic and lauric acids), protein (Linoleic) and carbohydrates are the main products of *I. gabonensis* and constitute an important part of West and Central Africa diet, providing income for all the actors along the market chain from the farmer,harvester to the final consumer even as it is traded across Europe and America(FAO,2015,ICRAF & FAO,2021).Income generation,especially among retired civil servants employed by the federating states of Nigeria is gravely difficult as many are owed over 12 months of salary arrears before retirement.

Many states in the South east, following the regime change in May 2023 inherited unpaid gratuity and backlog of months/years of salary and pension arrears with attendants warning strikes by labour unions (The Daily Sun,7th Sept,2023). The load will take months if not years to liquidate before attending to recent and about to retire civil servants. Retirement is the official disengagement from public or civil service (Pension, Act,2004). It could be by volition based on health grounds, fraud or public disaffection due to unpopular policies by a seating government or individual. The later is common in USA where a seating governor and in world bank where a Director resigned due to scandal. Retirement could also be statutory after one has put in useful time and energy at work and service for 35 years or attained 60 years of age. The ILO (revised ed.2018) maintained 40% (2 out of 5 portions) of civil servant last salary package as the monthly pension. In Nigeria, using Chilean model, one third (1 out of 3) that is about 33.3 % is by principle allowed (Pension Act, 2004, Odia &Okoye, 2012). Following monthly payment alerts via clients of many contributory Pension Fund Administrators within and among retired staffs of

NIHORT Okigwe, it ranged between 17,000 and 87,000 for level 6 – 13 staffs. Their state counterparts is quite lower than the afore mentioned Federal staff.

With the trend of worsening living standards and market prices, present civil servants should embrace the pre-retirement culture of planting Ogbono (*Irvingia gabonensis* var wombolu) tree in any available plot within and around their wild or homestead farms as a support to their retirement benefits. Ogbono, Garcia cola and Treculia africana produce are trending with high prices in both local and international markets with deficit in supply. This work is aimed at looking cross sectionally,the monitary value of kernel yields of Ogbono trees in NIHORT orchards and comparing same with the pensions of retired staffs.

MATERIALS AND METHODS

The survey was carried out from the of March to June 2023 that coincided with fruiting, picking and gathering of freely felled fruits of Ogbono trees (*Irvingia gabonensis* var wombolo) from various orchards in Mbato Okigwe out station, Imo State, Nigeria. The station lies on latitude 05^0 33^1N and longitude 07^0 23^1E and altitude of 130 meters above sea level. Okigwe is characterized by undulating dissected plains and soils derived from shale and sandstone, classified as ultisol. This cross-sectional view of Ogbono tree kernel yield was done to determine its proceeds dependability as a pre and post-retirement benefit support or venture in Okigwe geographical area. These trees were established by our staffs many of whom are of blessed memories in the years 1984 (about 20 stands),1994 (about 2 ha), 2001 (about 25 stands, scattered by bushfire) and 2005(extension of 1994 main orchard) and is found as documents in, Indigenous Fruit tree Establishment in: NHM/ADM/58/VOL_2 (1984-1997).

Samples of trees were chosen based on two (2) extremities of the highest and the lowest in terms of expressed growth parameters of heights, canopy spread diameters, stem diameters and number of branches of existing, grown and fruiting trees in the separate orchards. For Heights, trees were climbed with measuring tapes and one long, dry and slender (2-4cm girth) bamboo pole. Climbing was made to topmost apical branch that can support human weight and also has the highest twigs above the climber's head. With the tip of the measuring tape attached to the bamboo pole end, and the now improvised tool pushed and extended above the climber head to align (mere eye aid) with the tip of the topmost twig of the tree, height reaching is achieved. Having done this, the rest of the measuring tape with its rolling casen were released from above high under gravity to the base of the trees. The rolled out lengths of the measuring tapes is observed and recorded as tree heights.

Similarly, canopy spread diameters, were measured. For the stem diameters, it was done by taking the circumference measurements of trees at 100cm above ground and imputing same into circle formular for two times radius values. For the number of branches per tree stand, considerations for a branch to be counted was based on attainment to girth range of 7 – 12 cm girth using verniers caliper. Branches with their adjoining apical and side twigs recorded a range of 75 – 140 fruit per tree stand. A working mean of 100 fruits per tree stand was taken to estimate branches fruits number of per tree stand. In this part of Nigeria, our markets have standard container measures in cups and buckets. Tomato cup size(210ml) and custard starch bucket size(4200ml) are most popular, acceptable and routinely used as measure of standard scales for buying and selling in the open markets. Fruits and fruit kernel yield were in this trial measured using the fore mentioned scales. A range of 42 – 62 fresh fruits (pending fruits shape and size) makes a bucket full and the same range for a cup full of extracted cotyledon or kernel. A working mean of 55 fruit per paint of picked fresh fruit for the estimation of total fresh fruit yield per tree stand was adopted. The range of extracted kernel weights (g) in cups was 132 – 159g and their market price value in March - May 2023 was $1100 - $2000 per cup. It is worthy of note that twenty (20) tomato cup measure (210ml) makes a custard starch bucket(4200ml) and 30 custard bucket measure gives 100kg bag of extracted Ogbono kernel in the open market. The cost of mandays per 1000 fresh fruit picking and gathering ranged $1500 - $2000 while it cost $4000 to extract a bucket full of Ogbono kernel. Manual fresh fruit kernel extraction must involve very sharp knives; cutlasses etc to get cotyledons that are in-tight to attract market. It also goes with knife accidents that can disfigure or chop-off human fingers. Thus, costly labour/ mandays and yet less than 10% of the market value of a bucket of Ogbono kernel.

RESULTS AND DISCUSSIONS

Table 1, shows the varied tree spacing did not vary with kernel yields but every other parameter varied. Significant (P< 0.05) variations was observed across tree year of establishment, range for heights canopy, stem diameters, number of branches, number of fruits, and the per annum pension. The fruit proceeds from 1984 orchard was reportedly used in the establishment on 1994 orchard translating to 10 yr interval. Gestation period was at 7 – 10 years (Harris,1996). Height was highest at 19 – 22 metres on the 1984 orchard establishment. Vihotogbe, (2016) reported a range of 10 – 50 metres upon tree maturation. Chinaka and Obiefuna (1999) reported a gestation range of 15 – 20 years at about 30 meter high and stem diameter of 1.0 meters. The orchard established in 1984 measured 0.8 – 0.9 meters girths.

Table 2, shows the range of number of fruits in a custard starch bucket(4200ml), their corresponding number of cotyledons/kernels and also their corresponding weights in grammes in the market standard tomato cup(210ml) measure which did not show any significant (P< 0.05) difference. But there was for the total number of fruits per tree, their corresponding cups and bucket measures of kernels and market or monetary values as well as their mandays cost of picking and kernel extractions and the net profits. The oldest orchard of 1984 recorded the highest in fruit number at 4800 – 5700 fruit per tree with cups of kernel yields at 87- 103; translating to a range of 95,700 – 113,300 with 68,700 – 81,380 net profits. A 12-year old trees have yielded 1060 fruits, Tchoundjeu (1998). With improved agricultural technology, topping and budding can make a tree mature for economic yield at 5- 7 years (Chinaka and Obiefuna,1999). Just a tree stand from the middle year orchard of 1994, with 2900 – 3800 fruits and kernel sales net profit range of 57,000 – 66,000 is three times the monthly pension alert (17,000) of level-6 retired NIHORT staff and about twice the current minimum wage. The present minimum wage in Nigeria as approved by Civil Service Commission (2011) is thirty thousand (30000) naira. Yet, many private schools, circular and sacred organizations still pay lower killer wages to their numerous employees. Ten stands of such tree on a homestead or farm will give a net profit range,570,000 – 660,000. Which is more than 50% of the total annual pension alert of 1,044.000 for a level-13 retired NIHORT staff.

RECOMMENDATIONS

The take- away message of this work in this era of low Gross domestic product (GDPs) is that for the unsaturated (supply deficit) local and international market chains of kernels, there is now a clarion call on all private, public, circular and sacred employees to invest while in service on Ogbono tree as support for envisaged retirement benefits. Sometimes, these benefits due to analogue pension model still operational in the federating States do not come until a retiree dies. For the retired, please plant budded or progressively topped Ogbono seedling for early fruiting.

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Table 1: Growth and yield parameters, cost of labour and monthly pensions as it relates age distribution and marketing of ogbono (*Irvingia gabonensis* var wombolo) tree kernels as a pre and post retirement benefit support in Okigwe South Eastern Nigeria

ishm	Spacing (m)	Range of Heights (m)	Range of Canopy Spread Diameter (m)	Range of Stem Diameter (cm)	Range of Number Of Branches (7cm-12cm)	Range of Fruits per Tree Std.	Working Mean of Fruits Per Tree Std. =100	Range of Total Fruits Number Per Tree Std.	Range of Mandays Cost Feb-May 2023 (₦)	Range of Mandays Per 1000 Fruits Gathering	Cost of Mandays Per bucket Kernel Extracted Feb-May 2023 (₦)	Range For level 6 -13 staff monthly Pension (₦)	Range Per Annum For Level 6 -13 Retiree Pension (₦)
	10 x 10	19 -22	12 – 16	80 – 90	48 – 57	110-140	100	4200 - 5700	1,500 – 2,000	4.8 -5.7	40000	17,000 To 87,000	204,000 To 1,044,000
	9 x 9	12 –16	8.5 – 9.5	35 – 45	38 – 46	95 – 115	100	2900 – 3800	1,500 – 2,000	2.9 – 3.8	40000	17,000 To 87,000	204,000 To 1,044,000
	10 x10	8 – 11	4.5 -5.5	22 – 18	18 – 27	80-110	100	1800 – 2700	1,500 – 2,000	1.8 – 2.7	40000	17,000 To 87,000	204,000 To 1,044,000
	7 x 7	8 – 12	6 -8	20 – 27	12 – 21	75 -95	100	1200 – 2100	1,500 – 2,000	1.2 – 2.1	40000	17,000 To 87,000	204,000 To 1,044,000
5%)	Ns	2.5	4.5	15.0	6.0	12.0	Ns	250.0	500	1.0	Ns	13,000	130,000

Table 2: Kernel yields, cost of labour, geoss & net profits and pensions comparison as it relates age distribution and marketing of ogbono (*Irvingia gabonensis* var wombolo) tree kernels as a pre and post retirement benefit support in Okigwe South Eastern Nigeria.

ESTAB. YEAR	Spacing	Range of Fruits no. In one bucket Measure (paint=4200ml) Custard starch bucket	Range of cotyledon /kernel In one cup measure (cup=210ml) Tomato cup	Range of kernel weights In one cup measure (g)	Range of Prices Per cup measure Of cotyledon /kernel Mar-Aug. (₦)	Number Of tomato cup Measure Equivalent To a custard bucket Measure	Number Of buckets Measure Equivalent To 100kg Bag of Cotyledon /kernel	Range of total number Of Fruit Yield per Tree stand of Ogbono	Range Of Per tree Stand total fruit yield In bucket Measure	Range Of per Tree Stand Total kernel Yield In cup Measure (cups)	Ranges Equivalent of total Kernel Cup measure Yields in Custard bucket Measures . .i.e. (yields /20cups)	Gross Profit Using Lower Price Range (₦1100) For Total kernel Yields In cups per tree stand (₦)	Ranges Of Cost of Mandays Per Bucket Of Extracted Kernels ₦ 4000 x bucket of kernel (₦)	Range Of Mandays Cost per 1000 friuts Gathering (₦ 2000 per 1000 fruit Gather (₦)	Net Profits ranges = Gross Profit Less Mandays for Fruit Gathering and Kernel Extraction. (₦)
1984	10x10	48 -54	48 –54	132 -144	1100 – 2000	20	30	4800 - 5700	87 – 103	87 –103	4.35— 5.15	95,700- 113,.300	17400 – 20,600	9600- 11,320	68,700- 81,380
1994	9x9	51 – 59	51 – 59	137 – 149	1100 - 20000	20	30	2900 - 3800	52 - 60	52 –60	2.6 -3.0	57,200- 66,000	10,400 – 12,000	5,800 -7,600	41,000- 46,400
2001	10x10	50 – 60	50 – 59	157 -164	1100 - 2000	20	30	1800 – 2700	33 -49	33 – 49	1.65-2.45	36,300 - 53,900	6,600 – 9,800	3,,600 - 5,400	26,100- 38,700
2005	7x7	48 – 62	48 – 62	159 – 167	1100 - 2000	20	30	1200 – 2100	22 – 38	22 – 38	1.1 – 1.9	24,200 - 41,800	4,400 – 7,600	2,400- 4,200	17,400- 30,000
LSD(5%) 10	Ns	Ns	Ns	34	600	Ns	Ns	250	15	15	1.0	20,000	3,000	2,000	11,000

ISOLATION AND IDENTIFICATION OF PATHOGEN CAUSING LEAF NECROSIS ON *Blighia sapida* K. D. KOEING

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ABSTRACT
Blighia sapida K.D. Koenig is a tropical fruit crop belonging to the family Sapindaceae. It is commonly called ackee apple. Ackee is a crop of high economic importance which bear fruits that can be eaten raw when ripe or processed in brine. All parts of the tree has medicinal uses traditionally. Disease is among the major constraints to the production of all crops. Leaf necrosis was observed on some ackee trees within the indigenous fruits orchard of National Horticultural Research Institute, Ibadan. The disease incidence was between 40-60 % on the leaves. Infected leaf samples from B. sapida were surface sterilized using 70% ethanol, and cultured on sterilised Potato Dextrose Agar (PDA) for 3-4 days at 28±2^{0}C. The isolated fungus was identified based on its cultural and microscopic morphological characteristics as Fusarium species. The pathogenicity test showed that the fungal isolate was pathogenic on leaves of B. sapida.
Keywords: *Ackee, Blighia Sapida K. D. Koenig, Fusarium spp, Leaf necrosis.*

INTRODUCTION
Ackee, *Blighia Sapida* K.D. Koenig is a tropical fruit belonging to the family *Sapindaceae.* It is a polygamous, evergreen tree that originated in the forests of West Africa. It has been introduced to the America, Australia, some Asian countries and Caribbean. In Caribbean it is now grown wildly and also cultivated. It is called Ishin in South Western part of Nigeria. The genus name of ackee, *Blighia* is from the name of Captain William Bligh who in 1793 conveyed the fruit from Jamaica to England (Areces-Berazain, 2019). Ackee fruit was first known for its poisonous phytochemicals- hypoglycin A and hypoglycin B, The ripe fruit flesh (aril) contains only low quantities of hypoglycins, while unripe fruits has very higher quantities which is poisonous for human consumption (Wray *et al*., 2020). The fruits are naturally splitted open when ripe; four big glossy black seeds are embedded in spongy, cream-colored buttery arils which are edible. The fruit is consumed raw when ripe in Nigeria and other West African countries. The fruit arils can also be curried and used to prepare soups, stews, and other dishes in Caribbean countries. In Jamaica, it is an ingredient of the national dish ackee saltfish. Ackee fruit arils is a a good source of nutrients including lipids; linoleic, palmitic, and stearic acids as the major fatty acids, with 55% being linoleic acid an essential fatty acid (Emanuel and Benkeblia, 2012). Fruit arils contain a high total protein content, vitamin C, riboflavin, carotene, niacin, dietary fiber, calcium, potassium, zinc, and iron,

Ackee is a crop of high economic importance when processed and canned in brine in Jamaica, Haiti, and Belize. Jamaica is the largest producer and exporter. Between 2006 and 2009 export of canned ackee in brine earns Jamaica approximately $35.4 million (Gordon, 2015). Various plant parts of *Blighia sapida* is used traditionally for medicinal purposes. There are many health benefits attributed to the ackee tree and its fruit. Pulverised bark with some spices is used for treatment of various ailments in different part of West African. The fruit seed and capsule are used to produce soap (Wray *et al*., 2020). Hypoglycin A found in ackee is of interest in pharmacology, because it is believed that when the level of toxicity on ackee is reduced, there is a possibility that it could be used for the treatment of diabetes to reduce blood sugar to low levels, (Latif and Luthra, 2017).

Pest and disease is among constraints to production of all crops. Among reported fungal pathogen of ackee are *Collectotrichum* species, *Phomopsis* sp. *Verticillium* spp. (Subbarao, 2020). Necrosis was observed on leaves of some ackee trees within the Indigenous fruits orchard of National Horticultural

Research Institute (NIHORT), Ibadan. The disease incidence was between 40-60 % on the leaves. The occurrence of the leaf infection on ackee trees was noticed for the first time since the orchard was established about thirteen years ago. The objectives of this work are therefore to i) isolate the leaf necrosis causing pathogen (ii) identify the pathogen for proper management of the infection within the orchard.

MATERIALS AND METHODS

Collection of infected leaves

Infected leaf samples were randomly collected in bags from the indigenous fruits orchard of National Horticultural Research Institute (NIHORT), Jericho Area, Ibadan; and taken to the Pathology Laboratory of the Institute for pathogen isolation and identification

Isolation

The leaves were washed under running tap water to remove dirt and dust particles. The lesions on the infected leaves were cut into small sizes of between 2-3mm. The samples were surface sterilized using 70% ethanol for 30 seconds. The ethanol on the sample was rinsed thrice with sterilized distilled water and the samples were blotted dry between Whatman No 1 Filter papers. The surface sterilized samples were cultured on solidified chloramphenicol amended Potato Dextrose Agar (PDA) in petri dishes. Samples were cultured on many PDA plates and incubated at 28 ± 2^0C for 3-5 days. Mycelium from the edge of each colony was transferred to a new PDA plate till pure cultures were obtained.

Identification of fungal isolate

The isolate was identified based on cultural and microscopic features of the fungal isolate and by comparing with identification book available Barnnet and Hunter (1972)

Pathogenicity Test

This test was carried out to confirm that the isolated fungus was actually the disease- causing agent on *B. sapida.* The isolate was tested for pathogenicity using Koch's postulate (1893). Apparently healthy leaves of *B. sapida* were surface sterilised and inoculated with conidial suspension of the fungal isolate. The pure culture of the isolated fungus was sub-cultured on PDA plates and incubated at 28 ± 2^0C for 7 days. Each plate was rinsed with 15 mls of sterilized distilled water to collect conidia. The spore (conidia) concentration was adjusted to 1 x 10^6 conidia /ml by using haemocytometer. A 100µL of spore suspension was carefully dropped on each leaf previously surface sterilized; with a sterilized glass rod spreader, the suspension was spread on the leaf. Control experiment was leaves inoculated with 100 µL of sterilized distilled water. The leaves were incubated in desiccators which had their bases lined with pieces of moistened cotton wool to provide a humid environment for the germination and growth of the conidia. Incidence of the initial leaf disease noticed on the *B. Sapida* leaves in the orchard was daily looked out for and recorded. The experiment was repeated twice

The inoculated leaves became infected and the fungal pathogen was re- isolated and identified again as the initial fungal isolate.

RESULTS AND DISCUSSION

Leaf lesions were observed on leaves of *B. sapida* in late August, 2023 in the Indigenous fruits orchard of NIHORT. The incidence of the infection was between 40-60% on *B. sapida* trees (Fig. 1). This is the first time such infection was observed on the trees after thirteen years of establishment. The lesion expanded into irregular necrotic lesions and the infected leaf part turns brown/grayish white with yellow marginal (Fig. 3). Leaf infection on the horticultural crops impedes yield potential of crops. The leaf is the photosynthetic part of a plant. Any reduction in the leaf surface area results in a reduction of the amount of photosynthetic products by the plant Pathogens causing infections on leaf can produce toxins that interferes with normal metabolism in the plant (Okorski *et al*., 2008; Gortari *et al*., 2018; Farooq et al., 2019; Yang and Luo, 2021; Huang and Luo, 2021). Fungi identification was based on colony and microscopic morphological characteristics.The isolated fungus grew from every sterilized infected sample on PDA plate (Fig. 4). The colony growth was initially white cottony, aerial mycelia growth with pinkish pigmentation on the reverse side on plate (Fig. 5). At older age, the mycelium turns pinkish both front and reversed side.

The fungus isolate has septate and hyaline hyphae. It produced curved macroconidia (which are hyaline, multicellular) and clusters of microconidia which are hyaline, unicellular, and ovoid to cylindrical in shape) (Fig 6). These descriptions are in accordance with the *Fusarium* species identification illustrated by Nelson *et al*. (1983). *Fusarium* identification is based mainly on distinctive characters of the shape of sizes of macro- and microconidia, presence or absence of clamydospores and colour pigmentation and colony appearance (Leshie and Summrell, 2006). The isolated fungus from the infected leaves of *B. sapida* was identified as *Fusarium* species. The healthy leave inoculated with the fungus produced similar symptoms as infected leaves from the orchard and same fungus was re-isolated from the inoculated leaves. Leaves from the control experiment did not show the disease infection symptom. The pathogenicity test confirm that the isolated fungus *Fusarium* species was pathogenicon leaf of *B. sapida*.

Fusarium spp have been identified as pathogens of high economic importance in production of crops like tomato, lettuce, cucumber, eggplant, pepper, onion, banana, avocardo e.t.c. (Edel-Hermann *et al*., 2019). *Verticillium dahlia* was reported by McMillan *et al.* (2002 and 2003) to be a fungal wilt pathogen on *B. sapida* spreading from infected tree to health trees causing leaf necrosis and branch death. Other reported fungal pathogens of *B. sapida* are *Colletotrichum gloeosporioides, Phyllosticta* sp, *Cladosporium oxysporum*, *Rhizopus stolonifer*, *Phoma* sp. (Farr *et a*l., 2008)

CONCLUSION

There is a large variation within the genus *Fusarium,* therefore there is a need for further molecular identification of the pathogen for proper management of the disease.

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Fig. 1: *Blighia sapida*

Fig. 2: A ripe fruit of *B. sapida*

Fig. 3: Infection on leaves of of *B. sapida*

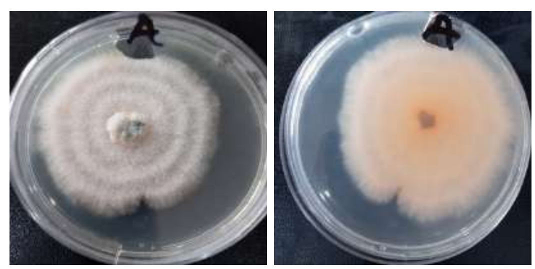

Fig 4: Cultures from many infected leaf samples growing similar isolates. **Fig. 5:** *Fusarium* spp isolated from infected leaf

Fig. 6: Photomicrograph of conidia of *Fusarium* spp isolated from infected leaf of *Blighia sapida*

VARIATION OF SOIL MOISTURE, HYDRAULIC CONDUCTIVITY, AND EFFICIENCIES OF SELECTED IRRIGATED FARMS IN OGUN STATE SOUTHWEST NIGERIA

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ABSTRACT

This study examined the changes in soil moisture, hydraulic conductivity, and irrigation efficiencies in six selected irrigation farms in Ogun State, Southwest Nigeria. Water melon was planted and soil moisture content was measured regularly during irrigation, and soil samples were collected to determine physical properties and hydraulic conductivity. The irrigation efficiency, water-use, conveyance, application, and overall efficiency, were also determined. The findings showed variations in bulk density, porosity, moisture content, and hydraulic conductivity among the farms. The efficiencies of conveyance, application, water use, and irrigation varied ratiosacross the farms. There was (R=0.75) correlations between water-use efficiency and moisture content, as well as (R=0.32) between yield and bulk density. Mokoloki and Ogun-Osun farms, which had larger land areas and higher water application, showed better efficiencies, increased moisture content, and improved crop performance. This study highlights the influence of water application and soil management practices on soil moisture, hydraulic conductivity, and irrigation efficiencies.

Keywords: *- Irrigation efficiency - Irrigation management - Soil compaction - Soil hydraulic properties - Soil moisture content*

INTRODUCTION

Irrigation has long been practiced to sustain crop production, but it can significantly alter the state of the soil. Irrigation is critical for sustaining agricultural production in areas with uneven rainfall. In Nigeria, only about 1% of cultivated land is irrigated, despite irrigation's potential to improve yields and food security (Anyanwu *et al*., 2010). Continuous irrigation alters soil properties including moisture content, porosity, bulk density, and hydraulic conductivity, with implications for agricultural sustainability (Kami, 2017). Understanding how intensive irrigation influences these parameters over the long term provides insights into appropriate soil and water management practices. Previously fertile lands, suitable for agriculture and grazing, have become barren wastelands owing to poor management practices. Unless we take heed of our current practices, we risk repeating these mistakes and follow the same path of destruction (Lal, R., 2015). This study investigated variations in soil moisture content, hydraulic conductivity, and irrigation efficiencies on six irrigated farms in Ogun State, southwest Nigeria. The farms studied were Asero, Odeda, Osiele, Ogun-Osun, Mokoloki, and Oyan, all relying on pressurized sprinkler irrigation. Soil samples were collected to measure bulk density, porosity, gravimetric moisture content, and particle size distribution. Hydraulic conductivity was determined using a constant head permeameter. Irrigation efficiencies were calculated for each farm based on water volumes applied versus stored in the crop root zone. This empirical study revealed how intensive irrigation alters soil physical properties and water dynamics in Nigeria's irrigated areas. The findings have important implications for maintaining agricultural productivity and soil quality while promoting sustainable water management tailored to local conditions. As irrigation expands in Nigeria but research remains limited, this study provides needed evidence on irrigation's long-term impacts on soils to guide appropriate management practices.

METHODOLOGY

Study Area and Experimental Design

The study was conducted on six irrigated farms in Ogun State, southwest Nigeria: Asero, Odeda, Osiele, Ogun-Osun, Mokoloki, and Oyan. The farms relied on pressurized sprinkler irrigation and had areas ranging from 1.85 to 5.85 ha. Field experiments were conducted using a split-plot design with irrigation efficiencies as the main plot and other management techniques as the sub-plot with water melon as the crop.

Soil samples were collected from each farm at depths of 0-8 cm using a cylindrical metal core auger. Samples were analyzed in the laboratory to determine particle size distribution, moisture content, bulk density, and total porosity. Particle size analysis was conducted using the hydrometer method. Gravimetric moisture content was measured by oven drying samples at 105°C to a constant weight. Bulk density was determined using the core method and total porosity was calculated.

Saturated hydraulic conductivity (Ks) was determined for soil samples from each farm using a constant head permeameter. Darcy's Law was applied to calculate Ks based on steady-state flow rate through the soil, cross-sectional area, and hydraulic gradient.

The water conveyance, application, storage, and overall irrigation efficiencies were calculated for each farm based on water volumes. Conveyance efficiency was the fraction of water delivered to the farm inlet versus diverted from the source. Application efficiency was the fraction of water stored in the crop root zone versus delivered to the farm. Storage efficiency was the fraction of water stored in the root zone versus the zone's capacity at field capacity. Overall efficiency combined conveyance and application efficiencies. Some empirical expressions used to evaluate the irrigation efficiency: (Pereira *et.al*., 2002)

1. Application Efficiency (Ea) Ea = (Water stored in root zone / Water delivered to field) x 100
2. Storage Efficiency (Es) Es = (Water stored in root zone / Water precipitated by system) x 100
3. Consumptive Use Efficiency (Ec) Ec = (Crop evapotranspiration / Water delivered to field) x 100
4. Irrigation Sagacity (Is) Is = Crop yield per unit irrigation water applied

The data on soil properties and irrigation efficiencies were statistically analyzed using analysis of variance (ANOVA) and means separated using Duncan's Multiple Range Test at $p \leq 0.05$. Correlations between variables were evaluated using the Pearson coefficient.

RESULTS AND DISCUSSION

Results

Bulk density increased while total porosity decreased over the plant growing period at all farms, indicating soil compaction. For instance, bulk density ranged from 0.77 to 1.08 g/cm3 at Asero and 0.94 to 1.38 g/cm3 at Mokoloki. Significant variation in gravimetric moisture content was found between farms and over time, ranging from 3.74% (Oyan) to 32.51% (Odeda). Volumetric moisture content followed similar trends. Hydraulic conductivity also varied significantly, from 13.80 cm/hr (Oyan) to 70.20 cm/hr (Asero).

Irrigation efficiencies differed between farms based on water management. Conveyance efficiency ranged from 50.90% to 75.50%, application efficiency from 20% to 35%, and overall efficiency from 61% to 79%. Mokoloki and Ogun-Osun had the highest efficiencies and yields, which also had the largest land area and water application ratios.

Correlation analysis found that water-use efficiency increased with higher gravimetric moisture content after 2 weeks (R=0.33) and 4 weeks (R=0.52). Hydraulic conductivity was positively correlated with total porosity (R=0.58).

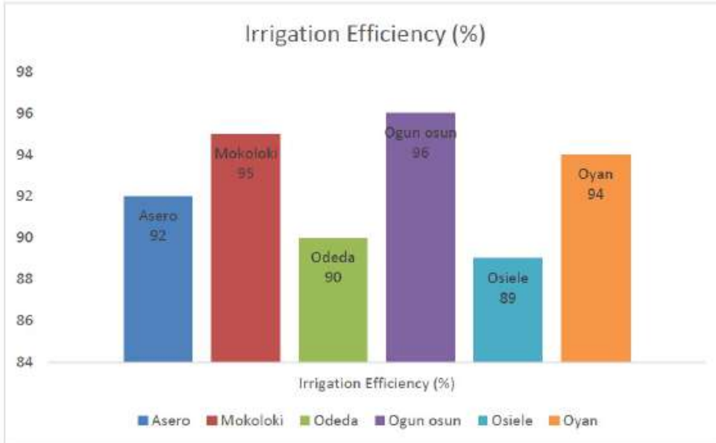

Figure 1: Irrigation Efficiency in Farm Locations

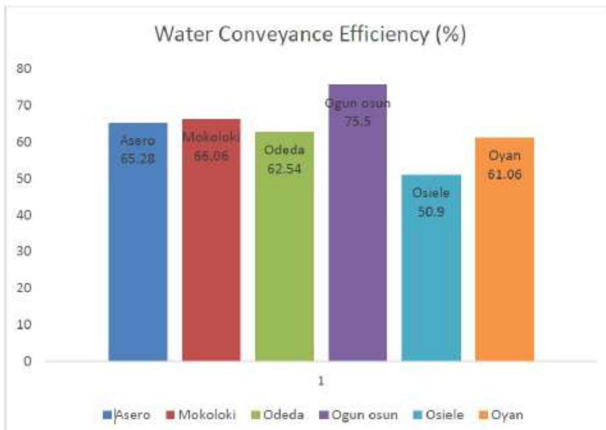

Figure 2: Water Conveyance Efficiency in Farm Locations

DISCUSSION

The reduction in porosity and increase in bulk density over time can be attributed to continuous wetting and mechanical compaction from irrigation. This likely impeded water flow and root growth. The differences in moisture content highlight spatial variability in water availability and plant uptake across farms. The wide range in saturated hydraulic conductivity indicates the soils had distinct transmission capacities shaped by texture, structure, and management. Mokoloki and Ogun-Osun's higher efficiencies and yields can be credited to sufficient water application enabled by larger water access. This maintained soil moisture at 32% and 31% for optimal plant growth. Correlations between moisture content, porosity, and yield further underscore the importance of available water and connected pore networks for crop productivity in irrigated systems.

This study reveals how intensive irrigation alters soil physical properties and water retention over successive cropping cycles. Managing irrigation to improve moisture uniformity and limit compaction is critical for sustainability in these systems. The findings provide practical evidence to guide irrigation decisions tailored to local soils and better leverage Nigeria's water resources.

CONCLUSION

This study investigated variations in soil physical properties and irrigation efficiencies on six farms water-melon was grown under intensive sprinkler irrigation in Ogun State, Nigeria. Key findings were:

- Bulk density increased while total porosity decreased over time on all farms, indicating progressive soil compaction.
- Gravimetric and volumetric moisture content varied significantly between locations and over the cropping cycle, highlighting spatial and temporal variability in soil water availability.
- Saturated hydraulic conductivity ranged widely from 13.80 to 70.20 cm/hr, reflecting differences in soil transmission capacities.
- Farms with larger irrigation water access and land area had higher efficiencies, stored moisture, and yields.
- Soil moisture content and porosity were positively correlated with crop yield and water use efficiency.

Continuous intensive irrigation was found to compact soil over successive cropping cycles, progressively reducing porosity and hydraulic conductivity. Managing irrigation to improve moisture uniformity and limit compaction is critical for sustainability. The results provide practical evidence to guide context-specific irrigation management in Nigeria tailored to local soils and cropping systems. We therefore recommend that irrigation practices should be careful carried out based on determined engineering accessmemts by a soil and water engineer.

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INFLUENCE OF PROCESSING METHODS ON GERMINATION AND SEEDLING VIGOUR OF PEPPER (*Capsicum annuum* L.) SEEDS

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ABSTRACT

Conservation of pepper seeds for utilization in its improved state is a major challenge. The objective of this study was to investigate the effects of two processing methods on the germination and seedling vigour of pepper seeds to know the best processing method. Ten accessions of freshly harvested pepper fruits were processed using two methods: (i) Extraction of seeds directly after harvesting and dried at 18±2^{0}C and 20±5% relative humidity and (ii) Extraction of seeds from sun-dried fruits. The experiment was arranged in 10 x 2 factorial in a completely randomized design (CRD) in three replications using one hundred seeds per sample. The samples were evaluated for standard germination and germination index test. Germination of pepper seeds dried under controlled environment was significantly higher (71.27%) compared with those extracted from sun-dried fruits (58.27%), which indicated that pepper seeds dried under sun may result in poor quality due to uncontrolled temperature and ultra violet radiations from the sun.

Keywords: *Pepper, processing, conservation, germination, emergence.*

INTRODUCTION

Pepper (*Capsicum annuum* L.) is an important fruit vegetable that belongs to the family Solanaceae. It forms a significant part of human diet in many parts of the world. Its' fruits are consumed fresh, cooked or in processed forms and fresh peppers are often used in salads. The fruits can also be processed into various fermented products, powders, sauces, and curry pastes. However, conservation of pepper seeds for utilization in its improved state is a major challenge. The germination and vigour of pepper seeds are two important physiological attributes of its quality. Germination capacity is a measure of maximum germination potential of a seed batch under optimum conditions. The standard germination test, also known as the "warm test", estimates germination under ideal growing conditions (Munamava *et al.,* 2004). The concept of seed vigour on the other hand, was developed on the basis of the observation that two seed batches or genotypes with similar viability would perform differently under stressful field conditions (Delouche and Baskin, 1973). Hence, vigour test have therefore been proven to be more useful as predictors of seed quality than the use of germination test.

Seed processing is an important aspect of gene-bank operations which involves cleaning seed samples, drying to optimum moisture levels, testing their germination and packaging in appropriate containers for conservation and distribution. Among these seed processing operations, seed drying is very crucial. The objective of this study was to investigate the effects of two processing methods on the germination and seedling vigour of different accessions of pepper seeds.

MATERIALS AND METHODS

The seeds of ten accessions of pepper were sourced from the seed gene bank of National Centre for Genetic Resources and Biotechnology (NACGRAB), Ibadan which were regenerated at the experimental field of the Centre during the late growing seasons of 2021. Fruits from the accessions were harvested at physiological maturity stage and processed using two methods as (i) Extraction of seeds directly after harvesting and dried in the drying room at 18±2^{0}C and 20±5% relative humidity and (ii) Extraction of seeds from harvested and sun-dried fruits. The materials were dried to about 10% moisture content and thereafter subjected to germination test. The germination test was conducted at the seed testing laboratory of NACGRAB in January, 2022. The experiment was arranged in 10 x 2 factorial using completely randomized design (CRD) in three replications. The two factors were ten accessions of pepper and two processing methods. The test was assayed by placing 100 seeds per sample in germination plastic containers lined with four layers of tissue paper and moistened with 15ml of distilled water. The containers were covered and placed in a germinating chamber at 25 ± 2°C. The seeds were kept moist every day for seven days. Germination percentages were calculated by expressing the number of seedlings in a replicate that emerged 7 days after planting as a percentage of the number of seeds planted. Germination Index (GI) was calculated by taking the germination counts at 5, 7 and 9 days after planting and the data were substituted into the formulae:

$$\text{Germination percent} = \frac{\text{Number of emerged seedling 7th day after planting}}{\text{Number of seeds planted}} \times 100$$

Germination Index (GI) was calculated by taking the germination counts at 5, 7 and 9 days after planting and the data were substituted into the formulae:

$$GI = \sum (Gt/Dt)$$

where Gt= number of germinated seeds on day t and Dt= time corresponding to Gt in days.

Data obtained were subjected to analysis of variance (ANOVA), using Generalized Linear Model Procedure (PROC GLM) of Statistical Analysis System (SAS, 1990) package. Treatment means were were separated by use of the least significant difference (LSD) at 0.05 level of probability.

RESULTS AND DISCUSSION

The results of analysis of variance (ANOVA) revealed that pepper accessions and processing methods interactive effects were significant ($P<0.01$) on germination percentage and germination index

Table 1: Mean squares, means, coefficient of determination (R^2) and coefficient of variation (CV) from the analysis of variance for germination (G%) and germination index (GI) of pepper seeds

Sources of Variation	DF	G%	GI
Replication	2	162.87ns	0.26ns
Accession (ACC)	9	334.82**	4.35**
Processing Method (PRM)	1	2535.00**	0.58ns
ACC*PRM	9	727.00**	1.98**
Error	38	74.09	0.26
Total	59	258.18	1.15
R^2		0.82	0.85
CV		13.29	8.58
Mean		64.77	5.94

*, **, Significant at probability level of 0.05 and 0.01, respectively; ns = not significant

index of pepper seeds (Table 1). This suggests that genetic differences exist among pepper cultivars for seed quality depending on the processing method used after harvest. Accession NGB01848 had the highest germination (84.33%), with the lowest germination index of about 5 days.

Table 2: Germination and Germination index of pepper seeds across genotypes and processing methods

Factors	Germination (G%)	Germination Index (GI)
Accession		
NGB01848	80.33a	5.45edf
NGB02621	70.00b	6.95b
NGB01864	65.67bc	5.37ef
NGB01858	65.67bc	7.63a
NGB02641	64.33bc	5.97dc
NGB00564	64.00bc	5.12f
NGB00701	64.00bc	5.94edc
NGB00620	63.67bc	5.33f
NGB01852	59.33dc	5.09f
NGB00704	50.67d	6.49bc
LSD	**10.06**	**0.60**
Processing method		
Controlled-drying	71.27a	6.03a
	58.27b	5.84a
Sun-dried fruits		
LSD	**4.50**	**0.27**

Means with different letters within the column of the same factor are significantly different at P=0.05

Accession NGB 02621 also had significantly lower germination rate (70.00%). However, it was less vigorous compared to NGB01848 with germination index of about of about 7 days. Accession NGB00704 had significantly lowest germination of 50.67% with germination index of 6 days (Table 2). Seed processing method significantly influenced the germination rate of pepper seeds. Although, the FAO/IPGRI (1994) gene-bank standard recommends the use of 15±5% relative humidity and 15±5^{o} C temperature for drying seeds; seeds of pepper freshly extracted and dried under controlled environment (18±2^{0}C temperature and 20±5% relative humidity) had significantly higher germination rate (71.27%) compared with pepper seeds extracted from sun-dried fruits with germination rate of 58.27% (Table 2). This was in line with the findings of Ibrahim, *et. al.* (2017) who reported that air-drying pepper seeds had significantly higher germination percentage and germination index compared with pepper seeds dried under sun.

CONCLUSION

The study helps to show that processing methods of pepper seeds plays an integral role in maintaining its seed quality and it was therefore suggested that pepper seeds at physiological maturity should be carefully extracted during processing and dried in a controlled temperature and relative humidity as recommended by FAO/IPGRI (1994) gene-bank standards. The study further revealed that dried under the sun may result to poor quality seeds due to the hot temperature and ultra violet radiations from the sun.

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ORCHARD ESTABLISHMENT OF AVOCADO (*Persea americana* L.)

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ABSTRACT.
Establishment of orchard were done in NIHORT, each plant was given a space of 8m x 8m, they were prepared by hand slashing and tractor about 3 months prior to planting. At each planting site poultry manure are dug in to a depth of 300 mm over a one square meter area before planting the seedlings. Control of weed were used by herbicide (CD erases), also ring weeding before fertilizer application, were given a spaced of 50cm gap before applying NPK 20.20.20 fertilizer application were basal (45gram for each plant). The application dose and proportion of manures and fertilizers are generally based on the soil fertility, tree age, growth and yield. Commence feeding of young trees after one year of growth, using a balanced fertilizer, four times yearly. Older trees benefit from feeding with nitrogenous fertilizer applied in late winter and early summer.

INTRODUCTION

Avocado (*Persea americana* L.) belongs to the family Lauraceae which is composed of 50 species. It is an evergreen tree found in tropical and subtropical areas. Cultivated species of avocado are native to Mexico, Central America and South America. There are three horticultural races of avocado that reflect the centre of origin i.e. the West Indian race native to West Indies (Central America and Northern part of South America); Guatemelan race; and the Mexican race. It is an ancient fruit and constitutes part of the diet in the countries of origin. The fruit spread to North America in the 18th century and the old world in the late 19th century. Avocado commonly referred to as the African Pear (*Dacryodes edulis*) is a well-known plant in West Africa. The fruits are edible, and the bark, leaves, stem and roots are used for local medicine against diseases (Neuwinger, 2000; Ji rovetz *et al.* 2003; Annabelle *et al.* 2004). In Nigeria the fruits are gathered for household use or for sale in local markets. Despite its increasing popularity as one of the most nutritious plants in the fruits family due to the rich presence of essential vitamins A, B and E in the fruits and are high demand in Europe, the plant species has remained largely underdeveloped in the country. As a matter of fact, the nation has continued to witness reduction on its non-timber forest products availability and utilisation. According to World Wildlife Foundation, the rate of deforestation in Nigeria has been put at 350,000 ha per annum (NEST, 1991). This has left in its wake the loss of endemic forest resources in different ecological zones as a result of destructive land use patterns and conversion of forest lands to other uses. The Federal Environmental Protection Agency reported that a total of 5,981 higher plants were identified in Nigeria. Out of these, 0.14% are threatened and 0.22% are endangered. Between 1980 –1992, a total of 43 – 48% of the nation's forest ecosystem are lost through human activities and natural ecological disasters such as erosion, flooding and desertification (FAO, 2000).

METHODOLOGY

Orchard establishment were are located to National Horticultural Research Institute field latitude and longitude N 07º 24′ 41.6″ , E 003º 57′ 35.7″ and the avocado fruits were gotten from three locations which is southeast, southwest and southsouth potted in nursery garden with different pot accessions at Institute , after 3 to 4 weeks or more of germinations depending on the fruit seed, emergence data was collected for the germination period and were transplanted at the field which were mapped 40 x 56, and extended to second field were also mapped out 16 x 64 which the seedlings were transplanted. Establishment of orchard each plant was given a space of 8m x 8m, they were prepared by hand slashing and tractor about 3 months prior to planting. At each planting site poultry manure are dug in to a depth of 300 mm over a one square meter area before planting the seedlings. Control of weed were used by herbicide (CD erases),also ring weeding before fertilizer application, were given a spaced of 50cm gap before applying NPK 20.20.20 fertilizer application were basal (45gram for each plant) for each.

Site selection

The selection of a suitable site is of the utmost importance. Avocados are extremely susceptible to the root rot fungus *Phytophthora cinnamomi*. No avocado rootstock is completely resistant to this disease. Surface and subsoil drainage must be excellent. Sloping ground with a porous top soil structure may be unsuitable if clay bands or hard pans prevent the free flow of water through the soil. Checking the profile with soil pits to a depth of about 2 metres is a pre-requisite. Natural vegetation can indicate localized soak ages and high water tables.

Pest management

Pest management practices, there are different and more varieties of pests found in Nigeria avocado orchards. Some common types of pests include loopers, moths, thrips, persea mites, gophers, and ground squirrels. In Nigeria, avocado orchards are under good biological control due to beneficial insects that prey on parasitize harmful pests like the omnivorous loopers and amorbia moth. Thrips and persea mite control methods include application of insecticides such as Abamectin (Agri-Mek) mixed with 1% narrow range 415 oil (NR415) once per year in April beginning in establishment year 3 when trees reach bearing age.

Weed Management

The weed management practice commonly used in the area for conventional avocado. Weeds can harbor insects and pests, making it difficult for rodent control. Also, too much weed interferes with efficient application of irrigation water to the avocado trees. The two typical weed management practices include herbicide applications and weed whipping. Herbicide is sprayed three times per year during February, May, and August. Each herbicide application consists of about 10 ounces of generic glyphosate and water mixture per acre.

CONCLUSION

The application dose and proportion of manures and fertilizers are generally based on the soil fertility, tree age, growth and yield. Commence feeding of young trees after one year of growth, using a balanced fertilizer, four times yearly. Older trees benefit from feeding with nitrogenous fertilizer applied in late winter and early summer. However, farmers should generally avoid establishing an avocado orchard in fields with poor drainage and high salinity. Additionally, avocados should be planted in fields with a maximum slope of 15% and areas protected from strong winds. It is generally recommended in colder areas to plant the young trees at the start of fall, while in warmer regions, the mid-end of spring is the most suitable period. This way, the plants will have time to establish and adjust before the extreme temperatures.

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ASSESSMENT OF COFFEE CONSUMPTION IN OGUN STATE, NIGERIA

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ABSTRACT
Obafemi Owode and Sagamu Local Government Areas were purposively selected to asses the status of coffee consumption among farmers in Ogun state from 2019-2021. Simple random sampling technique was used to obtain data, from 138 farmers, using structured questionnaire. Data were analysed using descriptive statistics, composite score analysis and linear regression. Majority of the farmers (77 %) were between 31 and 60 years in age with mean of 48±11 years, 88% were males, mean household and farm sizes were 7±4 persons and 1.4±1.3 ha respectively. Fortnightly, 42 % farmers consumed coffee; order of consumption in 2019 and 2020 was low level > intermediate > high levels while it was low level > high > intermediate in 2021. Determinants of coffee consumption include: price, taste, household acceptability and monthly expenditure. This study showed that coffee consumption in Ogun state is low. Companies producing coffee could improve on the taste by adding flavours in order to enhance consumption.
***Keywords**: Coffee, consumption, low level, Ogun state, taste*

INTRODUCTION

Coffee is mainly an agricultural export produce that is vital to the economies of the nations that produce it. About fifty nations in Africa, Latin America, and Asia depend heavily on the coffee industry for their economic prosperity (Dinesh *et al*. 2015); it provides job for sizable section of the populace (Krishnan, 2017); it is the second-most popular drink after water (Iscaro, 2014) that is consumed because of its great taste, aroma and nutritional value (Gebeyehu and Bilika, 2015). Coffee plant is categorized among medicinal plants (Eva *et al*. 2016). Poor farming techniques, lack of mechanization, climate change, poor funding and resources inhibit coffee productivity in Nigeria (PwC, 2017; Mohammed *et al*. 2013, and Ayoola *et al*. 2012). There is the need to assess the current status of coffee consumption among farmers in Ogun state and to sensitize them on the need to improve on the consumption of coffee, hence the justification for this study.

Objectives of the study

i) To profile socio economic characteristics of coffee consumers in the study area;
ii) To determine the level of consumption;
iii) To assess the factors influencing the level of coffee consumption in the study area.

METHODOLOGY

The project was carried out among coffee farmers in Ogun state. Obafemi Owode and Sagamu Local Government Areas (LGAs) were purposively selected in the state because of the high concentration of coffee farmers in these areas. Simple random sampling technique was used to collect data from a total of 138 farmers with the aid of structured questionnaire and the data obtained were analysed using descriptive statistics, composite score analysis, budgetary analysis and linear regression.

Composite score analysis

This was used to measure the level of coffee consumption categorised into 3 namely:

(i) High category = between highest coffee consumption (kg) to (mean + S.D) points
(ii) Medium (intermediate) category = between upper and lower categories
(iii) Low category = between (mean – S.D) points to 0 point.

RESULTS AND DISCUSSION

Demographic characteristics of coffee farmers in Ogun state

The farmers interviewed were 51 % and 49 % from Obafemi Owode and Sagamu Local Government Area (LGAs) respectively (Table 1). Majority (77 %) of the farmers were between 31 and 60 years in age with mean of 48 years which implies that most of the coffee farmers were in their active age to be agriculturally productive; majority (88 %) of them were male. This is in line with the findings of Kangile *et al.,* (2022) who reported gender disparity in farmers in Tanzania. The mean household size, as shown in Table 1, was 7 persons with 46 % of the households having 6-10 membership. Majority of the farmers in the study areas were small scale holders with a mean of 1.4 ha; most (94.2 %) of them were married and 30 % had secondary level of education. Majority (90 %) had farming as their main occupation and most (87 %) of them resided in rural areas, a situation that could make regular farm visits possible

In table 2, majority (90%) of the farmers did not process coffee. Coffee was consumed fortnightly by 42% of the respondents (Table 2). Coffee processors (85.7%) operated on a small scale. The high category of coffee consumption in 2019 was 5760 to 1341, intermediate 1340 to 579 and low 578 to 0. The values were 4250 to 1093, 1092 to 468 and 467 to 0 for high, intermediate and low levels of consumption respectively in 2020.

Table 1: Socio economic characteristics of coffee farmers in Ogun state

Variable	Frequency	%
Local government Areas		
Obafemi owode	70	50.7
Sagamu	68	49.3
Age of farmer		
0-30	6	4.4
31-60	106	76.8
61-max	26	18.8
Mean	48±11	
Gender		
Male	122	88.4
Female	16	11.6
Household size		
1-5	58	42.0
6-10	64	46.4
10 / max	16	11.6
Mean	7±4	
Farm size		
0-2	130	94.2
2.1-5	6	4.3
5.1/max	2	1.5
Mean	1.4±1.3	
Marital status		
Single	6	4.3
Married	130	94.2
Widow	2	1.5
Educational Level		
No formal education	30	21.8
Primary	26	18.8
Secondary	42	30.4
Tertiary	40	29.0
Main occupation		
Farming	124	89.8

Trading	12	8.7
Civil Service	2	1.5
Place of residence		
Rural	120	87.0
Urban	18	13.0

Source: Field survey, 2022

Table 2: Processing and Consumption of Coffee

Variable	Frequency	%
Do you process Coffee		
No	124	89.9
Yes	14	10.1
Scale of processing firm		
Small	12	85.7
Medium	2	14.3
Consume Coffee		
No	100	72.5
Yes	38	27.5
How regular		
Everyday	4	10.5
Weekly	10	26.3
Two weeks	16	42.1
Monthly	8	21.1

Source: Field Survey, 2022

In 2021, the high category was 3500 to 827, intermediate 826 to 340 and low 339 to 0 (Table 3). In 2019 there were more farmers in the low level of consumption compared to intermediate and high levels. Similar pattern was observed in 2020. However, in 2021, consumption was in the order of low category > high > intermediate as shown in Table 3.

Table 3: Levels of Coffee consumption by farmers in Ogun state from 2019 – 2021

Year	Low	Intermediate	High
2019	54 (78.3)	3 (4.4%)	12 (17.4%)
2020	54 (78.3)	12 (17.4%)	3 (4.4%)
2021	55 (79.7)	3 (4.4%)	11 (15.9%)

Source: Field Survey, 2022

Factors influencing consumption of coffee in Ogun state

Table 4 presented the result of the linear regression model used to determine the factors influencing the consumption of coffee in Ogun state. The dependent variable is the amount of coffee consumed in kg and

9 explanatory variables were considered in the model. Five variables were statistically significant at various levels. These were price of coffee, taste, no budget on coffee, household acceptability and coffee monthly expenditure. The coefficient for the cost of coffee sachet is negative and significant at 1% as shown in Table 4. This means that as the price of coffee increases the amount consumed will reduce. This could be due to the fact that the respondents were not sufficiently aware of the health benefits of coffee, such that an increase in the price would make respondents to opt out for other substitutes like lipton tea, milo, bournvita (Batat, 2020). The coefficient for taste is positive and significant at 1%. This implies that the taste of coffee plays a great role in its consumption. In Table 4, the coefficient for no budget on coffee is positive and is significant at 10 %, which implies that although farmers do not budget for coffee yet they consume it. The coefficient for household acceptability is negative and significant at 5% among the respondents in the study areas. This is majorly dependent on mothers who prepare the meal for their household. When women don't like coffee the probability that their household will not like it is high. Thus, the quantity of coffee purchased and consumed would be low. The coefficient for coffee monthly expenditure is positive and significant at 1% such that an increase in monthly expenditure for coffee increases consumption.

Table 4: Factors influencing consumption of coffee in Ogun state from 2019 - 2021

Variable	Coefficient	Std.Error	T	P>|t|
Age of farmer	-2.8533	8.1688	-0.35	0.729
Gender	-59.1929	188.3845	-0.31	0.755
Marital status	-57.9863	205.1348	-0.28	0.779
Level of education	-14.0654	70.1206	-0.20	0.842
How much sold	-0.0101***	0.0025	-4.02	0.000
Taste	615.4811***	208.5226	2.95	0.005
No budget on coffee	435.0952*	249.2323	1.75	0.088
Household acceptability	-479.2206**	182.4382	3.62	0.012
Coffee monthly expenditure	0.3326***	0.0919	3.62	0.001
Constant	1355.573**	636.6382	2.13	0.039
R^2	0.6895			
Prob > F	0.0000			

Source: Field Survey, 2022

CONCLUSION

This study has shown a reduction in the consumption of coffee in Ogun state. Price of sachet of coffee, its taste, no budget for coffee, household acceptability and coffee monthly expenditure were determinant factors for coffee consumption among respondents in the study areas. Sensitization of farmers on the health benefits of coffee, improving on its taste and reduction in price could enhance its consumption in the study area.

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PERCEIVED CONSTRAINTS AFFECTING COFFEE PRODUCTION IN NIGERIA, A CASE STUDY OF EDO STATE

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ABSTRACT
The study examined the perceived constraints affecting coffee production in Nigeria, a case study of Edo State. Specifically, the study describes the socio-economic characteristics of the respondents; ascertained some coffee production technologies engaged in by the respondents, identified some constraining factors affecting coffee production, and determine coffee farmers' perception towards constraining factors affecting coffee production. Multistage random sampling techniques was used to select ninety (90) respondents for the study. Data was collected using a comprehensive questionnaire and analysis was done using means, frequencies percentages and Chi square. The result revealed that the average age of the respondents was 41.6years, male 61.1%, married 88.9%, no primary education 40%, farming as primary occupation 86.7%, family size (1-5) 86.7% and 91.1% got labour source from both personal and hired. The finding also revealed that 44% of the respondents' prune regularly, 70%, 64%, 73%, and 68%occationally practiced gapping up and use of improved varieties seedlings, control of pest and diseases, Timely harvesting and recommended spacing respectively. The constraining factors affecting coffee production are; Land tenure system (mean=1.58) ranked 1st, farmers'/herders clash and lack of technical know-how on coffee wet processing method(mean=1.57) ranked 2nd, price fluctuation and inadequate credit facilities (mean= 1.56) ranked 3rd pest and diseases (mean=1.55) ranked 4th. The chi-square analysis revealed a significant relationship between level of education(X=42.252), sources of labour (X=20.422), sources of capital(X=15.262) and constraining factors affecting coffee production. Farmers need training on some coffee production technologies like coffee rehabilitation technique.
Keywords*: Farmers, Constraints, Coffee, Production.*

INTRODUCTION

The origin of coffee farming has been traced to Ethiopia in Africa before its spread to other countries of the world (Williams, 2008, Ngussie and Dererse, 2007). Coffee belongs to the botanical family Rubiaceae, which has some 500 genera and over 6,000 species (Davis 2001). Most are tropical trees and shrubs that grow in the lower storey of forests. Other members of the family include gardenias and plants that yield quinine and other useful substances, but Coffee is by far the most important member of the family economically (Payel G *et al* 2014) Brazil is by far the largest grower and exporter of green coffee beans in the world followed by Vietnam, Colombia, Indonesia, Ethiopia and India – producing nearly 2.5 million tonnes of green coffee beans per year (Franca *et al* 2009). Although Coffee is grown and exported by more than 50 developing countries, it's mainly consumed in the industrialized countries namely United States of America, Finland, Sweden, Belgium and Japan among others (Agbongiarhuoyi *et al*., 2006; and Daviron and Ponte, 2005). The two most important species of cultivated coffees in Nigeria are Arabica coffee (highland coffee) and Robusta coffee (lowland coffee). In the international market, Arabica coffee is of the greatest economic importance but in Nigeria, Robusta coffee account for 94% while Arabica coffee accounts for only 4% of coffee export.

The increasing use of Robusta coffee in the preparation of instant (soluble) coffee is making it to gain ground on Arabica coffee in the international market (Williams, 1998). In the world market, Coffee plays a vital role in the balance of trade between developed and developing countries; being an important foreign exchange earner, contributing in varying degrees to the national income of the producing countries (Cambrony, 1992 as cited by Ayoola *et al* 2012.). Despite the importance of coffee products to nations economy, its production is faced with so many challenges Several factors and challenges have been attributed to the country's dwindling production level, majority of which have forced farmers to abandon coffee for other crops to make ends meet. Major factors contributing to the abandonment of coffee farms, include poor pricing and marketing channel, lack of training on good coffee farming practices and value chain for coffee, lack of government support in terms of funding, provision of inputs and land acquisition.

According to Gbenga Akinfenwa (2019), explained that most of the coffee plots are old and farmers have suspended major cultural practices on their farms. Other noticeable factors constraining coffee production are Transport problem, Land tenure system, Prolonged draught, Climate change, Soil erosion, Pests and diseases, Farmers/herders clash and Lack of technical know-how on wet processing method. All the aforementioned production constrains are being considered with the aim of determining ways of bringing coffee farming back to its lost glory Specifically, the objectives were to describe the socio-economic characteristics of coffee farmers; ascertained some coffee production technologies engaged in by farmers, identify some constraining factors affecting coffee production, and determine coffee farmers' perception towards constraining factors affecting coffee production. The hypothesis of the study was stated in null form; there is no significant relationship between socioeconomic characteristics of the respondents and the constraints to cashew production.

METHODOLOGY

The research work was carried in Edo State. Multi stage sampling procedure was used in selecting respondents for the study. The first stage involved purposive selection of three Local Governments Areas noted for coffee production. These are Owan East, Owan West and Uhunmwonde. The second stage involved purposive selection of one community per LGA where coffee is produced in large quantity. Lastly, thirty respondents were randomly selected in each community to make a total number of ninety respondents. A structured interview schedule was used for field data collection from coffee farmers in the study areas. Descriptive statistics and chi-square were used in data analysis. The variables were measured at 0.05 Level of probability. The variables of the study were measured as follows

Perceived Constraints to Coffee Production

The respondents were presented with a list of fourteen perceived constraints to coffee production. A three-point scale of 'Not a constraints', 'Minor constraints' and 'Major constraints with scores of 0,1 and 2 assigned respectively. The mean score for each perceived constraint was obtained and used to rank them in order of severity

RESULT AND DISCUSSION

The socioeconomic characteristics of the respondents

The result of socioeconomic characteristics shown in Table 1 revealed that 67.7 percent of the respondents are between 31to 50 years of age with mean age of 41 years. This indicates that the respondents are still in their productive age. The result of age distribution of farmers contradicted the findings of Ayoola *et al* (2012) that the majority of sampled coffee farmers was above 50 years old The result also revealed that 61.1 percent of the respondents were male while 38.9 percent are female. The male dominance in coffee production may be as a result of having access to land through inheritance which their female counterpart did not. Also, greater percentage (88.9%) of the respondents are married, this may be because coffee production needs more hands during maintenance and processing. Sixty percent of the respondents had primary school certificate and above. It indicates that most of coffee farmers in the study areas are literate. The table also indicates that majority (91.1%) used both family and hired labour in their farm. This could be as result of tedious nature of coffee work that required more hands

Table1: Distribution of the respondents based on Socioeconomic characteristics n=90

Variables	Frequency	Percentage	Mean
Age			
Less than or equal to 30	11	12.2	
31- 40	27	30.0	41.6 yrs
41-50	33	36.7	
51-60	12	13.7	
61 and above	7	7.8	
Sex			
Male	55	61.1	
Female	35	38.9	
Marital status			
Single	5	5.6	
Married	80	88.9	
Divorced	4	4.4	
Widowed	1	1.1	
Religion			
Christianity	63	70.0	
Islam	24	26.7	
Traditional	3	3.3	
Level of Education			
No formal education	36	40.0	
Primary	30	33.3	
Secondary	20	22.2	
Tertiary	4	4.4	
Primary Occupation			
Farming	78	86.7	
Business	2	2.2	
Civil Servant	10	11.1	
Family size			
1-5	66	73.3	
6-10	19	21.1	
10 and above	5	5.6	
Source of labour			
Family	3	3.3	
Hired	5	5.6	
Both	82	91.1	

Source: survey, 2022

Distribution of the respondents based on coffee production technologies utilization

The distribution of respondents based on coffee production technologies utilization is shown in Table2. The result revealed that 18.9% of the respondents never prune their coffee plantation while 36. 7% and 44.4% occasionally and regularly prune their coffee plantation with mean score of 0.75. coffee farmers need to be encouraged to regularly prune their plantation to enhance high productivity. Also, 13.3% of the respondents never gap up the death stands while 70% and 16.7% occasionally and regularly gapping up dead coffee stands in their plantation. Furthermore, 63.3% of the respondents never practiced coffee rehabilitation. This technique is very important in order to increase the economic life span of unproductive coffee plantation and coffee farmers must be trained on rehabilitation technique. The table also revealed that 64.4%, 73.3% and 70% of the respondents occasionally practiced control of pest and diseases, timely harvesting of coffee berries and use of improved coffee seedlings respectively while only 7.8% of the respondents never practiced recommended planting spacing

Table 2: Distribution of the respondents based on coffee production technologies utilization

Coffee production Tech.	Never	Occasionally	Regularly	Mean
Regular pruning	18.9	36.7	44.4	0.75
Gapping up	13.3	70	16.7	1.02
Coffee Rehabilitation	63.3	23.3	12.4	1.11
Control of pest and diseases	13.3	64.4	22.2	1.07
Timely Harvesting	6.7	73.3	20.0	1.13
Use of improved coffee seedlings	12.2	70	17.8	1.06
Recommended planting spacing	7.8	68.8	23.3	1.14

Source: Field survey, 2022.

Distribution of respondents based on constraining factors affecting coffee production

The various production constraints encountered by coffee farmers and their rank order of severity was presented in table 3. Constraints like land tenure system farmers-herder clashes and Lack of technical know-how on wet processing method ranked 1st and 2nd. respectively. The issue of farmers-herder clashes is a serious problem in coffee farming in fact, some farmers are almost given up as a result of incessant attacks by herdsmen. Also, coffee wet processing method is the best method to get good quality coffee products but unfortunately, farmers lack needed training and equipment to carry it out. Price fluctuation and inadequate credit facilities ranked 3rd in order of severity in constraints faced by coffee farmers. Coffee farming is a capital intensive project, farmers need to purchase agrochemicals, pay wages to labourer and purchase some farm implements. It is difficult to get loan from the bank to finance coffee farming Akinbode SO (2013) explained that the requirement from commercial banks make it difficult for farmers to access credit to finance farming work Also, pests and diseases, inadequate information and climate change with mean 1.55 ranked 4th while soil erosion and unavailability of labour with mean score 1.48 ranked least.

Table 3: Distribution of respondents based on constraining factors affecting coffee production

Constraints	Not a constraints	Minor constraints	Major constraints	Mean	
Inadequate credit facilities	24.4	31.1	61.1	1.19	3rd
Unavailability of labour labour	5.6	41.1	53.3	1.48	8th
Transport problem	3.3	41.1	55.5	1.51	6th
Poor extension visit	4.4	41.1	54.4	1.49	7th
Prolonged draught	5.6	38.9	55.5	1.49	7th
Soil erosion	6.7	37.8	55.5	1.48	8th
Climate change	6.7	31.1	62.2	1.55	4th
Unstable government policies	6.7	34.4	58.9	1.53	5th
Land tenure system	5.6	31.1	63.3	1.58	1st
Price fluctuation	4.4	34.1	61.1	1.56	3rd
Pests and diseases	5.6	34.1	60.0	1.55	4th
Inadequate information	5.6	33.3	61.1	1.55	4th
Farmers/herders clash	8.9	31.1	60.0	1.57	2nd
Lack of technical know-how on wet processing method	10.0	30.9	59.1	1.57	2nd

Source: Field survey, 2022.

Respondents perception to coffee production constraints

The table revealed that greater percent (93.3%, and 85.6%) of the respondents agreed that credit facilities is not readily available and unstable government policies affect coffee production while 70% of the respondents strongly disagreed that farm labour is cheap and affordable. The table also revealed that 60%, 51.1%, 52.2% and 56.7% of the respondents agreed that pilfering is common practice in coffee farm, information about GAP is not readily available, farmers-herders' clashes is a problem and pest and diseases respectively are serious constraints affecting coffee production while 54.4% and57.4% of the respondents strongly disagreed that climate change is not a serious problem and it is cheap to transport coffee

Table 4: Coffee farmers' perception about constraining factors affecting coffee production

Statements	SA	A	U	D	SD
Credit facilities are not readily available	5.5	93.3	1.2	/	/
Unstable government policies	4.4	85.6	6.7	3.3	/
Farm labour is cheap and affordable	8.9	/	1.1	20.0	70
Pilfering is common practice in coffee farm	22.2	60	18	26.7	3.3
Information about GAP is not readily available	18.9	51.1	25.6	1.1	3.3
Farmers/herders clashes	44.4	52.2	/	3.3	/
Pests and diseases is a problem in coffee production	17.8	56.7	20.0	2.2	3.3
Middlemen make more gain	16.7	57.8	20.0	2.2	3.3
Climate change is not a serious problem	21.1	1.1	3.3	20.0	54.4
It is cheap to transport coffee	13.3	24.4	1.1	3.3	57.4

Source: Field survey, 2022.

Test of hypotheses

The result of chi-square showing relationship between respondents selected socioeconomic characteristics and constraints to coffee production. The table revealed a significant relationship between level of education (X=42. 252; p<0.000), Sources of labour (X=20.422; p<0.000), Sources of capital (X=15.262; p<0.000) and constraints to coffee production. The implication of significant relationship between education and constraints is that the more educated a farmer is the less constraints he/she may likely face because of the high level of exposure. Also, the significant relationship between sources of labour, sources of capital and constraints implies that labour and capital are key factors in coffee production. A farmer that has good sources of finance is likely to overcome some of the constraints to coffee production. It may likely assist farmer to hire labour instead of depending on family labour only.

Table 5: Chi- square analysis between respondents' socioeconomic characteristics and constraining factors affecting coffee production.

Variable	X^2	DF	p-valve	Decision
Marital status	30.293	3	0.532	NS
Level of Education	42.252	3	0.000	S
Sources of labour	20.422	2	0.000	S
Sources of capital	15.262	2	0.000	S

Source: Field survey, 2022.

CONCLUSION AND RECOMMENDATION

The study concludes that coffee farmers are still in their productive stage. Farmers frequently utilized most coffee production technologies. The study had revealed array of constraints facing coffee farmers which might affect coffee production in commercial purposes these include; lack of access to credit, price fluctuation, farmers-herders' clashes, sharp practices of middlemen, price fluctuation etc. As a result of the importance of coffee production and its products to Nigerian populace, government should intervene in the present crisis rocking the coffee sector by creating appropriate marketing channel and put in place price control system. Farmers need to be encouraged by making available to them credit facilities as most of them depend on personal savings and money gotten from family and friends to finance their farming operation. Inputs should be subsidized by government and made available to farmers in large quantity. Lastly, farmers need training on some coffee production technologies like coffee rehabilitation technique

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GROWTH AND YIELD OF IRRIGATED GARDEN CRESS (*Lepidium sativum* L) VARIETRIIES AS INFLUENCED BY SOWING METHODS AT SAMARU

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ABSTRACT
A field experiment was conducted at the student demonstration field in Samaru College of Agriculture, Division of Agricultural College, Ahmadu Bello University, Zaria in the Northern Guinea savannah ecological zone of Nigeria (11° 11 N, 07°38 E and 686mm above the sea level) during 2021 dry season to determine the growth and yield of irrigated Garden cress (Lepidium sativumL) varieties as influenced by sowing methods at Samaru. The treatments consist of three sowing methods (Broadcasting, Drilling and Dibbling) and two varieties (Ex Jaba and Halim). The treatments were factorially combined and laid out in randomized complete block design (RCBD) and replicated three times. The result shows that taller plants with more number of leaves and branches as well as earlier flowering, fresh and dry yield were recorded when Ex Jaba variety and broadcasting methods were used compared to the other variety and sowing methods. In conclusion, Ex Jaba variety and broadcasting method of sowing could be used for optimum growth and higher vegetable yield of garden cress during dry under irrigation at Samaru.

INTRODUCTION

Garden cress *(Lepidium sativum)* known as garden or common cressis an annual herb belonging to the family *Brassicaceae* and the centres of origin of the crop is the high lands region of Ethiopia and Eritrea (Stchenkova, 2009). The genus *Lepidium* comprises of several species growing mostly in warm climate. Species in this family have a worldwide distribution and have the highest diversity in the Mediterranean region, West and Central Asia and parts of Northern America (Jubrin 2012 and Vipul D. *et al*, 2014). The crop can grow on wide range of environmental and soil conditions as it tolerant slight acidity and insects attack, therefore its cultivations becomes easier and widely distributed across the globe (H. Falana *et al.* 2014). In Nigeria the crop is grown in the Sudan and guinea savannah ecological zones, throughout the during wet and dry seasons. Garden cress is a short live, easily perishable leafy vegetable, cultivated for its nutritional and medicinal values and serve as source of income for part time vegetable producers (Jibrin *et al.* 2016). However, the cultivation of the crop is greatly affected by inadequate quality seed and choice of suitable variety and sowing methods by the poor resource vegetable farmers. Therefore, appropriate sowing method has to be employed in order to avoid seed wastage, poor germination and establishment of the crop in the field which will affect the yield.

Garden cress has varieties and the performance of the varieties depends on variation in geographical location as influences by environmental conditions and soil type. Mostly farmers in Samaru cultivate only the local Ex Jaba variety and do not cultivate of improved exotics varieties which may attain maturity at very much earlier period, resist pest and diseases compare with local variety (s). Based on the foregoing, this study was conceived with the following objectives

- To determine the suitable garden cress variety (s) for higher growth and yield of garden cress in Samaru and environs.
- To determine the proper sowing method proper growth and higher of garden cress.

MATERIALS AND METHODS

The experiment was conducted at student demonstration field of Samaru College of Agriculture, Ahmadu Bello University Zaria in the Northern Guinea Savanna Agroecological zone of Nigeria (11° 11 N, 07°38 E and 686mm above the sea level) during 2021 dry season. It comprises of six (6) treatment combinations consisting of two varieties (Ex Jaba and Halim) and three sowing methods (Drilling, Dibbling and Broadcasting). The treatments were factorially combined and laid out in a randomized complete block design (RCBD) replicated four times. The field was harrowed twice and made into a sunken bed. The gross plot size was 1m × 1m (1 m^2) and 0.5m^2 net plot .A spacing of 0.5m between the plots and 1m between the replicates were made. The seeds (Ex Jaba and Halim) were sown according to the layout using drilling, dibbling and broadcasting methods on 1st May, 2021. Seeds were covered with a thin layer of soil immediately after sowing. NPK 15:15:15 was applied to the field at sowing to supply N, P and K for the crop at the rate of 40 Kg per hectare immediately after sowing. Weeds were controlled during land preparation using 360g/l of Grammazone and by hand picking and hoe weeding at 2 and 3 weeks after sowing (WAS). The crop was harvested by uprooting the whole plant at 4 WAS. Data on plant height, number of leaves, days to 50% flowering, fresh and dry yield were recorded.

RESULTS

The effect of sowing method on plant height of garden cress varieties was presented on Table 1. At week 2, 3, and 4 there was significant difference between the varieties. Ex Jaba variety produced significantly the tallest plants while Halim produced the shortest plants. No significant response was noted throughout the sampling periods due to varietal differences and varied sowing methods used. In addition, the interaction between varieties and sowing methods was not significant on plant height at all the sampling weeks. Table 2 shows the effect of sowing method on number of leaves of garden cress varieties. No significant response was recorded for both varieties and sowing methods with regards to number of leaves at week 2, 3, and 4. The interaction of the varieties and sowing methods on the same parameter was also not significant in all the sampling period.

The effect of sowing method on days to 50% flowering of garden cress varieties was presented on Table 3. There was a significant difference between the days, took by the varieties to attain 50% flowering. Ex Jaba has attained 50% flowering earlier than Halim. The significant effect due to varied sowing methods showed that dibbled garden cress took more days to attain 50% flowering compared to broadcast and drilled plants which were statistically at par and attained 50% flowerings much earlier. There was no significant response on the days to 50% flowering due to differences in varieties and sowing methods. The effect of sowing method on the fresh and dry yields of garden cress varieties was presented on Table 4. Varietal differences and dry yields where higher yields were recorded in in ex Jaba compared to Halim variety. When sowing methods were compared, significant differences was recorded in which broadcast and drilled garden cress had higher and similar fresh yield, whereas higher dry yield was noted using broadcasting methods. However, lower yield was observed in dibbled garden cress which was at par with drilled plants. There was no significant response on the fresh and dry yields between the two varieties under varied sowing methods.

Table 1: Effect of sowing method on plant height (cm) of garden cress varieties during 2021 dry season at Samaru.

Treatments	Weeks after sowing		
	2	3	4
Varieties (V)			
Halim	4.04b	5.34b	9.85b
Ex Jaba	4.96a	11.55a	18.82a
S.E	0.225	0.617	0.672
Sowing method (S)			
Broadcasting	4.69	8.74	14.65
Drilling	4.46	8.58	15.34
Dibbling	4.34	8.05	13.01
S.E	0.275	0.755	0.862
Interaction (I)			
V*S	NS	NS	NS

Means followed by the same letter (s) within treatment group are statistically similar using D.M.R.T at 5% of probability. NS= Not significant

Table 2: Effect of sowing method on number of leaves of garden cress varieties during 2021 dry season at Samaru.

Treatments	Weeks after sowing		
	2	3	4
Variety (V)			
Halim	29.38	37.17	42.73
Ex Jaba	30.63	41.10	43.52
S.E	1.010	1.787	2.259
Sowing Method (S)			
Broadcasting	31.30	40.38	43.23
Drilling	30.73	40.98	44.95
Dibbling	28.00	36.05	41.20
S.E	1.273	2.189	2.767
Interation (I)			
V*S	NS	NS	NS

Table 3: Effect of sowing methods on days to 50% flowering of garden cress varieties during 2021 dry season at Samaru.

Treatments	Days to 50% floweing
Variety (V)	
Halim	28.50a
Ex Jaba	25.17b
S.E	0.245
Sowing Method (S)	
Broadcasting	26.50b
Drilling	26.13b
Dibbling	27.88a
S.E	0.300
Interaction (I)	
V*S	*

Means followed by the same letter(s) within treatment group are statistically similar using D.M.R.T at 5% of probability. *= Significant 5%

Table 4: Effect of sowing methods on fresh and dry yields of garden cress varieties during 2021 dry season at Samaru.

Treatments	Fresh yield (kg/ha)	Dry yield (kg/ha)
Variety (V)		
Halim	7.70b	2.79b
Ex Jaba	30.30a	8.79a
S.E	3.268	0.960
Sowing Method (S)		
Broadcasting	25.09a	7.75a
Drilling	22.08a	6.39ab
Dibbling	9.84b	3.24b
S.E	4.00	1.176
Interation (I)		
V*S	NS	NS

Means followed by the same letter(s) within treatment group are statistically similar using D.M.R.T at 5% of probability. NS= Not significant

DISCUSSION

Both plant height and number of leaves have produced no significant difference with regards to sowing method. However, sowing method was observed to significantly affect other parameters like days to 50% flowering, fresh yield and dry yield**.** This could be due to high temperature when the experiment was carried out as against the temperature requirements of the crop. The earlier flowering of the broadcasted plants could be due to the number of plants per stand in broadcasting. For drilling, the earlier flowering was because it has closer inter row spacing compared to dibbling. The broadcasting and drilling methods resulted in the higher fresh yield, while the dibbling method had the lower yield. This could be due to earlier flowering coupled with the number of plants per stand which allow the plants to utilize more sunlight which is an ingredient for photosynthesis. For the dry yield on the other hand, broadcasting produces the highest value while dibbling produced the least value but the two methods are all at par with drilling. This could be attributed to the non significant response of plant height and number of leaves to the different sowing methods.

This is in agreement with the experiment of Azizur Rahman *e.t al* (2019) on Mustard which shows sowing method having effect on parameters like seed weight and yield of seed per hectare and biological yield per hectare with broadcasting producing highest values than drilling. Ex Jaba has produced higher plants with more leaves, while Halim has highest value for canopy spread. This different might be due to the variation in their genetic makeup and adaptability. Abey *et al.* (2002) also reported that different crop varieties possess varying genotypic and phenotypic traits.

CONCLUSION

In conclusion, it was observed that efficient growth and higher yield of garden cress under irrigation at Samaru was obtained when Ex Jaba variety was sown using broadcasting method.

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A REVIEW ON THE NUTRITIONAL AND HEALTH IMPORTANCE OF AFRICAN NIGHTSHADE (*Solanum scabrum*): AN UNDERUTILIZED VEGETABLE

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ABSTRACT
Vegetables are considered essential for well-balanced diets as they are sources of phytonutrients, vitamins, minerals and dietary fibre. Daily intake of vegetables has strong connection with overall good health, reduced risk of some forms of cancers, anaemia and other non-communicable diseases. The industrial standard of counting calories as metric for food security does not lead to improved nutrition, rather to persistent malnutrition, ill health and hunger. To meet the nutritional needs and reduce the over dependence on few vegetable crops, attention should be given to the impact of Neglected and underutilized species of vegetables on their nutritional requirements to the general public. One of such local vegetables with excellent nutrition and medicinal potentials is African nightshade, Solanum scabrum. This review explored the nutritional and medicinal attributes of Solanum scabrum in improving food and nutritional security with the view of bringing the attention of the public to its importance in human well-being. The review also x-rayed the enormous medicinal uses of the vegetable with the view of improving the health and economy of rural communities in Nigeria and the world in general.
Keywords: *African nightshade, Medicinal, Nutrition security, Solanum scabrum, Vegetable*

INTRODUCTION

Vegetables constitute an important portion of human diet in various parts of the world and play a vital role in human nutrition, particularly as providers of phytonutrients, vitamins, minerals as well as dietary fibre. Some of these phytochemicals in vegetables have strong antioxidant and antibacterial properties that are believed to aid in the reduction of the risk of chronic diseases by protecting human bodies against free-radical damage, through the modification of metabolic activities and detoxification of carcinogens or even influencing the processes that alter the course of tumor cells (Herrera *et al*., 2009). A daily intake of vegetable have been strongly linked with overall good health, improved gastrointestinal health and vision, reduced risk of some forms of cancer, heart disease, stroke, diabetes, aneamia, arthritis and other chronic diseases (Keatinge *et al*., 2010). In the year 2017 alone, about 3.9 million deaths worldwide were attributed to non-eating of enough vegetables (WHO, 2019). Inadequate vegetable intake in an unbalance diets have been projected to cause approximately 14% of deaths from gastro-intestinal cancer, 11% of those due to ischemic heart disease and about 9% of those caused by stroke globally (Afshin *et al*., 2019).
The year 2021 was declared by the United Nations (UN) General Assembly as the International Year of Vegetable to raise awareness of the nutritional and health benefits as well as Food and Nutrition Security of vegetables and their contribution to a balanced and healthy diets and lifestyle. Nutrition Security refers to sustainable access to available and affordable foods and beverages that promote human well-being and prevent and possibly treat disease. Therefore, in this context, Food Security does not exist without Nutrition Security (Aliyu *et al*., 2022). On the contrary, many food policies rather focus on quantity than quality. It is the difference between eating bread every day or a diverse diet incorporating all the food groups every day. One satisfies our hunger while the other enriches our body to reach its full potential (FAO, 2020). Although the World Health Organization (WHO) recommends a daily consumption of at least 400g of vegetables to reap their nutritional and health benefits, the Food and Agriculture

Organization on the other hand, opined that the industrial standard of counting calories as the metric for food security is not leading to improved nutrition outcomes. Persistence of malnutrition, ill health, hunger and nutrition-related non-communicable diseases are still on the rise globally (Baldermann *et al*., 2016), indicating that the world is not on track to reaching any of the targets set by the United Nations Sustainable Development Goal 2 of zero hunger by 2030 (FAO, 2020). Recent reports by the United Nations on micronutrient malnutrition showed that in 2020, about 12% of the world population were severely food insecure and that 22% of children below age five (5) suffered from stunting (UN, 2021). To correct the misdirected focus on only delivering calories, there is a global paradigm shift to focusing on Nutrition Security through dietary diversity and utilization of locally available vegetables. This forms the basis of the concept Food Security as outlined by Aliyu, *et al*. (2022).

To meet the nutritional needs of the ever growing population and to reduce over dependence on few vegetable crops, research and development scope should be broadened to include a much wider range of vegetable species. Most vegetables we have today were collected form the wild by crop-gatherers and brought under cultivation in different parts of the world. Plants that are useful to humans and grown by them are called crops. However, certain crop plants that are either not useful to their full potential or strongly linked to their cultural heritage or adapted to a specific agro-ecological niche are referred to as Neglected and Underutilized Species (NUS). In Nigeria and many other countries of the world appreciable attention has not been given to the impact of these underutilized vegetables on the nutritional requirements of the people. This is evidence in the global production of vegetables in 2021, by type where no record is mentioned about underutilized vegetables (Shahbandeh, 2023). Many of these underutilized or minor vegetables are nutritionally rich and complement significantly to the diet based on few staple crops by providing important vitamins and minerals. Similarly, some of these neglected vegetables and herbs have multiple uses (i.e. food and medicinal) and the key to unlocking their true potential lies in our ability to harness their uses beyond the traditional single-use approach (GFAR, 1999). One of such vegetables with tremendous potentials to enhancing food and nutrition security cheaply in Nigeria is the African nightshade, *Solanum scabrum*. Though of an uncertain geographical origin, Linnaeus attributed it to Africa where it is cultivated as edible leafy vegetable or pot herb (Mwai *et al*., 2007). Therefore, the objective of this review is to examine the nutritional and health benefits of African nightshade, *Solanum scabrum* in enhancing food and nutrition security.

The African nightshade, *Solanum scabrum*

African nightshade also known as garden huckleberry is an annual or short-lived perennial plant that belongs to the family solanaceae. Its growth habit varies from herb to tree and grows up to 1m in height. The stem is hairless or sparsely hairy. The leaves are ovate in shape, 7-12cm in length and 5-8cm in width, together with fresh shoots are widely used as cooked vegetable and served with corn flour or *tuwo masara*. Inflorescence is simple or sometimes branched. The flowers are 4-5 parted with the petals fused into a tube-like structure that contains the stamens (Garjila, 2016). The fruits which are initially green in colour but turns dark-blue or black when mature are not edible berries, 10-17mm in diameter developed from ovaries and contain more than one seed. The vegetable is commonly cultivated in Sardauna Local Government Area in Taraba State of Nigeria and the areas bordering the hilly highlands of the Republic of Cameroon. Studies have shown that African nightshade production extends from the coast of West Africa to East Africa, and south to Mozambique and South Africa where it is extensively cultivated as leafy vegetable (Abukusta-Onyango *et al*., 2013). The wide range of diversity of African nightshade particularly in Nigeria and Cameroon suggests that its origin is likely to be in the warm humid forest belt of West and Central Africa (Muthomi and Musyimi, 2009) with different names among the locals such as *mange* and *nzhi* in Mambilla and Kaka languages, respectively. However, in Taraba State and other neighboring States of Adamawa and Gombe in Northeastern Nigeria, it is locally referred to as *kumbi*.

Nutritional benefits of African nightshade

African nightshade is principally cultivated for its leaves that are cooked and eaten as pot herb served with different types of such as corn flour, semovita, rice, pounded yam or even pounded coco yam. The leaves are rich in micronutrients, especially vitamins A, C, and E, ascorbic acid, riboflavin, minerals (iron, calcium, and zinc) and dietary fibre (Neugart *et al*., 2017), making it an important source of nutrients for the resource-poor. A variety of health promoting bioactive phytochemicals such as phenolic compounds, carotenoids and chlorophylls have also been not quite long identified in *Solanum scabrum* (Jimenez-Aguilar and Grusak, 2015), which could be the reason for its popularity in its area of origin and by extension its long use in traditional medicine. The nutrient composition of the leaf is likely comparable to other green leafy vegetables. As it has bitter taste, some people especially the elderly appreciate the taste and prefer not to use salt. The bitter taste is associated with high content of alkaloid and solanine which is found throughout the plant but with more concentration in the unripe fruits and in older leaves. That might be the reason why the fruits are not consumed because of high content of anti-nutrient substances such as solanaceous glycoalkaloids (Yuan *et al*., 2018). However, the bitterness is reduced by discarding the very dark-green cooking water and replacing it with fresh water. Vitamin A plays an important role in cell growth, vision, and the immune system. It helps skin develop and stay healthy and promotes the growth of bones and teeth. Ascorbic Acid or Vitamin C, a food substance needed by humans to prevent scurvy, a disease of the gums, bones, and blood vessels, and to increase the body's resistance to infection. Ascorbic acid acts as an *antioxidant,* a nutrient that chemically binds and neutralizes the tissue-damaging effects of substances in the environment known as free radicals. As a result, ascorbic acid is vital for the growth and maintenance of healthy bones, teeth, gums, ligaments, and blood vessels (Markell and Siddiqi, 2022). Because of its role in the formation of *collagen,* the body's major building protein, ascorbic acid is a central component of all body organs (Keller, 2004).

Riboflavin, also called vitamin B_2 is a substance essential for the breakdown and utilization of carbohydrates, fats, and proteins in the body, and in the production of energy. Riboflavin plays a vital role in the health of the skin and is needed for production of certain hormones by the adrenal glands, the pair of hormone-secreting organs that sit on top of each kidney. Because it is a water-soluble vitamin—that is, it is not stored in the body, but is excreted in sweat or urine—riboflavin needs to be constantly replaced in the body. Hemoglobin is contained entirely in the red blood cells, amounting to perhaps 35 percent of their weight. To combine properly with oxygen, red blood cells must contain adequate hemoglobin. Hemoglobin, in turn, is dependent on iron for its formation (Litwack, 2022). A deficiency of hemoglobin caused by a lack of iron in the body lead to anaemia. There are different types of anaemia but the most common type is iron-deficiency anemia. When the body's need for iron increases—such as during periods of rapid growth in childhood, during pregnancy, or when there is chronic bleeding—an iron deficiency may develop. Low iron levels impair the body's ability to produce hemoglobin, a primary component of red blood cells. All these nutrients are provided by Solanum scabrum. Even though the cultivation and utilization of African nightshade is restricted to few communities in Taraba Sate, its nutritional importance in food security cannot be overestimated especially in the north-east sub-region of Nigeria.

Medicinal benefits of African nightshade

Generally, over the past few years, plants have become an indispensable source of food and medicine to mankind globally (Sodipo *et al.*, 2000). In most parts of rural Africa, traditional healers prescribing medicinal plants are the most easily accessible and affordable health resource available to the local community and at times the only therapy that subsists (Mahomoodally, 2013). These medicinal plants play an important role in the lives of the rural people who produce and consume them, especially those in the remote parts of the developing countries where adequate health facilities are limited (Safwan and Mohammed, 2016). The nightshade family has about 90 genera and 2600 species including African nightshade, *Solanum scabrum* or garden huckleberry. The garden huckleberry though mainly cultivated for its leaf that is eaten as pot herb, there is strong indication that it has some medical attributes that remains hidden in indigenous knowledge systems, thus justifying its continuous cultivation and consumption as leafy vegetable (Chivenge *et al*., 2015). Odongo *et al.* (2018) reported that African nightshade extracts showed strong health promoting potential, especially when fermented.

Therefore, the consumption of *Solanum scabrum* leaves should be encouraged, preferably after cooking or fermentation of the plant against eating it raw as practiced by some Mambilla natives. For instance, the use of African nightshade as a remedy for ailment has a long-standing history in Africa where extracts prepared from leaves and fruits are used in the treatment of jaundice and diarrhea in children (Roy *et al*., 2014). It is believed among the locals especially in East Africa that African nightshade is an excellent preventive medicine for jaundice by helping in strengthening the liver muscles thereby limiting the chances of coming down with the disease when included in daily diet. It is also recommended as an ideal treatment for stomach ulcer and other related painful sores (Malaika, 2006) and because of its antibacterial properties, regular consumption of the leaves as part of diet helps in healing stomach ulcer. However, being viewed as part of folk medicine among the natives of Mambilla plateau in Taraba State, it is believed that African nightshade can help to calm sore throats by crushing some fresh leaves and squeezing the extract directly into the throat of the victim and therefore it is recommended as an ideal pot herb for local singers. As a traditional medicinal plant, Nyeem *et al*. (2017) reported that the rich fibre content in African nightshade can act as a natural laxative agent by inhibiting constipation.

This assertion is validated by Mrs. Rose W. Okan (personal communication) who confirmed that daily consumption of the vegetable contributes in regular bowel movements and overall digestive system improvement. Similarly, Mrs. Rose W. Okan explained that in Mambilla ethnomedicine, juice extracts from fresh leaves of *Solanum scabrum* can be used in treating convulsion in children. Herbal medicine, also known as phytomedicine or botanical medicine, have been using parts of plant such as the leaves, fruits, bark or roots for over 5,000 years (Jabeen-Begum, 2021). *Solanum scabrum* might have anti-diabetic properties as reported by Mrs. Nellis Gimba (personal communication), a diabetes patient who said on regular consumption of the plant, her blood sugar level dropped drastically to an extend that she has not use any diabetes drugs for the past two years. She said whenever she eats the vegetable, she kept passing urine indicating that *Solanum scabrun* might have some diuretic properties that enhances the flow of urine and thus eliminates accumulation of water in the cells, tissues, blood and organs.

On the diuretic nature of the plant, Odongo *et al*. (2018) reported that the potassium content in *Solanum nigrum*, another species of the nightshade family is a natural diuretic that can help to reduce the risk of heart disease. Mrs. Nellis' testimony seems to be a common believe among the natives who prefer eating the diet in the morning hours rather than late in evening to enable them urinate throughout the day than disrupting their sleep at night. All these show that African nightshade holds the ability to assist in regulating blood sugar levels and flushing out of urinary tract infections and can be of advantage to people with diabetes and those suffering from urinary tract infections. Other medicinal uses of the nightshade family in parts of Asia include treatment of atopic dermatitis (AD) of various skin infections such as allergies, heat boils, eczematous skin and skin irritation as reported by Hong *et al*. (2020). Similarly, Mrs. Rose W. Okan (personal communication) confirmed that in Mambilla folk medicine, African nightshade fruits are used for the treatment of eczema and ring warm infections especially in infancy and childhood and sometimes even in adults where paste from the fruit is externally applied directly to the affected areas of the body.

These findings and reports clearly indicates that African nightshade, *Solanum scabrum* has some medicinal potentials that if judiciously harnessed, can positively impact on the well-being and economy of local communities in Nigeria in particular and the world in general.

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EFFECT OF DIFFERENT INDUCTION SUBSTANCES ON FLOWERING, FRUIT YIELD AND QUALITY OF PINEAPPLE PLANTS (*Ananas Comosus*) IN OGBOMOSO, NIGERIA

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ABSTARCT
One of the limitations of pineapple production is erratic natural inflorescence and fruit production. This could be ameliorated by using different induction chemicals. Field experiments were carried out at Teaching and Research farm, Ladoke Akintola University of Technology; Ogbomoso to assess the effects of different induction substances on post induction growth, fruits yield and quality of pineapple plants. The treatments tested included Calcium carbide, ethephon, Urea, ethephon + Urea, compost extract, and iced block. The treatments were applied on 14 month old pineapple plants plots previously laid out in a Randomized Complete Block Design replicated 3 times. Data were collected on growth parameters, fruit and fruit yield attributes as well as fruit proximate, elemental and phytochemical compositions. Data collected were subjected to analysis of variance and significant means were separated using Duncan Multiple range Test at 0.05 level of significance. There were significant difference in performance of pineapple plants treated with various induction chemicals. The use of calcium carbide resulted in the highest mean number of flowers, (105.21) which was significantly higher than the number of flowers produced by the other treatments, while plants treated with iced block produced the lowest number of flowers (45.84) at 2 months after application. The use of calcium carbide and ethephon did not negatively affected the proximate, elemental and phytonutrient components of pineapple fruits. The results obtained with the use of these substances compared favourably with what was obtained with plants treated with compost extracts. Therefore, any of the ethephon, calcium carbide or compost extracts is therefore recommended for use by farmers for pineapple floral induction in the study area.
***Keywords**: Induction chemicals; flowering, Fruit Yield, fruit quality; Pineapple plants*

INTRODUCTION

Pineapple (*Ananas comosus* (L.) Merr.), is an herbaceous monocotyledonous perennial tropical plant of the family *Bromeliaceae*. It is cultivated in more than 60 countries, where its present great demand and economic importance. In Brazil, it is the fifth more cultivated tropical fruit and represents a great option for cultivation in non-traditional areas such as the semi-arid region. Pineapple is a well appreciated fruit all over the world. It plays an important role in human diets and a good source of fiber and micronutrients especially vitamins and minerals. The pineapple is a tropical plant with an edible fruit and the most economically significant plant. It is indigenous to South America, where it has been cultivated for many centuries. The crop is the third most important tropical fruit in world production. In the 20th century, Hawaii was a dominant producer of pineapples, especially for the US; however, by 2016, Costa Rica, Brazil and Philippines accounted for nearly one-third of the world's production of pineapples (Bartholomew et al; 2002). The rich nutritional content of pineapple is highly beneficial for strengthening bones and connective tissue, thus preventing fractures and osteoporosis. Pineapple have been shown to regulate glucose metabolism, which makes it ideal for diabetics and people with high blood sugar.

Pineapple fruit is low in calories as 100 grams of this tropical fruit provide 20% of the suggested limit for sugar intake (up to 50 grams per day). This is due to its high levels of dietary fiber, which improve glucose metabolism, making it ideal for diabetics and people with hyperglycemia (Dass, et al; 1975). A significant problem of pineapple farmers is the low predictability of fruit yield and harvest date. In order to circumvent this problems, pineapple plants are induced at certain age with different chemicals. Calcium carbide, ethephon, and or urea have been reported to the efficient in stimulating flowering and fruiting in pineapple plants. However, the phyto toxicity, health hazard, and cost associated with the use of some of these chemical substances call for concern, and thus necessitated research into alternate safe and cheaper methods (Cunha, 1998; Cunha, 2005). The objective of the present work is to access efficacy of different induction chemicals on the flowering and fruiting of pineapple plants.

MATERIALS AND METHOD

Experimental Site

The field experiment was carried out at the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso Oyo state. Ogbomosho falls on latitude 41^0E and longitude 81^0N which is located in the guinea savanna zone.

Experimental Materials

The smooth cayenne pineapple suckers were obtained from Ladoke Akintola University of Technology, Ogbomoso**.**

The induction substances used are:
T1: No application of any material
T2: Ice Block applied at the rate of 10g/stand
T3: Compost Extract (5kg of compost in 10 litres of water) applied at 40ml/stand
T4: Ethephon (Mix 30ml of ethephon in a 6 litres of water) applied at 40ml/stand
T5: 50% Compost Extract + Ethephon. The mixture applied at the rate of 40ml/stand
T6: Calcium Carbide (22.8g of calcium carbide in 6 litres of water) applied at 40ml /stand.
The treatment was laid out in Randomized Complete Block Design with 4 replicates.

Crop Management

i. **Weeding:** Weeding was done twice per month depending on how rapid the weed grows.
ii. **Application of Fertilizer (Urea):** A uniform application of urea at the rate of 120kg N/ha was supplement the soil nutrients

Data Collection: Data were collected on days to 50% flowering and fruiting, mean fruit weight, and fruit yield. The fruit proximate, elemental, and Vitamins A and C contents were also assessed.

Data analysis: The data collected were subjected to analysis of variance (ANOVA). Means were compared using Duncan Multiple Range Test (DMRT) at 5% level of significant.

RESULTS AND DISCUSSION

The effect of induction chemical types on the number of pineapple flowers at 2 months after application is presented in Fig. 1. Application of calcium carbide resulted in the highest number of flowers (105) which was significantly higher than the number of flowers produced by the other treatments with the least from plants treated with iced block. All physicochemical properties of the pineapple fruits measured were significantly affected (with the exception of pH) by types of induction chemicals. Nonetheless T4, T5 and T6 were highest in titratable acid and sucrose. The T1, T2 and T3 were highest in total sugar and lactose whereas only T4 was highest in fructose.

Effect of induction chemical types on proximate analysis of pineapple is presented in Table 2. The T4 and T6 produced the highest crude protein which were not significantly different from the other treatments. Plants treated with T4, T5, and T6 produced the highest fat content, crude fiber and total ash but were not significantly different from the values obtained from the other treatments. The moisture content was comparable among the six treatments however, T4 had the highest moisture content. The effect of induction chemical types on chemical composition of pineapple fruit is presented in Table 3. Pineapple plant treated with T4, T5 and T6 produced fruits with the highest calcium content which were not significantly different from other treatments. The T4 produced the highest sodium and iron content while T6 produced the highest potassium. T4 and T6 produced the highest phosphorus content and were not significantly different from the other treatments. T5 and T6 both produced the highest magnesium contents but were not significantly different from the other treatments. T4, T5 and T6 produced the highest zinc content and was similarly not significantly different from the results of the other treatments.

Effect of induction chemical types on mineral analysis of pineapple is presented in Table 4. T5 produced the highest vitamin C and vitamin A and were not significantly different. The effect of induction chemical types on pineapple fruit yield is presented in Table 5. T1 resulted in the highest weight in whole fruit, fruit and crown but were not significantly different.

Chemically induced fruits have higher sugar contents than non-induced fruits, as a result of low moisture content and high sucrose. The pH value also shows that the induced fruits are more acidic than non-induced fruits. This confirms that the report of Chang (2000), which asserts that treatment of pineapples with chemicals for floral induction affect the acidity of the fruits. However, the pH values of both induced and non-induced fruits fall within the range of 3.8-4.5. This implies that the use of calcium carbide, ethephon, compost extract and iced block does not seriously affect the acidity of the pineapple fruit beyond the acceptable limit. Pineapple fruits with no induction chemicals produced a higher weight of the whole fruit, fruit and the crown than the induced fruits but the induced fruits ripened faster than the non-induced fruits. The non-induced fruit had lower vitamin content in them than the induced fruits which ranges from 9.12-9.74 in vitamin C and 2.70-3.50 in vitamin A, which makes the chemically induced fruit more accessible to boost the immune system in the body. In the elemental composition, the chemically induced fruit has higher contents than the non-induced fruits. Fruits treated with ethephon and calcium carbide especially had the highest content in calcium, sodium, iron, magnesium and zinc. This four elements are essential and important in human health and also help builds the body system.

CONCLUSION AND RECOMMENDATION

The study concluded that the use of calcium carbide and Ethephon for floral induction influenced positively the quality of pineapple fruits. Fruits from chemically induced pineapples were preferred due to high accumulated sugar content. Thus, Ethephon and Calcium carbide are therefore recommended for use by farmers in this study area.

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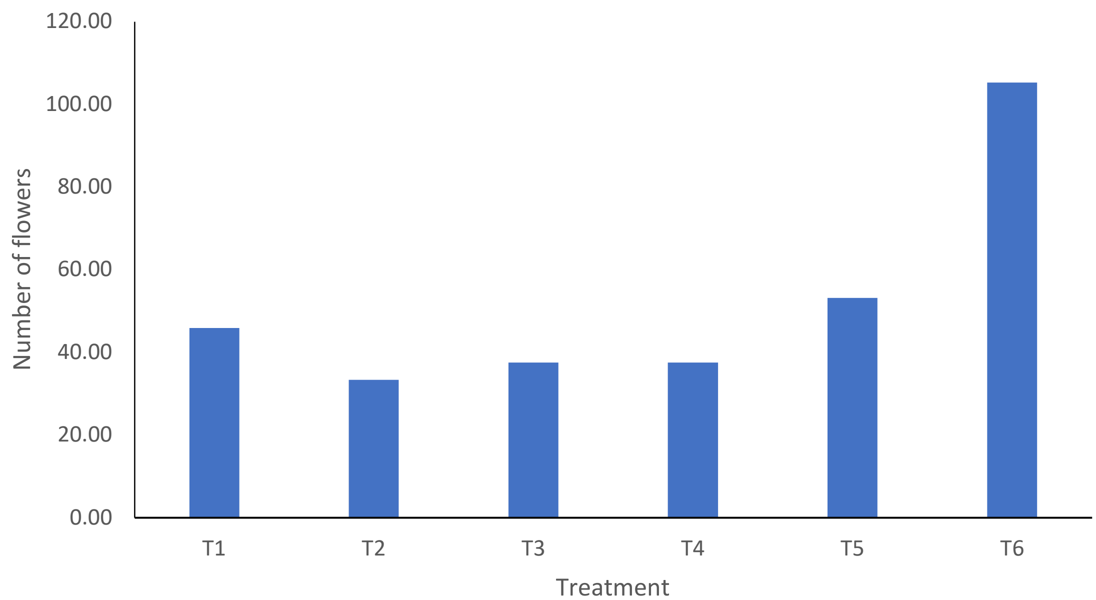

Fig 1: Effect of induction chemicals on the number of pineapple flowers at 2 months after application.

T1= No treatment; T2= Iced block; T3= Compost extract; T4= Ethephon; T5= Compost extract + Ethephon; T6= Calcium carbide

Table1: Effect of induction chemical types on physicochemical properties of pineapple fruits

Treatments	pH	Titratable acid (%)	Total Sugar (%)	Sucrose (%)	Lactose (%)	Fructose (%)
No treatment	4.13b	1.23a	9.58a	4.00a	3.80a	1.53a
Iced Block	4.16b	1.22a	9.58a	4.02a	3.81a	1.55a
Compost extract	4.15b	1.22a	9.58a	4.01a	3.81a	1.54a
Ethephon	4.33a	1.42a	9.45a	4.51a	3.80a	1.79a
Compost extract + ethephon	4.30a	1.42a	9.47a	4.52a	3.80a	1.60a
Calcium carbide	4.32a	1.42a	9.46a	4.52a	3.80a	1.70a

Means followed by different alphabets are significantly different

Table 2: Effect of induction chemical types on proximate contents of pineapple fruits.

Treatments	Crude Protein (%)	Fat (%)	Crude Fiber (%)	Ash (%)	Moisture content (%)
No treatment	0.45a	0.22b	0.42b	0.25a	81.38a
Iced block	0.45a	0.22b	0.42b	0.25a	81.45a
Compost extract	0.45a	0.22b	0.42b	0.25a	81.25a
Ethephon	0.47a	0.24a	0.45a	0.27a	81.81a
Compost extract + ethephon	0.46a	0.24a	0.45a	0.27a	81.53a
Calcium carbide	0.47a	0.24a	0.45a	0.27a	81.68a

Means with the same letter are not significantly different

Table 3: Effect of induction chemical types on elemental composition of pineapple fruit

Treatments	Calcium	Sodium	Potassium	Phosphorus	Iron	Magnes -ium	Zinc	Copper
				mg/100g				
No treatment	1.19a	0.78a	135.10a	7.55b	0.54bcd	6.26b	0.06ab	0.03ab
Iced block	1.19a	0.78a	134.94a	7.56b	0.53d	6.26b	0.05b	0.02b
Compost extract	1.19a	0.78a	135.02a	7.56b	0.54cd	6.26b	0.06ab	0.03ab
Ethephon	1.23a	0.81a	139.57a	7.65a	0.56a	6.69a	0.07a	0.03a
Compost extract + ethephon	1.23a	0.61a	139.47a	7.64a	0.55abc	6.70a	0.07a	0.03ab
Calcium carbide	1.23a	0.71a	186.45a	7.65a	0.55abc	6.70a	0.07a	0.03a

Means with the same letter are not significantly

Table 4: Effect of induction chemical types on vitamin contents of pineapple fruits.

Treatment	Vitamin C (mg/100g)	Vitamin A (mg/100g)
No treatment	9.12b	2.79b
Iced block	9.13b	2.76b
Compost extract	9.13b	2.77b
Ethephon	9.72a	3.25ab
Compost extract + ethephon	9.74a	3.48a
Calcium carbide	9.73a	3.37a

Means with the same letter are not significantly different

Table 5: Effect of induction chemical types on pineapple fruit attributes.

Treatments	Whole fruit	Fruit Kg	Crown
No treatment	1.975	1.806	0.421
Iced block	0.931	0.245	0.245
Compost extract	1.271	0.235	0.235
Ethephon	1.614	0.281	0.281
Compost extract + ethephon	1.837	0.314	0.314
Calcium carbide	1.116	0.350	0.350

Means with the same letter are not significantly different

ECONOMIC ANALYSIS OF COST- RETURN STRUCTURE OF COFFEE PRODUCTION IN KOGI STATE, NIGERIA

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ABSTRACT
The study examined the profitability of coffee production in Kogi state, Nigeria. There have been a lot of studies on cost return structure of annual crops with little attention given to perennial crops such as coffee. Therefore, this study examined the profitability of coffee production. Multi stage sampling technique was used to select the respondent for the study. The first stage was the purposive selection of three Local Government Areas (LGAs) from the State. Second stage was the random selection of 15 coffee producing communities from the three selected LGAs (the selection was proportionate to size), while the third stage was the random selection proportionate to size of 400 coffee farming households from the selected communities. Data were collected with the use of structured questionnaire for the literate respondents and an interview schedule for the illiterate respondents. The data collected were analyzed using descriptive statistics, Gross Margin (GM) and Net Revenue (NR) to analyze the profitability of the coffee farmers. The result showed that production of coffee as a venture is profitable because for every ₦1 invested in the business, it yielded ₦1.39. The study also recommended that government should support expanded production of coffee to other potential areas by taking further research on cost and benefit analysis of increasing coffee production, government and other lending agencies should also do more in assisting the farmers with soft loans in order to reduce the problem of inadequate capital among the farmers. These will enhance connectivity in research and extension for an improved coffee productivity and quality.
Keywords; *Coffee, Production, Productivity and Profitability*

INTRODUCTION

Agriculture is the mainstay of the Nigerian economy from the standpoint of its various contributions to the economy. During the 1960s, agriculture contributed about 85.5% of the total export and hence became the vital source of foreign exchange earnings. However, by 1984, Its contribution to export dropped to 2.6 percent while in 2004 the contribution to as low as 0.81 percent (Central Bank of Nigeria, 2010). Coffee belongs to family member of the Rubiaceae. lt has two major species in Nigeria, *Coffea arabica and Coffea canephora (robusta).* Coffee plant is native of Africa. The origin of Coffee arabica has been traced to Ethiopia in the 9th century while Coffee robusta is believed to have come from Central Africa. In 1859 specifically coffee was introduced to Nigeria and is mostly cultivated in the lowland areas (*Coffea canephora*) and Highland areas (*Coffea arabica*). Coffee growing and drinking started in Ethiopia. Today, it is an important commodity and a popular beverage in the world. Coffee is one of the important export crops commodities in Africa and Latin America countries (Opeke, 2005).

Costs-Return Structures and Gross Margin Analysis

Gittinger (1994) defined the cost ascribed to any good or service as the amount in monetary value of the good or service and what it requires to acquire the good or service. Total cost represents the totality of all cost incurred by a farm in a production process. It is simply the summation of the variable cost and fixed inputs used in a production process, that is,

$$TC = FC + V$$

Fixed cost is the cost incurred in the period during which some factors of production (particularly capital equipment) are fixed.

This cost does not vary with the output. The following are described as component of fixed cost: machinery cost, farm buildings and structures, salaries of administrative staff among others, variables cost, on the other hand are which vary positively with output, rising as more is produced and falling as less is produced. Examples include, cost of seeds, fertilizer, herbicides, labour wages etc.

Revenue is the total income accruing from the sales of product or service. The revenue to be accrued is dependent on the total quantity of produce (i.e. quantity consumed and quantity of produce yet to be sold) and the price/unit of this produce. Thus, Revenue refers to the product of the unit Price and output Quantity; Gross margin, is defined as benefit accruing when the fixed cost of the process of production has not been charged or rather when only cost of variable input have been charged (deducted) in the revenue. It is the return made when depreciation on fixed assets, administrative charges, and other explicit cost have not been charged in the total revenue. That is, Gross margin is the Total Revenue less the Total Variable Cos**t.**

Objectives of the Study

(a). describe the socio-economic characteristics of the respondent (coffee farmers) in the study area and

(b). determine the profitability of production of coffee in the study area.

RESEARCH METHODOLOGY

The study was specifically carried out in Kogi State, Nigeria, It's capital is Lokoja, located in north central of Nigeria, confluence of the two largest rivers in West Africa - Rivers Niger and Benue. First administrative headquarters of Nigeria is Lokoja. Kogi state is located in central States of Nigeria, created on the 27th August, 1991.The state has a total population of about 3.278 million (NPC, 2006). Kogi State occupies a total land area of 29,833 square kilometres. The annual temperature varies between 27°C and 37°C with relative humidity between 30 and 40% in January and rising between 70 and 80% in July to August. the annual rainfall is between 1000mm and 1500mm. The research design adopted for the study was the surveying method in which sample was drawn from the population which is considered to be the representative of the population. The study made use of primary and secondary data. A multi-stage sampling technique was used for the study. First stage involved the use of purposive sampling technique to select 3 out of 4 Agricultural zones in the state. ln the second stage of sampling, 3 out of the 15 Local Government Areas in the selected zones were selected using simple random sampling in order to guarantee that each of the 15 Local Government Areas had equal and independent possibility of being selected since they are all producers of coffee. In the final stage of sampling, simple random sampling proportionate to size was again used to choose the respondents that were administered structured questionnaire. Descriptive statistics were used to analyse socio economics characteristics of the respondent and Gross Margin (GM) and Net Revenue (NR) were used to analyze the profitability of the farmers in the study area; Gross Margin (G.M) = TR-TVC

Where:

TR = Total Revenue

TVC = Total Variable Cost (operating expenses which include; cost of agrochemical, transportation, labour wage, cost of seed/cuttings).

RESULTS AND DISCUSSION

Sex of the Respondents

Sex determines the ability to perform some physical work. It is generally believed that men are more efficient in activities than woman. This perhaps, is because they are more energetic and can handle more tedious work than their female counterparts. This is in fact, the basis for comparing the sex of the Farmers. Table 4.1 showed that majority of the respondents, (77.8%) were male while 22.2% were females. This tends to show that any likely increase in efficiency of coffee production would be as a result of the predominant involvement of male farmers who are most likely to be more agile than their female counterparts. This implies that activities of coffee production in the study area are gender sensitive.

Table 1: Distribution of Respondents by Sex

Sex	Frequency	Percentage
Male	311	77.8
Female	89	22.2
Total	**400**	**100.0**

Source: Field Survey, 2022.

Primary Occupation of Respondents

The primary occupation distribution was analyzed to show the different primary occupation of the respondents was involved apart from farming. Table 2 show the main occupation of the respondents. The result showed that 69.8% of the farmers were farming by occupation. However, respondents engaged in other income generating activities such as marketing (13.0%) This implies that majority of the farmers engaged in farming which might have provided employment and means of livelihood for them, Also, the emphasis given to agriculture by the successive administrations in the country might be a reason for many people going into farming.

Table 2: Distribution of Respondents by Primary Occupation

Primary occupation	Frequency	Percentage
Farming	279	69.8
Marketing	52	13.0
Agricultural labour	31	7.8
Craftsmanship	8	2.0
Civil servant	27	6.8
Others	3	0.8
Total	**400**	**100.0**

Source: Field Survey, 2022.

Result of Cost - Return Structure and Profitability of Coffee Production

The average gross total revenue was ₦673,530.00 and the average gross total variable costs excluding the cost of seed purchased was ₦36304.27, whereas the average gross profit margin was ₦637225.73 and average net profit margin of ₦492347.60 and return on investment was ₦1.39. The result showed that production of coffee as a venture is profitable because for every ₦1 invested in the business, it yielded ₦1.39 (Table 16). This result is closely similar to that of Haruna, *et al.,* (2012), who reported ₦1.20 as returns per naira invested on fresh tomato marketing in Bauchi State, Nigeria. The benefit/cost ratio for goat in Oyo State according to Oladejo (2014) was ₦1.17, and for Ado-Ekiti Metropolis in Ekiti State according to Bamgboye *et al*., (2019) was ₦1.45, suggesting the enterprise is profitable in the study area. Mafimisebi *et al*., (2013). Profitability Index for the study showed a value of 0.14, whereas the efficiency index of 0.4 was obtained. According to Mafimisebi *et al*., (2013), if the value for profitability ratio is greater than 0, marketing is said to be money-making to the group of market intermediaries in question while if the value obtained is less than 0, the group of market intermediaries being studied are operating at a loss.

Therefore, when the value of the efficiency ratio is greater than 1, it is concluded that the market is operationally efficient while a value of less than 1 is interpreted to mean operational inefficiency. Thus, the findings from the coffee markets in the study area can be adjudged to be relatively profitable but operationally price inefficient. The findings are similar to what Mafimisebi *et al*., (2013) reported for cattle markets in Ondo and Oyo States. Bila and Bulama (2007) however observed a low marketing margin (47-84 percent) for cattle markets in Maiduguri, Borno State while the marketing efficiency was significant (42.6 percent) with inefficient pricing (-333.54 percent) and net income per head was ₦1,698.76. the authors concluded that the market is fairly efficient with inefficient pricing system. Price inefficiency could have arisen from non standardisation in product nature and the existence of market associations that brought a lot of distortions to the pricing system in cattle. This is consistent with the position of Adekanye (1982): Akanni (2013) who posited that the aim of overall marketing efficiency is to provide goods to the consumers in the required from, time and place at the lowest possible costs as desired by the producers. This is however achieved by passing the costs to producer and or consumer under the force competition.

Result of Cost- Return Structure and Profitability of Coffee Production

Table 3: Distribution of the Respondents by Cost -Return Structure of Coffee Production

Variable	Mean value (₦)	Standard Deviation
Hired labour cost	16809.50	14641.95
Family labour cost	13129.50	15828.67
Seed cost	5441.50	6043.47
Fertilizer cost	9190.50	139.44
Chemical cost	2136.25	1342.22
Total Variable Cost	**36304.27**	**31530.95**
Cutlass cost	1162.00	686.72
Hoes cost	198.63	111.09
Axes cost	8392.50	10241.86
Baskets cost	135225.00	80251.79
Total Fixed Cost	**144878.13**	**81910.39**
Total Cost	181182.39	93684.05
Total Revenue	673530.00	199495.37
Gross Margin	637225.73	209004.36
Net farm income	**492347.60**	**212643.63**
Profitability Index MM	0.14	0.013
Efficiency Ratio	0.4	0.012
Price Inefficiency	0.12	
Return on one Naira Invested	1.39	

Source: Field Survey, 2022

CONCLUSION AND RECOMMENDATION

The result shows that larger percentages (69.8%) of the respondents were farmers by occupation. The average gross total revenue was ₦673, 530.00 and the average gross total variable costs excluding the cost of seed purchased was ₦36304.27, whereas the mean gross profit margin was ₦ 637225.73 and average net profit margin of ₦492347.60 and return on investment was ₦1.39. The result showed that production of coffee as a venture is profitable because for every ₦1 invested in the business, it yielded ₦1.39. With regards to farmer's specific factors, especially education, there is need for policy to promote formal education as a mean of enhancing the production of coffee over a long-term period. As this would enable the farmers to make better technical decision and help in allocating their production input effectively. More coffee farmers should be encouraged to form and join viable cooperative societies in order to access financial assistance at concessional rates, obtain goods and services at low prices, thereby importing their standard of living.

Lastly. Farmer should make sure that the farm environments are kept clean especially during the dry season to prevent fire outbreak which may cause havoc to coffee farm and drastically reduce efficiency of coffee production.

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ASSESSMENT OF SEEDLING EMERGENCE AND VEGETATIVE GROWTH OF RUBBER ((*Hevea brasili*ensis Muell Arg.) AS INFLUENCED BY SEED ORIENTATION FOR ROOTSTOCK PRODUCTION

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ABSTRACT
*Hevea brasiliensis of the Euphorbiaceae family supplies 99 per cent of the world's natural rubber. The seeds have useful chemical composition and are utilized mainly for the production of root stocks. This study was initiated to assess early emergence and growth vigour of Hevea brasiliensis as influenced by seed orientation in Rubber Research Institute Substation Akwete, Abia State. The seeds were sown in three seed orientations; horizontal with hilum side wards (HHS), vertical with hilum downwards (VHD) and vertical with hilum upwards (VHU). The experiment was laid out in a completely randomized design replicated three times. The study revealed non- significant effect ($P > 0.05$) of seed orientation on days to seedling emergence initiation (DEI), percentage emergence at 3 weeks after sowing (% E), stem girth growth rate (SGR), seedling shoot length rate (SLR), seedling root length rate (RLR), total seedling length rate (TLR), vigour index rate (VIR). However, Leaf area growth rate (LAR), number of leaves per seedling rate (NLR), and total dry weight growth rate (TWR) were significantly ($P < 0.05$) influenced by seed orientation. Positive and significant correlations were found between TWR and LAR (r=0.831**), NLR (r=0. 677 *), RLR (0.741*) and TLR (0.705*). VIR and % E (r=0.899**), SLR (r=0.893**), RLR (0.764*) and TLR (r=0.946**). Generally, vertical seed orientation with hilum downwards (VHD) gave early days to seedling emergence initiation (5 days), higher % E (100 %), larger LAR (2.97 cm^2), longest SLR (5.36 cm) and highest VIR (860) of rubber root stocks.*
Keywords: *Emergence, seed orientation, rootstock, vegetative growth.*

INTRODUCTION

Rubber tree (*Hevea brasiliensis* Muell. Arg.) is a multipurpose plant grown primarily for latex production with numerous useful by-products such as rubber seed, woods and oil. The seeds are dispersed by explosive mechanism which occurs from the period of August break to early October. The seeds are regularly collected during this time to avoid mouldiness which can affect viability of seeds (Uraih and Omokhafe, 2001). The mode of germination is hypogeal which occurs within six to seven days after sowing and about 75 percent germination is considered good. Fresh and heavy seeds show early germination (Saraswathyamma and Nair, 1976) and viability can be maintained for about seven days when kept under shade (Marattukalam and Mercykutty, 2000). Each rubber tree yields about 800 seeds (1.3 kg) and 500 999kg/ha/yr. The tree growth has limitation at the seed production level. Seeds collection, maintenance of seeds quality and low seeds germination make it necessary to use large quantity of seeds for plant establishment (Moreno *et al*., 2006). There is a great demand for certified rubber planting materials. In order to raise large scale rubber plantation, quality seeds and proper seed orientation are considered in the root stock pre nursery establishment.

Germination is a life cycle that produces new generation. Seeds have a physiological ability to germinate and correctly orient themselves according to gravity, a process known as gravi -tropism (Takakura *et al*., 1996). Seed orientations during sowing and in a suitable environment greatly affect the germination rate, seedling emergence, high plant population, seedling physiology and seedling morphology (Kevin *et al*., 2015; Lee *et al*., 2016). According to Jha *et al*. (2012) when radicle points upwards, the embryonic root and stem emerge in the wrong direction and have to change orientation, which requires energy and subsequently reduces plant growth. Several studies have been carried out on seed orientation effect on plant germination, growth vigour and its interactive effect (Rama Bhat, 2011; Ahn 2017). This study investigated the effects of seed sowing orientation on emergence and vegetative growth of rubber for root stock production.

MATERIALS AND METHODS

Study Area

The study was conducted in screen house of Rubber Research Institute of Nigeria, Sub-Station Akwete Abia State between August and November, 2022. Akwete is located at a latitude of 4^o 50′ and 4^o 65′ N and Longitude 7^o 00′ and 7^o 19′ E at an elevation of 122 meters above sea level in the tropical rainforest zone of south east Nigeria (Kamalu *et al*., 2014). The area is characterized by annual rainfall of about 2352.23 mm, mean air temperature range of (23 to 34 ^oC) and relative humidity range of (50 to 86.4 %). The soil was classified in USDA soil taxonomy as Fluvaquentic Dystrudept (Ugwa *et al*., 2017).

Planting Material

The seeds of Nigeria 811 (NIG 811) obtained from rubber clonal garden in the Substation were laid in a complete randomized design replicated three times in the screen house. The nursery bags filled with top soil were sown with one seed per bag and arranged according to three seed orientations (horizontal with hilum side wards (HHS); vertical with hilum downwards (VHD) and vertical with hilum upwards (VHU)). However, there was no fertilizer application and the pots were maintained accordingly.

Traits Assessments

Vegetative traits measured included: days to seedling emergence initiation – recorded as number of days between sowing and emergence, percentage emergence- done by counting the number of seedlings that emerged per treatment divided by the total number of seeds sown for each treatment multiplied by 100 , seedling height- measured with a meter rule from ground level to the apical region of the stem, root length- measured from soil base to the longest root, number of leaves per plant- counted and recorded of fully formed leaves, leaf area per plant - obtained by multiplying the leaf Length x Breadth with a correction factor of 0.654 (Tim and Narayana, 1972). Stem girth was also measured using a vernier caliper at 10 cm from the seedling base and biomass accumulation was obtained by cutting the shoot biomass (stems and leaves) and oven dried until a constant weight was obtained. Vigour index (VI) was computed as percentage emergence x total seedling length (root + shoot) (Abdul-Baki and Anderson, 1973) and expressed as a whole number. These activities were performed on monthly basis. However, for this study, instead of comparing the measured traits from different ages, the seedling growth rate was obtained by dividing9999 vegetative traits by the seedling age at the end of the study (4 months). The seedling growth rates evaluated included; seedling shoot length rate (SLR), seedling root length rate (RLR), total seedling length rate (TLR), number of leaves rate (NLR), stem girth rate (SGR), leaf area rate (LAR), vigour index rate (VIR) and total dry weight rate (TWR).

Data Analysis

The data obtained were subjected to one-way analysis of variance and the means separated using the least significant difference at 5 % level of probability (LSD) Genstat (2009).

RESULTS

The days to seedling emergence initiation was within two weeks and varied from 5.7 to 8.7 with no significant difference ($P > 0.05$) among the treatments. Similarly, percentage emergence was not significant (Table 1). Seed orientation; vertical with hilum downwards (VHD) with lower days to seedling emergence initiation (5 days) recorded the highest percentage emergence of 100 %. While seed orientation; vertical with hilum upwards (VHU) and horizontal with hilum side wards (HHS) with days to emergence initiation of 5.7 days and 8.7 days recorded percentage emergence count of 83.3 % and 66.7 % respectively. Seed orientation had no significant ($P > 0.05$) effect on all measured seedling growth rate except LAR, NLR and TDWR (Table 2). Seed orientation- VHD produced larger LAR which was 52.2 %

and 7.74% higher than HHS and VHU respectively; longer SLR and better VIR. While seed orientation - VHU recorded the highest and smallest NLR (1.90), RLR (3.39), TLR (8.48) and TWR (0.41) respectively. Also, SGR values were higher when seeds were sown with HHS followed with VHD orientation. The results also revealed that the higher the percentage emergence with corresponding earlier days to seedling emergence initiation, the greater the leaf area, number of leaf and seedling height growth rates.

The Pearson's correlation coefficients (Table 3) showed that TWR had a significant correlation with leaf area rate (LAR) with correlation coefficients (r) = 0.831**, NLR (r = 0. 677 *), RLR (0.741*), TLR (0.705*). The relationship with % E (r = 0.447), SLR (0.517) and VIR (r = 0.15) were not significant. Similarly, VIR had a positive and highly significant relationship with % E (r = 0.899**) and SLR (r = 0.893**), TLR (r=0.946**) and RLR (0.764*). The association of TLR with % E (r = 0.727*), SLR (0.911**), SLR (0.842) were also positive. % E and RLR were positively correlated with the studied parameters except with DEI (- 0.289) and SGR (r = - 0.262) respectively. TLR and NLR were also positively correlated with LAR (r = 0.484), NLR (r = 0.438) and LAR (r = 0.438) and LAR (0.586) respectively.

DISCUSSION

Seed orientation did not show any significant influence on emergence traits suggesting that acceptable rubber rootstock seedlings could be raised irrespective of seed orientation. However, Bowers and Hayen (1972), Masilamani *et al*. (1999), Ahn *et al.* (2017) reported significant effect of seed orientation on germination and seedling growth in bean, canjan and peanut, respectively indicating a close relationship between seed orientation and germination.

Table 1: Effect of seed orientation on germination characters

Treatments	Days to seedling emergence initiation	% seedling emergence at 3 weeks after sowing
HHS	8.7	66.7
VHD	5	100.0
VHU	5.7	83.3
$LSD_{(5\ \%)}$	12.72ns	47.09ns

LSD = Least significant difference, ns = not significant. Seed orientations; (HHS) = Horizontal with hilum side wards, (VHD) = vertical with hilum downwards and (VHU) = vertical with hilum upwards.

Table 2: Effect of seed orientation on seedling growth rate traits

Treatments	LAR (cm^2)	NLR	SGR(mm)	SLR(cm)	RLR(cm)	TLR(cm)	VIR	TWR (g)
				Month $^{-1}$				
HHS	1.42	1.06	0.56	3.77	1.98	5.75	439.0	0.24
VHD	2.97	1.50	0.43	5.36	3.24	8.4	860.0	0.39
VHU	2.74	1.90	0.44	5.09	3.39	8.48	706.38	0.41
LSD (5 %)	0.701**	0.59*	0.42ns	2.384ns	2.131ns	3.603ns	549.9ns	0.1051*

LSD = Least significant difference, ns = not significant, **, * Correlation is significant at the 0.01 and 0.05 level (2-tailed) respectively. Seed orientations; (HHS) = Horizontal with hilum side wards, (VHD) = vertical with hilum downwards and (VHU) = vertical with hilum upwards. Leaf area rate **(LAR),** number of leaves rate (**NLR**), stem girth growth rate (**SGR**), Seedling shoot length growth rate (**SLR**), Seedling root length growth rate (**RLR**), total seedling length growth rate (**TLR**), vigour index growth rate (**VIR**), total dry weight growth rate (**TWR**).

Table 3: Correlation matrix of the studied parameters of the evaluated rubber seed orientation

	LAR	SGR	NLR	DEI	% E	SLR	RLR	TLR	VIR	TWR
LAR	1									
SGR	-.343	1								
NLR	.586	-.530	1							
DEI	-.316	-.187	-.246	1						
% E	.399	.287	.015	-.289	1					
SLR	.473	.063	.233	.226	.756*	1				
RLR	.360	-.262	.555	.030	.508	.548	1			
TLR	.484	-.097	.438	.160	.727*	.911**	.842**	1		
VIR	.444	.026	.263	-.016	.899**	.893**	.764*	.946**	1	
TWR	.831**	-.266	.677*	-.218	.447	.517	.741*	.705*	.615	1

**, * Correlation is significant at the 0.01 and 0.05 level (2-tailed) respectively. leaf area growth rate (LAR), stem growth rate (SGR), number of leaves rate (NLR), days to seedling emergence initiation (DEI), percentage seedling emergence (% E), seedling shoot length rate (SLR), seedling root length rate (RLR), total seedling length rate (TLR), vigour index rate (VIR), total dry weight rate (TWR).

The earliness to days of emergence initiation and high percentage emergence recorded was in line with the works of Wongvarodom *et al*. (2014) and Atminingsih and Andriyanto (2020) who reported between 54 to 85.50 percent germination of rubber seeds within two weeks after sowing. In this study, VHD largely had earlier time to emergence initiation and greater percentage emergence followed by VHU. Similar results were obtained by Rama Bhat (2011) in *Calamus prasinus* and Srimathi *et al*. (2014) in *Jatropha curcas* L. According to Ma and Hasenstein (2006), Finch-Savage *et al*. (2010) and Jha *et al*. (2012), this was attributed to proper radicle direction leading to a rapid emergence, germination and initial downward growth of the seedlings little energy. In contrast to our result, Gunasekaran (1997) observed that horizontal orientation with micropylar end facing sideways proved superior to vertical and inverted position in Clove (*Syzgium aromaticum*), Nutmeg (*Myristica fragrans*) and Rubber (*Hevea brasiliensis*). While Krishnasamy (1992) in cucurbitaceous vegetables and Rama Bhat (2011) in *Calamus stoloniferus* and *C. thwaitesii* reported early and higher percentage emergence as well as seedling vigour when seeds were in sown vertical orientation. This really indicated that selection of seed orientation expressed in the emergence traits is genetic identity of each species. Though the plants from seed orientation; VHD and VHU generally exhibited better growth rate traits, the difference was statistically significant ($P < 0.05$) for LAR, TWR**.**

The non –significant effect of the growth rates; SGR, SLR, RLR, TLR and VIR of the seedlings among treatments exhibited similar pattern; indicating that rootstock seedlings and traits are not affected by seed orientation. According to Atminingsih and Andriyanto (2020), Marattukalam and Mercykutty (2000) budding is dependent on rootstock age and type of budding thus, not necessarily on seed orientation. The maximum SLR, VIR and RLR recorded at seed inverted and up orientation were similar to the earlier reports of Rama Bhat (2011) in *C. prasinus* and *C. thwaitesii*. The observable higher seedling emergence with corresponding higher seedling growth rate is similar with the results of Atminingsih and Andriyanto (2020). The positive and significant correlations between TWR and most parameters suggested that an increase in performance of one implies an increase in performance of the others. According to Prawiranata and Tjonodronegoro (1995), TWR of seedlings expresses an indicator to determine whether or not plant reflects the plant nutrient status, the rate of photosynthesis and plant respiration. The positive correlation between RLR and SLR according to Budiman *et al*. (2015) reflects the capacity of the root to support the above ground biomass not only for anchorage but also in absorbing water and nutrients from the soil especially in limited soil water area (Takoutsing *et al*., 2014). Similar reports were also made by Budiman *et al*. (2015).

CONCLUSION

The results of this present study inferred that vertical seed orientation with hilum downwards (VHD) resulted to a better seedling emergence and general growth vigour. Thus, could be utilized in pre-nursery for raising of rubber root stock materials. To confirm this result, further work is expected to be done using more rubber seed genotypes.

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PERCEIVED EFFECT OF ADOPTION OF EXPORT STANDARD PRACTICES (ESP) ON COFFEE FARMERS' PRODUCTIVITY IN KOGI STATE, NIGERIA

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ABSTRACT
The study investigated perceived effect of adoption of Export Standard Practices (ESP) on Coffee farmers' productivity in Kogi State, Nigeria. Specifically, the study described the personal characteristics of the respondents, assessed the extent of adoption of ESP and examined the effect of the adoption of ESP on coffee productivity. Multistage random sampling was used to select two hundred and twenty seven (227) coffee farmers. Data was collected using validated interview schedule while frequency count and percentages, weighted mean score and binary logistic regression were used for data analysis. The results revealed that 43.74 is the mean age of the respondents, majority of the respondent were male (84.1%), married (86.8%) with mean household size of 8.52 persons and mean farm size 5.8ha. The farmers did not deliberately adopt this practice with the continuous usage of only 5.7% based on the findings of this study. The extent of adoption of ESP among the coffee farmers' is very low indicated by the result analysis. The effect of awareness of export standard practices (Mean = 2.59) did not contribute to farmers' productivity. This means that awareness may not lead to adoption and utilization but it is just the first stage in the adoption process. However, if awareness is well managed, it can determine adoption provided inputs information and monitoring are incorporated at the awareness stage.
Keywords: *Adoption, awareness, practice, coffee, farmer, effect, export standard practices.*

INTRODUCTION

Coffee used to be one of the major cash crops of Nigerian economy before the discovery of petroleum. People rely on coffee for their livelihood and major means of survival, thus it recognition falls due to poor management practices, inadequate post-harvest handling, poor pricing. Coffee production ranged from 18,000 bags in 1961 to 50,000 bags in 2008. The highest annual production (95,000 bags) was obtained in 1964, 1988 and 1990 respectively (Williams 2008). Coffee is produced in more than 70 countries in the world and 97% of these countries are exporting members of International Coffee Organization. Most of these countries coffee export is not only vital contributor of foreign exchange but also accounts for a significant proportion of tax income and Gross Domestic Product (ICO, 2013). During the year 2010, it was estimated that about 26 million people in 52 producing countries were employed by the sector. The importance of the crop is diminishing as it was only in seven producing counties between 2000 – 2010 where average share of total export earnings exceeded 10% compared to 15% in the same category in the period 1996-2000.

Globally consumption of coffee is seen to grow at low rate but steady from 1980 to date (ICO, 2013), which is a good gesture towards sustainable coffee market. Over 600,000- 700,000 smallholder farmers are engaged in coffee production commanding a 48% share of the market. Over 80% of coffee from developing countries particularly Nigeria, is produced by small scale farmers who have inadequate technical education and are faced with low market prices leading to poor management, poor productivity and abandon farms (Agbongiarhuoyi *et al*., 2006). There has been a decline in coffee production in recent years mainly due to decline in prices and non-compliance with adoption of ESP in coffee production that could guarantee improves sales. Consequently, farmers are faced with poor price, low income, low profits and increased poverty. Idrisu, *et al.* (2012), reported that some problems arising from several factors related to the quantity and quality of the product, these factors include poor information on appropriate husbandry practices, good agricultural/management practices, quality of the product, processing, pricing, marketing problem.

Kogi State is known as the major producers of Coffee robusta in Nigeria. Income generated from production and marketing of coffee in the State has contributed immensely to sustenance of livelihoods and development of communities. It is unfortunate that marketing of coffee is no longer lucrative in the State. A lot of factors have been suggested to cause crisis in coffee trade; however, the issue in marketing chain and low price were considered paramount (Idrisu *et al*, 2012). According to Laven and Boosma (2012), the adoption of improved export standard practices is a platform for increased price of coffee, farmers' profits, through higher yields, good quality and internationally accepted coffee for export.

The specific objectives of the study were to;

1. describe the personal characteristics of coffee farmers in the study area,
2. assess the extent of adoption of ESP,
3. examine the perceived effect of adoption of ESP on coffee productivity in the study area

MATERIALS AND METHODS

Kogi state is purposively selected for this study because the state is the highest producer of coffee in Nigeria (Akinpelu and Oluyole, 2020; Idrisu*et al.* 2012). A three stage sampling procedure was used to select coffee farmers. The first stage is purposive selection of Kogi State for their higher coffee production in the country. The second stage was random selection of four Local Government Areas (LGAs) among the 16 LGAs in the State with the highest production of coffee. The third stage is random selection of 227 respondents coffee farmers from the list obtain from coffee association in Kogi State. The primary data collected through field survey. Respondents' was interviewed through the use of structured questionnaire and it was supplemented by information through focus group discussion with the coffee farmers' group leaders. The questionnaire was designed to obtain information relevant to the objectives of the study. The questionnaire was designed and presented for modification before experts in Agricultural Extension Services to ensure its validity.

Effect of adoption of ESP on farmers' productivity on coffee production was measured by asking the respondents to indicate their extent of agreement with the statement on productivity which will be ranked using a 5-point likert-type scale such as Strongly agree (SA-5), Agree (A-4), Undecided (U-3), Disagree (D-2), Strongly disagree (SD-1). This will be added to obtain 15 and will be divided by 5 to obtain the mean point of 3; any statement of productivity below 3 points will be regarded as statement not true with productivity. This study considered two paramount sets of variables which are independent and dependent variables. The dependents variable of this study is perceived effect of adoption of export standard practices (ESP) while independent variable includes: socio-economic characteristics of the respondents, profitability of ESP to adopters and non-adopters,

Coffee is an important crop globally. It contributes to National GDP, tax generations, job creation food security and inequality reduction. Globally, 25 million people in coffee growing countries are employed in the sector. Low coffee production resulting from world coffee prices of 1990s saw the production dwindling resulting to increase in poverty especially of small scale farmers due to low finances to support it's production. In Kenya for example 80% of coffee is produced by 700,000 small scale farmers currently the production dropped from 130,000 MT tones in 1987/88 to current 55,000 MT and contribution to national GDP dropped from 40% to currently 3.2% and hundreds of jobs were also lost(Karanja and Nyoro, 2002). Irrespective of poor coffee prices due to global crisis and inefficiencies throughout the coffee production value chain, farmers are still producing coffee which is of low quality despite of country's potential of producing specialty coffee due it's ecological positioning and unlikely to uplift them from poverty mainly because of lack of better paying alternatives, over regulation and high sunk cost associated with uprooting the crop (Kegonde, 2005).

RESULTS AND DISSCUSSION

Socioeconomics Characteristics of Coffee Farmers

Results in Table 1 show that the mean age of the respondents was approximately 44 years, hence, the farmers are still in their economically productive age and can therefore withstand the rigour associated with plantation farming. This implies that farmers are still young to know the significance of export standard practices of coffee on the quality of produce and pricing. This is because research has confirmed that learning reduces with an increase in age (Kelemen, 2014) and adoption of farming related practices has been documented to be influenced by age (Serebrennikov, Thorne, Kallas and McCarthy, 2020; Wauters and Mathijs, 2014 and Liu; Bruins; Heberling, 2018). Evidence in Table 1 also shows that majority (84.1%) of the respondents were male while women constituted less than one-quarter (25%) of the coffee farmers in the study area. The reason for this may not be farfetched as women and youth are less likely to be allocated farmland for tree crops in many parts of Nigeria due to cultural implications of land ownership (Chigbu, 2020). Culturally and traditionally, women access to farmland is limited as they are not mostly allowed to access farmland for plantation farming. This is because this type of farming is assumed to be synonymous to permanent ownership of farmland. Also, Kidido and Lengoiboni (2019) asserted that the fear of selling farmland by the youth and the impatience of the youth for the gestation period of most tree crops were responsible for the limited access given to youth with respect to farmland. However, both women and youth may be encouraged through mixed farming and communal land ownership as this would curtail the traditional fear of transferring ownership of farmland to women and the fear of youth selling the farmland if they are given the full ownership. It was also observed those majorities (86.8%) were married and widowed (1.8%). Marital status is said to be a measure of commitment as opined by Aderolu *et al*., 2014.

This finding is in line with Akinpelu and Oluyole (2020) who reported marital status of coffee farmers in Kogi State as a significant variable in their involvement in coffee production. The high marital status may be useful in the area of family labour and commitment to coffee production. Results in Table 1 further shows that about 18.1% and 23.3% of the respondents had no formal education and primary education, respectively while 45.8% had secondary education and only 12.8% had tertiary education. The findings show that most of the coffee farmers had between primary and secondary education while few had tertiary education. The level of education is adequate to promote awareness and adoption of practices that may enhance their mean of livelihood such as coffee farming. This is because education has been researched as a significant determinant of adoption of farming practices by extant literature such as Akinpelu and Oluyole (2020), Adinoyi and Attanda (2016) and Mohammed, Ayanlere and Ekenta (2013) in their various studies on adoption. This implies that with this moderate level of education in which majority had between primary and secondary education, the level of awareness and adoption may be high if other various are assumed to be constant. Based on the results of analysis of the findings, it was revealed that 39.2% and 43.6% of the farmers who produced Coffee in Kogi State were either Muslims or Christians while relatively high proportions believe in the traditional way of worship. The findings show that Islam and Christianity are the dominant religion practice by the respondents, although few of them were still found in the traditional religious belief system.

The finding is in consonant with the findings of Agwu,Ndakotsu and Ifeonu (2019) that reported that the ratio between Christians and Muslims farmers in Kogi State was about 50:40 as the findings specifically stated that about 54.2% and 45.8% of the farmers were Christians and Muslims, respectively. However, the findings further stated that religious affiliation has not influence whatsoever on the cultivation of tree crops and no religious restriction was found on the cultivation of major tree crops among farmers in the State. Meanwhile, religious affiliation may be advantageous to farmers as they could represent a viable and sustainable information sources on members means of livelihood. The numbers of members of a household are those that eat from the same pot and sleep under the same roof at a particular period of time. In this study, it was found that on average, about 9 persons were found as members of the Coffee farmers household and about 45.4% had between 5 and 10 household members while 28.6% had between 11 persons and above as their household size. The findings show that Coffee farmers in the study area had moderately high household members and the implication of this is that they may have enough members of their family being used as family labour provided their interest in farming is aroused through better yield, the use of technology and better profit. The finding is in-line with the findings of Agwu *et al*. (2019) that reported that about 50% of farmers in Kogi State had between 5 and 10 household size and Akinpelu and Oluyole (2020) reported that in the same state, about 52.0% and 24.0% of Coffee farmers had between 5-10 and 11 and above as members of their household, respectively.

Results in Table 1 show that farmers had huge experience in Coffee production as the mean years of experience was found as approximately 22 years and about 38.3% and 41.4%, respectively had between 20 and 29 years and 30 years and above as their years of experience in the production of Coffee. This means that the experience of the farmers may come to play in the awareness and adoption of practices that will ensure that the crops, being an export crops are internationally recognized and accepted, provided the information of the export standard practices are sought for by the farmers. The finding conforms with the findings from the various authors such as Agwu *et al*. (2019) that reported that in Kogi State the average farming experinec recorded by the Coffee farmers was 19 years, while Akinpelu and Oluyole (2020) asserted that Coffee farmers in the State had approximately, on average, 29 years of farming experience and Mohammad *et al*. (2013) affirmed that about 78% of the Coffee farmers in the state had over 30 years of farming experience.

Farm size was measured in hectares as the standard of measurement and report from the study shows that the average farm size by the farmers was about 5.76 hectares while only 4.0% of the farmers had less than 2.5 hectares of farmland, 35.7% had between 2.5 and 5 hectares and 60.4% had 5 hectares and above as the size of the farms dedicated for Coffee production. The findings show that Coffee farmers in the study area operate medium scale farming as most of them operate on a farm land that is more than 5 hectares. In Africa, due to land tenure system, farm land ranging from 1 – 5 hectares are classified as small scale while between 5 hectares and above are classified as medium scale according to Lowder and Raney (2016). This implies that most of the farmers in this study operate at medium scale farming with 5.76 hectares as the average farm size. The finding conforms to the previous findings by Akinpelu and Oluyole (2020) whose results showed that farmers cultivated about 5 hectares of farmland for Coffee production while Aderolu*et al.* (2014) posited that the average farm size dedicated for Coffee production in Kogi State was approximately 6.1 hectares.

Table 1: Socio-economic characteristics of respondents

Variables	Freq., n = 227	%	Mean
Age (Years)			
<30	8	3.5	
30 - 49 yrs	97	42.7	43.74
50 - 59 yrs	87	38.3	
60 years and above	35	15.4	
Sex			
Male	191	84.1	
Female	36	15.9	
Marital status			
Single	17	7.5	
Married	197	86.8	
Divorced	9	4.0	
Widowed/widower	4	1.8	
Level of education			
No formal education	41	18.1	
Primary education	53	23.3	
Secondary education	104	45.8	
Tertiary education	29	12.8	
Religion			

Traditional	39	17.2	
Islam	89	39.2	
Christianity	99	43.6	
Household Size			
<5	59	26.0	
5 - 10	103	45.4	8.52
11 persons and above	65	28.6	
Experience in cultivating coffee			
<10	19	8.4	
10 -19 yrs	27	11.9	
20 - 29 yrs	87	38.3	21.51
30 yrs and Above	94	41.4	
Size of land (ha) for coffee production			
<2.5	9	4.0	
2.5 - 5ha	81	35.7	5.76
5 ha and Above	137	60.4	

Source: Computed from Field Survey, 2021.

Results in Table 2 show that almost 90% (89.9%) of the Coffee farmers in Kogi State cultivated Robusta species of the tree crop while only 10.1% cultivated Arabica type. The findings show that the most common type of Coffee cultivated in the study area is the Robusta type. This is in line with the previous findings by authors like Aderolu *et al*. (2014) that reported that 100% of farmers in Kabba Local Government Ares of Kogi State cultivated Coffea Robusta, Ali, Adesanya, Agboola-Adedoja, Adelusi, Ogunwolu, Ugwu and Akinpelu (2021) revealed that although two types of Coffee are cultivated in Nigeria but Coffea Robusta was the common cultivate species suitable for the soil and other climatic conditions in Nigeria. On the mode of farmland acquisition, report shows that most of the respondents, a little below average (48.0%) acquired their farmland by inheritance, 34.8% acquired farmland by outright purchase while 9.7% rented and 7.5% were gifted their farmland used for Coffee farming. This shows that most of the respondents used family land inherited from their family members for the Coffee plantation. Usually, land is a critical factor in the production of economic tree crops in Nigeria due to the undue pressure on land as a result of land tenure system.

Therefore, the easiest way of securing a land for such permanent crops is through inheritance because land ownership is in the hands of individual and community as an entity, hence, individual and community control the ownership of land. In situation where a farmer has enough money to purchase, it is always difficult to acquire large expanse of farmland due to the communal and family influence that usually generate into crisis for the buyers. This finding is in tandem with the studies of Aderolu *et al*. (2014) and Mohammed *et al*. (2013) that reported that 90.0% and 87.0% of the coffee farmers in Kogi State acquired their farmland by inheritance while only 10.0% and 8.0% were respectively reported by the authors as those that purchase their farmland. This simply means that land by inheritance is the viable mode of land acquisition for plantation farming like Coffee.

Evidence in Table 2 shows that most of the Coffee farmers used hired labour as slightly above 80% (82.2%) reported the use of hired labour for Coffee production while only 10.6% indicated that they used family labour. Similarly, about 38.8% of the farmers used both family and hired labour. This means that hired labour is the common form of labour used. The use of family labour for farming has been affected by rapid migration of youth out of rural areas to urban areas due to lack of basic amenities that could make them to stay (Ajaero and Onokala, 2013). This has been a major set-back to farming in Nigeria as farming primarily takes place in rural areas due to less pressure on land for building construction and other industrial uses (Yusuf, 2018).

Results in Table 2 show that on average farmers earned about ₦795, 500.14 from the sales of Coffee annually. This means that on a monthly basis, a farmer earns about ₦66, 291.00 as an income from the sales of Coffee. This shows that Coffee farmers in Nigeria earn far more above the monthly minimum income of ₦30, 000.00 per month and ₦360, 000.00 per annum. This implies that Coffee production may be profitable just like every other tree crops in Nigeria. Though, cost of inputs and other factors of production may grossly affect the farmers' income under adequate cost and returns analysis of Coffee production. Even with this, it could be observed from the above analysis that Coffee farming enterprise is profitable. This is in conformity with the finding of Mohammad *et al*. (2013) that stated that the profitability index of Coffee farmer was 0.29; an indication that Coffee farmers earn 0.29 on every naira invested into production and this low level of profit was attributed to the high cost of labour. This is because the study submitted that the cost of labour takes about 95.16% share of the total variable cost. This may be attributed to the scarcity of family labour in rural areas where farming takes place; hence, farmers have no choice than to depend on hired labour.

Findings show that Coffee farmers did not just depend on Coffee production as the only mean of livelihood but engage in other forms of enterprises such as crop and animal rearing, artisanship, trading and civil and public services to complement the income from Coffee. Specifically, the findings show that 85.9% of the farmers engaged in other forms of faring activities, 29.5% engaged in artisanship, 31.3% were found to have indicated their involvement in trading while about 25.6% were involved in public service. The findings show that Coffee farmers have high degree of income diversification. This may be of great benefit as income from other occupation may be useful in keeping the family going before the maturation of Coffee trees. This is based on the assertion of Feintrenie, Ollivier and Enjalric (2010) on the significance of agro-forestry as a strategy to alleviate poverty. This is because tree crops take a longer period to attain gestation and farmers on solely depend on them for survival may suffer before this period. The concept of agro forestry is a strategy to support the establishment and maintenance of tree crops. Also, establishment of tree crops require huge investment and getting income from other sources may be of great help in securing such an investment in tree crop farming.

Evidence further shows that reasonable amount of income is obtained by farmers from other sources. It was revealed that on average, farmers earned approximately about ₦507, 590.44 from other sources. This will serve as a great source of investment for the maintenance of Coffee plant which takes approximately 3 – 4 years for the newly established plantation. Specifically, about 33.5% earned less than ₦500, 000 as their annual income from other income sources apart from Coffee production while only about 5.7% earned ₦900, 000 and above. Just like every other tree crop farming in Nigeria, farmers involve in other economic enterprises that sustain them during the growing period and off season. This may also be the case among Coffee farmers in the study area as this finding found that they involved and earned substantially from other occupation apart from Coffee production.

The finding reveals that contact with extension agents was very poor as just about a quarter (26.9%) of the farmers indicated that they had contact with extension agents. This shows that extension visit to coffee farmers was poor and the implication of this is that coffee farmers may be poorly updated with respect to technologies that would be used for optimal production and information that could enhance the quality of coffee beans, most especially information on the export standard practices that may promote and encourage the production of high quality coffee beans that would be internationally recognized and accepted by the international communities, hence, better earnings. The finding support the study of Aderolu *et al*. (2014) that submitted that only 15.0% of Coffee farmers received information from extension agents in the Kogi State. The significance of extension contact was emphasized by the study of Ntshangase, Muroyiwa and Sibanda (2018) where extension contacts made huge contributions to the adoption of zero tillage among farmers in Zashuke, KwaZulu-Natal Province in South Africa**.**

Access to credit is also another critical factor of production in farming. Based on the findings of this study, it was observed that less than the average (42.3%) of the farmers had access to credit in form of either loan or grants. This shows that farmers may be unable to manage large hectares of farmland if they are to depend on their own finance without assistance from external sources such as the government, NGOs, and other stakeholders in agriculture. Similarly, Ntshangase *et al* (2018) indicated that only about 10% of farmers in South Africa could access credit for farming while Ajah (2017) posited that farmers in Nigeria only access credit within their self-built effort such as cooperative society and other forms of self-help mechanism as government pays less attention toward improving agricultural productivity in terms of credit and grants to farmers.

Results in Table 1 show that very few (5.3%) of the respondents indicated their awareness of Export Standard Practices in Coffee production. The findings show that awareness of ESP among Coffee farmers was low despite the introduction of these practices by CRIN with a view to increasing farmers' profitability in cocoa production in line with the guideline of International Coffee Organization (ICO, 2018) Coffee Exporter's Guide for coffee processing. The implication of this finding is that Coffee farmers may still be using old technique for Coffee production. The low awareness of the export practices in Coffee production and processing may be attributed to the poor extension contact earlier recorded. This may have negative significant implication on the quality of Coffee beans and farmers' profit in the study area.

Table 2: Socio-economic characteristics of respondents (Cont'd)

Variables	**Freq., n = 227**	**%**	**Mean**
Type of coffee cultivated			
Robusta coffee	204	89.9	
Arabica coffee	23	10.1	
Mode of farmland acquisition			
Rent	22	9.7	
Gift	17	7.5	
Purchase	79	34.8	
Inheritance	109	48.0	
Type of labour used**			
Family labour	24	10.6	
Hired	182	80.2	
Both	88	38.8	
Average income from coffee (Naira)/year			
<700,000	27	11.9	
700,000 - 800,000	55	24.2	
800,001 - 900,000	21	9.3	795,500.14
900,001 - 1,000,000	63	27.8	
1,000,000 and Above	61	26.9	
Other occupation**			
Other farming activities	195	85.9	
Artisan	67	29.5	
Business	71	31.3	
Public service	58	25.6	
Income from Other occupation/annual (Naira)			
<500,000	76	33.5	
500,001 - 600,000	41	18.1	
600,001 - 700,000	27	11.9	
700,001 - 800,000	39	17.2	507,590.44
800,001 - 900,000	31	13.7	
900,001 and Above	13	5.7	
Contact with extension agent	61	26.9	
Access to farm credit	96	42.3	

Source: Computed from Field Survey, 2021.
**Multiple responses given

The extent of Adoption of Export Standard Practices

Results in Table 3 show that only about 8.4% of the respondents were aware of the regular harvesting of ripe berries fortnightly and weekly at peak period as one of the export standard practices that must be adopted to improve the quality of Coffee bean while the remaining 91.6% indicated that they were not aware of this practice. The findings further show that the few farmers that indicated awareness also interested evaluated and tried this practice while only 5.7% were still using it as at the time of this research. However, 2.6% used but later rejected it. This shows that most of the farmers did not deliberately adopted this practice with the continuous usage of only 5.7% based on the findings of this study. The low number that adopted the ESP must have seen the positive implication of carrying out this practice as a way of improving the quality of the produce for international market and they must have made deliberate effort or unconsciously adopting such practice without knowing the implications on the quality of Coffee beans. Meanwhile, only 7.9% of the farmers aware of the sorting out of berries after harvest while majority 92.1% indicated their not aware of this practice as one of the practices to improve the acceptability of the produce as foreign earner. Interestingly, all the 7.9% who indicate their awareness developed interest, evaluated, tried and used but never rejected.

Similarly, all the respondents (100.0%) were aware that fermentation must be covered and protected from rain with continuous usage but none of the respondents indicate their awareness of the turning of beans once daily during fermentation. This shows that fermentation is taken very seriously by the respondents as an important practice in improving the quality of the Coffee beans but they failed to recognize the importance of turning daily for even dryness and quality of the Coffee beans. This may be responsible for the poor Coffee beans quality usually recorded in Nigeria by the international markets (Aderolu *et al.*, 2014). The level of adoption is recorded to be low as a result of the low knowledge they have about the significance of fermentation to the quality of agricultural produce. This is in line with the assertion of Nutley *et al.* (2002) that identified knowledge as the first and critical stage in the innovation decision making process. In addition, 87.7% never aware of drying of beans on a raised slab but only 12.3% continued the usage of this practice. The significance of this practice may need to be re-integrated into agricultural extension programme for better adoption as this seems to encourage fast and better drying of Coffee bean for quality assurance purpose. The poor adoption and continuous usage is an indication that respondents had poor knowledge of the importance of this practice as part of the export standard practices that could enhance the quality of Coffee beans.

Furthermore, thickness of the drying materials that must be between 3 and 5 cm was not aware by all the respondents (100.0) and none of them was found to be using it as at the time of data collection for this study. This shows that respondents never consider this practice as a measure to improve on the quality of Coffee beans. On the storage in a well-ventilated house, respondents never aware of this practice while the practice of avoiding strong odour like smoke where Coffee beans are being stored recorded 6.6% awareness and continuous usage. This shows that Coffee farmers had poor adoption level on the various practices on the export standard practices that would promote the recognition and acceptability of high quality Coffee beans in the study area.

Table 3: The extent of Adoption of Export Standard Practices

	NA	A	I	E	T	UR	SU
ESP Practices	**F(%)**	**F(%)**	**F(%)**	**F(%)**	**F(%)**	**F(%)**	**F(%)**
Regular harvesting of ripe berries fortnightly and weekly at peak periods.	208 (91.6)	19 (8.4)	19 (8.4)	19 (8.4)	19 (8.4)	6 (2.64)	13 (5.7)
The berries is sorted out after harvesting and either of the processing technique is carried out (Dry and Wet processing).	209 (92.1)	18 (7.9)	18 (7.9)	18 (7.9)	18 (7.9)		18 (7.9)
Fermentation must be covered and protected from rain and/or cold.		227 (100.0)	227 (100.0)	227 (100.0)	227 (100.0)		227 (100.0)
Turning of beans once daily during fermentation.	227 (100.0)						
Drying of beans on a raised slab.	199 (87.7)	28 (12.3)	28 (12.3)	28 (12.3)	28 (12.3)		28 (12.3)
Thickness of layer of drying should be	227						

between 3 to 5 cm.	(100.0)						
Regular turning during drying.	201 (88.5)	26 (11.5)	26 (11.5)	26 (11.5)	26 (11.5)		26 (11.5)
Dried beans should be packed into clean jute bags.	222 (97.8)	5 (2.2)	5 (2.2)	5 (2.2)	5 (2.2)		5 (2.2)
The bagged beans should be stored off the ground and away from walls.	195 (85.9)	32 (14.1)	32 (14.1)	32 (14.1)	32 (14.1)		32 (14.1)
The storage house should be well ventilated.	227 (100.0)						
Store beans away from strong odours e.g. smoke	212 (93.4)	15 (6.6)	15 (6.6)	15 (6.6)	15 (6.6)		15 (6.6)

Source: Computed from Field Survey, 2021.
NA= Not Aware, A= Aware, I= Interest, E= Evaluate, T= Trial, UR= Used but Rejected and SU= Still Using

Effect of adoption of ESP on farmers' productivity

Results in Table 4 show that adoption of ESP has effects on Coffee farmers' productivityscale-type. Specifically, it was observed that selection of fertile soil (Mean = 3.91), planting of viable seeds (Mean = 3.53), adequate maintenance of farms (Mean = 4.15), adequate training (Mean = 3.61), good processing techniques after harvest (Mean = 4.27), adoption of ESP (Mean = 4.11), planting of improved varieties (Mean = 3.55), up-date on new technologies (Mean = 3.57) and length of adoption (Mean = 3.12) were the variables that had high effects on farmers' productivity in Coffee production.

The findings imply that many of the variables had significant effects on the Coffee farmers' productivity. However, awareness of export standard practices (Mean = 2.59) did not contribute to farmers' productivity. This means that awareness may not lead to adoption and utilization but it is just the first stage in the adoption process but if awareness is well managed, it can determine adoption provided inputs, information and monitoring are incorporated at this awareness stage based on the findings of Mignouna*et al*. (2011), Lavison (2013) and Rogers (2003) that regarded awareness as a critical stage in the adoption process.

Table 4: Effect of the adoption of ESP on farmers' productivity

	Mean	**Std. Dev**
Selection of good fertile soil for coffee production enhances good productivity	3.91*	0.11
Planting of viable seeds/seedling boost coffee productivity	3.53*	0.52
The bigger the size of coffee farm land the more the productivity	1.43	0.17
Adequate maintenance of coffee farm land determine the productivity	4.15*	0.21
Awareness of ESP increases the productivity	2.59	0.42
Adequate training on ESP on post harvesting handling discourage loss of coffee productivity	3.61*	0.61
Good processing of coffee after harvesting increases acceptable productivity internationally	4.27*	0.13
Adoption of ESP increases productivity	2.65	0.28
Adoption of ESP enhances the price of coffee	4.11*	0.09
Planting of improve varieties always improve productivity	3.55*	0.19
Productivity will increase while planting old varieties	2.21	0.25
Updates on new technology, innovation and adoption often enhance productivity on ESP	3.57*	0.12
Length of adoption (in years) usually enhance increase in productivity	3.12*	0.32
Adoption of ESP increases connection and relationship with other coffee farmer across the world which facilitates to higher productivity	2.55	0.27

Source: Field Survey, 2021
*Mean > 3.0 = High effect

CONCLUSION AND RECOMMENDATION

The study concludes that farmers are still in their economically productive age and can therefore withstand the rigour associated with coffee farming. It was also discovered that the extent of adoption on each practices is low while some were higher this indicate that respondents need serious enlightenment on ESP. The adoption of ESP has effects on Coffee farmers' productivity with the numerous variables that had their means greater than 3.0 benchmark for a 5 - point likert scale-type. Specifically, it was observed that selection of fertile soil, planting of viable seeds, adequate maintenance of farms, adequate training on good processing techniques after harvest (Post-harvest training), planting of improved varieties, adoption of ESP, up-date on new technologies and length of adoption were the variables that had high effects on farmers' productivity in Coffee production. If the farmers' adhere to ESP practices strictly, it will have positive effect on their production, quality and quantity of the produce, marketing and price of the produce, livelihood, revenue to the government and more people will develop interest on coffee production. Therefore, the youths should be encouraged and motivated by providing financial assistance to coffee farmers because those that were producing coffee now were aged farmers. Efforts should be geared by government and relevant agencies towards encouraging coffee farmers to practice export standard practices because it produces good quality green coffee which attracts high premium in the international market.

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SOIL IMPROVEMENT AND WATER CONSERVATION STRATEGIES IN HORTICULTURAL PRODUCTION SYSTEM: A REVIEW

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ABSTRACT
Sustainable horticultural production requires measures for improving the soil and conserving water. Soil and water conservation are crucial to lowering production expenses and has a positive influence on the environment. Sustainable agriculture and the preservation of the natural ecosystem depend on the integrated management of soil and water resources. The necessity of the hour is to safeguard soil and water from deterioration through efficient management. Some of the commonly employed methods towards the conservation of soil and water include mulching, zero or minimal tillage, composting, mulching, cover cropping, crop rotation, contour farming, afforestation and grassing among others. This article reviews the extent to which the aforementioned conservation practices are used in Nigeria. It aims to raise knowledge of the different institutional and procedural frameworks, both governmental and non-governmental, that have been built in Nigeria to carry out effective soil and water conservation projects.
Keywords: *Horticulture, Soil Conservation, Water Management*

INTRODUCTION

Soil generally needs to be protected since it provides the physical environment in which plants develop. These soils are necessary for agriculture and other primary production activities. It is composed of both organic and mineral components. While it takes nature hundreds or even thousands of years to develop a 2.5 cm layer of soil, tons of earth can be swept away during a strong rain event. Soil resources are now a key concern in the country's effort to conserve its natural resources (Abbas *et al*., 2013). For effective and profitable crop production, it is crucial to provide soil conditions that can retain enough soil nutrients and moisture for sustained seed development and growth. Sustainable horticulture production requires measures for improving the soil and conserving water. Organic matter is abundant in healthy soil, which serves to increase water infiltration and retention, lessen erosion, and supply nutrients to plants. Water conservation is crucial since it lowers expenses and has a positive influence on the environment. (FAO, 2019)

However, soil is also a fragile resource that can be easily eroded by wind and water (Lal, R. 2015). This is especially true in agricultural areas, where the soil is often disturbed by ploughing and other farming practices. Numerous issues might result from soil being eroded, including: Increased risk of flooding reduced crop yields, siltation of waterways, loss of biodiversity, increased water pollution. The Nigerian government persisted in promoting soil protection measures after independence. Government officials created the National Soil Conservation Program (NSCP) in 1972. The NSCP was created to assist farmers in putting soil conservation techniques into place and enhancing soil fertility. The Nigerian government has also started a number of additional programs recently to encourage soil conservation, such as:

- The Great Green Wall Project: The Great Green Wall Project is a massive tree-planting project that aims to plant 25 million trees by 2030. The project is designed to help reduce soil erosion, improve soil fertility, and combat climate change.
- The National Agricultural Land Development Authority (NALDA): NALDA is a government agency that works with farmers to implement soil conservation practices and improve agricultural productivity.

- The Federal Ministry of Agriculture and Rural Development: The Federal Ministry of Agriculture and Rural Development provides a variety of resources and support to farmers to help them implement soil conservation practices. (FAO, 2019)

The study was aimed at reviewing the progress that researchers have made in the area of soil improvement and water conservation strategies in horticultural production system in Nigeria. For this study, related literature was downloaded in January 2022 (only studies published within a space of one decade, i.e., 2013–2023, were downloaded) from search engines such as Google Scholar, Scopus, and Researchgate.

Soil improvement and water conservation strategies

The history of soil conservation practices in Nigeria can be traced back to the pre-colonial era. Indigenous farmers used a variety of techniques to protect their soil from erosion, below are some but not limited to the techniques in soil and water preservation in Nigeria

Composting: Breaking down organic debris to produce a nutrient-rich soil amendment is known as composting. Compost can be put to the soil to enhance the soil's structure, increase its ability to retain water, and supply nutrients. In addition, compost can aid in the control of diseases and weeds.

Mulching: This is the process of adding an organic layer of material to the soil, such as compost, straw, or wood chips. Mulch aids in stopping soil erosion, holding onto moisture, and controlling weeds. Mulch can aid by enhancing soil structure by incorporating organic matter.

Minimal or zero tillage: Reduced soil disturbance is achieved through minimal tillage, a type of tillage. This lessens soil erosion and helps to improve soil structure. Reduced runoff and improved water infiltration can both be achieved with minimal tillage.

Cover cropping: In Nigeria, where soil erosion is a significant issue, cover cropping is a particularly crucial method of soil conservation. Numerous issues, such as decreased agriculture yields, increased water pollution, and biodiversity loss, can be brought about by soil erosion. In many ways, cover crops can aid in preventing soil erosion. In the beginning, cover crops aid in reducing runoff. Second, cover crops aid in shielding the soil from the damaging effects of rain. Also, cover crops contribute to the soil's organic matter content, which strengthens the soil's structure and reduces the likelihood of erosion. A simple and reasonably priced method of conserving soil is to plant cover crops. On a variety of soils and in a range of climates, cover crops can be produced. Additionally, a number of crops may be cultivated with cover crops. Some examples of cover crops that can be grown in Nigeria are: Beans, cowpea, Mucuna, pigeon pea, Sesbania, e.t.c

Crop rotation: Growing several crops in the same field over time is known as crop rotation, which helps save soil. Crop rotation can assist to control pests and diseases, improve soil fertility, and prevent soil erosion. In Nigeria, where soil erosion is a significant issue, crop rotation is a particularly significant soil conservation method. Numerous issues, such as decreased agriculture yields, increased water pollution, and biodiversity loss, can be brought about by soil erosion. Crop rotation can aid in preventing soil erosion in a number of different ways. First, crop rotation shortens the period of time the land is bare. Second, crop rotation aids in enhancing soil structure, making the ground less prone to erosion. Thirdly, crop rotation aids in the management of weeds, which can rob crops of water and nutrients and worsen soil erosion. Crop rotation can help to increase soil fertility in addition to preventing soil erosion. Crop rotation aids in increasing the amount of organic matter in the soil, which enhances soil structure, boosts water retention, and provides nutrients. Crop rotation can also aid in the management of diseases and pests. Different crops require various nutrients and are vulnerable to various pests and illnesses. Farmers can lessen the risk of pests and diseases as well as the loss of soil nutrients by rotating their crops. A simple and reasonably priced method of conserving soil is crop rotation.

Examples of possible crop rotation patterns for Nigeria include: Maize - cowpea – cowpea, Maize - bean – bean, Maize - cassava – cassava, Yam - cowpea - cowpea

Contour farming: Crops are planted along the contours of the land as part of the practice of contour farming, which conserves soil. Runoff is slowed, and erosion is decreased as a result. In Nigeria, where soil erosion is a significant issue, contour farming is a particularly significant method of soil conservation.

Numerous issues, such as decreased agriculture yields, increased water pollution, and biodiversity loss, can be brought about by soil erosion. Numerous contour farming techniques can aid in preventing soil erosion. In the beginning, contour farming slows runoff. Contoured farming also aids in retaining water and sediment on the ground.

Afforestation: Planting plants and creating forests in previously arid places is known as afforestation. In Nigeria, where soil erosion is a significant issue, it is a crucial method of soil conservation. Numerous issues, such as decreased agriculture yields, increased water pollution, and biodiversity loss, can be brought about by soil erosion.

In many ways, reforestation can aid in preventing soil being eroded. First, trees help in reducing runoffs. Furthermore, trees aid in capturing sediment on the ground. Also, trees contribute to the development of organic matter in the soil, which strengthens the soil's structure and reduces the likelihood of erosion.

Afforestation can also be practiced in conjunction with a variety of other soil conservation practices, such as cover cropping and conservation tillage.

Examples of afforestation practices that can be used in Nigeria include:

- Planting trees in areas that have been cleared for agriculture or other development.
- Planting trees in areas that have been degraded by erosion or other factors.
- Planting trees in areas that are at risk of flooding or landslides.

Grassing: often referred to as vegetative cover, is the process of putting down and keeping up a layer of grass or other vegetation on top of the soil. In Nigeria, where soil erosion is a significant issue, this method of soil conservation is crucial. Numerous issues, such as decreased agriculture yields, increased water pollution, and biodiversity loss, can be brought about by soil erosion. Grassing has several advantages for preventing soil erosion. First, vegetation such as grass and trees slows runoff. Second, vegetation such as grass and trees aids in the sedimentation of the land. Third, grass and other vegetation help to increase the organic content in the soil, which strengthens the soil's structure and reduces the likelihood of erosion. The Government encouraged farmers to plant grass on their land to help reduce soil erosion and improve soil fertility.

Examples of grassing practices that can be used in Nigeria include:

- Planting grass on bare land.
- Overseeding existing grasslands.
- Interseeding grass into crops.
- Establishing grass strips along waterways.
- Planting grass on terraces and bunds.

Also, some practices for water conservation in horticultural production systems:

- **Drip irrigation**: Drip irrigation is a method of irrigation that delivers water directly to the roots of plants. This helps to reduce water evaporation and runoff.
- **Rainwater harvesting**: Rainwater harvesting is the collection and storage of rainwater for later use. Rainwater can be used to irrigate crops, water livestock, and for other purposes.
- **Water mulching**: Water mulching is the practice of covering the soil with a layer of water. This helps to reduce water evaporation and suppress weeds. Water mulching can also help to improve soil structure by increasing water infiltration.
- **Drought-tolerant crops**: Drought-tolerant crops are crops that can withstand periods of drought. Growing drought-tolerant crops can help to reduce water use in horticultural production systems.

Some benefits of practices used in soil improvement and water conservation in horticultural production systems: Improved soil health, reduced soil erosion, increased water holding capacity, Improved soil structure, reduced water use, reduced runoff, Suppressed weeds and diseases, increased crop yields

CONCLUSION

Sustainable horticulture production strategies depend on improving the soil and preserving water. Cover crops, crop rotation, composting, mulching, minimal tillage, drip irrigation, rainwater harvesting, water mulching, and drought-tolerant plants are just a few methods that can be utilized to promote soil health and preserve water. The particular horticultural production system, the environment, and the available resources will all influence the choice of soil improvement and water conservation measures. However, many of the techniques covered in this essay can be applied to horticultural production systems to enhance soil health and save water. Improved soil structure, enhanced water holding capacity, less soil erosion, decreased water consumption, decreased runoff, suppressed weeds and diseases, and higher crop yields are all advantages of utilizing soil improvement and water conservation measures in horticultural production systems.

Overall, sustainable horticulture production strategies depend on improving the soil and conserving water. A more sustainable and fruitful horticultural sector may result from the application of soil enhancement and water conservation techniques. In order to equip farmers with the skills and technical know-how, they need to conserve their soil and water resources, stakeholders in soil and water conservation should participate in rigorous planning for the utilization and management of soil and water resources. Regular research, education and extension (training) of soil and water conservation technologies for stakeholder should be prioritized. Soil and water conservation practices should be site-specific considering the variations in soil types, crops and climatic conditions across the various ecological zones in the country.

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EFFECT OF PALM BUNCH AND SAWDUST SUBSTRATES ON MINERAL AND BIOACTIVE COMPOSITION OF OYESTER MUSHROOM

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ABSTRACT
The result of this study concludes that there are strong and varying differences in their mineral content. Phosphorous and potassium were the highest minerals present. There were no significant differences in their presence when tested across different substrates. Phytochemical compositions were relatively low. Saponin content was the highest (1.11±0.02 for Palm bunch and 0.18±0.01 for Saw dust). Interestingly, antioxidant activities of Pleurotus pulmonarius exhibited high DPPH free-radical-scavenging ability and TEAC. Pleurotus pulmonarius grown on Saw dust exhibited higher DPPH free radical scavenging ability while Pleurotus pulmonarius grown on Palm bunch exhibited higher ABTS scavenging ability and reducing power in Saw dust. This proved that Pleurotus pulmonarius could be more effective in managing oxidative stress condition and its various complications.*
Keywords: *Antioxidant, phytochemical, mineral content, Oyester mushroom.*

INTRODUCTION
Oyster mushroom belong to the class Basidiomycetes and family Pleutaceae and this specie of mushroom is known to grow naturally in temperate and tropic regions (Sánchez, 2010). Apart from mushrooms being known to grow abundantly in the wild, they are capable of converting agro-waste into protein rich palatable food through enzymatic reactions (Waquas *et al*., 2011). The cultivation of Oyster mushroom is not only commercially purposed but also as a therapeutic agent (Waquas *et al*., 2011). Mushroom are repositories for important phytochemicals such as phenol, saponin, alkaloid and flavonoid. Not only that these mushrooms have bioactive components, they have also shown important antioxidant activities (Ivanova *et al*., 2014). In vivo and in vitro studies on edible mushroom have shown antioxidant, antitumor, antihypertensive and antiaging potentials (Iwalokun *et al*., 2007). These bioactive compounds in mushroom mediate biological activities including the stimulation of interleukin-12, nitric oxide synthase activation, free radical scavenging and iron chelating properties (Kinge *et al.*, 2016). This research aim to determine the phytochemical, antioxidant and mineral contents of Pleurotus pulmonarius grown on palm bunches and sawdust subtrates.

MATERIALS AND METHODS
Study area and sample collection
The various samples used for this research were collected from Okigwe town in Imo State, Nigeria. The samples collected include; Saw dust, Palm bunch and spawn for inoculation. Sawdust of Gmelina aboreawas collected from the timber shops at Okigwe town in Okigwe L.G.A, Imo State, Nigeria. The Palm bunches was sourced at Umuowa-Ibu village and National Horticultural Research Institute (NIHORT), Mbato premises, both located in Okigwe L.G.A, Imo State. The spawn of Pleurotus pulmonarius was obtained from the mushroom unit, NIHORT, Ibadan.
Composting
The method of Adebola *et al*., (2016) was used with slight modifications. Saw dust was moistened sufficiently. One kilogram each of the substrate was weighed and packed tightly in polythene bags. The neck of the bag was made with heat resistant PVC tubes and covered with a cotton plug. The bags

containing each substrate was then sterilized by tyndalization and then allowed to cool to room temperature.

Spawn inoculation and incubation

After cooling, 10% w/w ratio of the spawn to the substrate was introduced into the bags through the neck aseptically and incubated for 28 days. Thereafter the bags were transferred into a dark room. After primordial initiation, the substrates were then transferred to a cropping house (Kinge *et al*., 2016; Adebola *et al*., 2016).

Preparation of sample for phytochemical analysis

The mushroom will be air dried, grinded into powder using a blender with stainless steel, blade and body and processed for phytochemical analysis (Adebola *et al*., 2016). The phytochemical and antioxidant activity of Pleurotus pulmonarius in this study was conducted at IITA, Ibadan, Nigeria following standard laboratory procedure.

RESULTS

The bioactive components of mushroom such as its antioxidant and phytochemical composition are mainly contributed by the active compounds present in them (Iwalokun *et al*., 2007). These important phyto-components may contribute to improving the quality of life by inhibiting the onset of degenerative diseases which are usually associated with ageing (Ibe *et al*., 2014). There were significant differences in Palm bunch than sawdust substrate. Though this work aims at determining the effect of two substrates (Palm bunch and Saw dust) on the mineral contents, and bioactive component of *P. pulmonarius*. The result indicated that, there are no significant differences ($p \leq 0.05$) in their phosphorous, calcium, magnesium and potassium content, overall, saw dust possessed the highest mineral content (Table 1). Phytochemical analysis of *P. pulmonarius* was shown in Table 2. There are significant differences ($p \leq 0.05$) in the phenolic, tannin, saponin, flavonoid and alkaloid content. Table 3 shows the antioxidant activity of. pulmonarius. Free-radical-scavenging ability of the extract against 1, 1-diphenyl-2-picrylhydrazyl (DPPH) was relatively higher in Saw dust compared to palm bunch substrate. ABTS scavenging ability and the reducing power of the extracts were higher in Palm bunch than in Saw dust.

DISCUSSION

The mineral content of P. pulmonarius includes phosphorous, calcium, magnesium, sodium, potassium, manganese, iron, copper and zinc. Potassium content (3.93%) is higher in percentage compared to other minerals for P. pulmonarius grown on palm bunch and 3.9% for Pleurotus pulmonarius grown on Saw dust substrate. Calcium content was relatively low in mushroom harvested from both substrates (about 0.18%) and there was no significant difference. Phytochemical content was relatively low in P. pulmonarius. The total saponin, alkaloid and other phytochemicals were significantly different. The review of the biological activities of saponins showed that they exhibit antioxidant activities. Saponins have haemolytic and hypolipidaemic activities as well as the ability to lower cancer risks and inhibit microscopic life forms. Pure alkaloids were also present, though no report of the antioxidant activity as yet and their derivatives have basic medicinal value due to the analgesic, antispasmodic and antibacterial properties they posses.

DPPH radicals have been extensively used by many workers to investigate the scavenging activity of some natural components. This is due to its high sensitivity. This was employed to investigate the free-radical-scavenging ability of the mushroom. As antioxidants donate protons to this radical, the absorption decreases. The extent of the decrease in absorption is taken as a measure of the extent of radical scavenging (Ibe et al., 2014). The SC50 value for P. pulmonarius grown on saw dust substrate caused the inhibition of DPPH absorbance (73.57 ± 0.27) presented in Table 3. Since SC50 is a measure of inhibitory concentration, a lower SC50 is a reflection of greater antioxidant activity of the sample. Pleurotus pulmonarius grown on saw dust has the highest inhibition potential (73.57) for saw dust compared to 28.22 recorded for alm bunch). The amazing high antioxidant activity of P.s pulmonarius grown on saw dust could still be attributed to the crude composition of the substrate.

ABTS* scavenging ability which was reported as the trilox equivalent antioxidant activity (TEAC). The results showed that there was significant difference ($p \leq 0.05$) in the order of palm bunch (38.45) > saw dust (14.71) respectively. Interestingly, DPPH was significantly higher in P. pulmonarius grown on aw dust. This shows that substrate plays a major role in the composition of mushroom. It could therefore be inferred that P. pulmonarius grown on palm bunch exhibited a better ABTS* scavenging ability. The reason for varying antioxidant activity of P. pulmonarius grown on different substrates may be due to difference in methods even though P. pulmonarius grown on both substrates exhibited antioxidant capabilities.

ABTS assay is based on the inhibition of the absorbance of the radical cation. ABTS* which has a characteristic long wavelength adsorption spectrum. ABTS* radicals are more reactive than DPPH radicals and unlike the reactions with DPPH radical which involves H atom transfer; the reactions with ABTS* radicals involve electron transfer process (Boutaoui et al, 2018). The extensive use of DPPH for screening antioxidant activity assay may have been because it can accommodate many samples in a short period and it is sensitive enough to detect active ingredients at low concentration (Ezeonu and Ejikeme, 2016).

CONCLUSION

The result conducted proved that Pleurotus pulmonarius could be more effective in managing oxidative stress condition and its various complications. Pleurotus pulmonarius could therefore be recommended as important food due to its high its medicinal value.

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Table 1: Mineral composition of *Pleurotus pulmonarius* grown on Palm bunch and Saw dust.

Mineral analysis	Phosphorous (%)	Calcium (%)	Magnesium (%)	Potassium (%)	Sodium (PPM)	Iron (PPM)	Copper (PPM)	Zinc (PPM)	Manganese (PPM)
Palm bunch (Exp 1)	1.02	0.17	0.22	3.92	79.52	151.15	5.00	82.09	13.85
Palm bunch (Exp 2)	1.03	0.18	0.23	3.93	79.53	151.17	4.58	82.10	13.90
Palm bunch (Exp 3)	1.01	0.19	0.21	3.94	79.50	151.19	5.02	82.08	13.80
Mean±SD	1.02±0.01	0.18±0.01	0.22±0.01	3.93±0.01	79.52±0.02	151.17±0.02	4.87±0.25	82.09±0.01	13.85±0.05
Saw dust (Exp 1)	0.98	0.17	0.25	3.87	89.82	186.04	7.59	92.07	17.97
Saw dust (Exp 1)	1.00	0.19	0.24	3.89	89.82	186.06	7.48	92.11	17.98
Saw dust (Exp 1)	1.02	0.18	0.23	3.93	89.84	186.07	7.62	92.08	18.01
Mean±SD	1.00±0.02	0.18±0.01	0.24±0.01	3.9±0.03	89.83±0.01	186.06±0.,02	7.56±0.07	92.09±0.02	17.99±0.02

Table 2: Phytochemical composition of *Pleurotus pulmonarius* grown on palm bunch and Saw dust.

Phytochemicals	Total phenolics (mg/g)	Total flavonoids (mg/g)	Total tannins (mg/g)	Total saponins (mg/g)	Total alkaloids (mg/g)
Palm bunch (Exp 1)	0.60	0.29	1.51	1.13	0.35
Palm bunch (Exp 2)	0.57	0.28	1.49	1.08	0.33
Palm bunch (Exp 3)	0.58	0.30	1.50	1.11	0.36
Mean±SD	0.59±0.02	0.29±0.01	0.50±0.01	1.11±0.02	0.35±0.02
Saw dust (Exp 1)	0.22	0.12	1.18	0.18	0.09
Saw dust (Exp 1)	0.23	0.11	1.17	0.17	0.08
Saw dust (Exp 1)	0.24	0.13	1.18	0.19	0.07
Mean±SD	0.23±0.01	0.12±0.01	0.18±0.01	0.18±0.01	0.08±0.01

Table 3: Antioxidant activities of *Pleurotus pulmonarius* grown on Palm bunch and Saw dust.

Antioxidant	DPPH* SC_{50} (mg/mL)	$ABTS^{*+}$ scavenging ability (mmol TEAC/g)	Reducing power (mg GAE/g)
Palm bunch (Exp 1)	22.79	38.69	0.72
Palm bunch (Exp 2)	28.33	38.18	0.74
Palm bunch (Exp 3)	28.55	38.48	0.73
Mean±SD	28.22±0.39	38.45±0.25	0.73±0.01
Saw dust (Exp 1)	73.88	14.48	0.29
Saw dust (Exp 1)	73.41	14.96	0.28
Saw dust (Exp 1)	73.43	14.67	0.30
Mean±SD	73.57±0.27	14.71±0.24	0.29±0.01

RESPONSE OF OKRA (*Abelmoschus esculentus* (L). Moench) TO SOIL AMENDMENTS AND WEEDING REGIME

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ABSTRACT
Field trials were conducted in 2020 and 2021 at the Teaching and Research Farm of the Federal University of Agriculture Abeokuta, Ogun State, Nigeria to evaluate the effect of biochar application under different weeding regimes on growth and yield of okra. Treatments were laid out in split- plot in a randomized complete block design with three replications. Main plot treatments were three levels of biochar while sub-plots treatments consisted of four weeding regimes. Results showed that biochar applied at 20 t/ha increased okra yield by 47.5% compared to the control. Weeding at 3, 6 and 9 WAS gave the highest okra yield. Uncontrolled weed infestation throughout crop growth resulted in 87.3% yield reduction in okra. It is concluded that weed suppression, growth and yield of okra can be enhanced by the application of biochar at 20t/ha and weeding at 3, 6 and 9 WAS hence recommended.
Keywords: *Biochar; Okra; weeding; weed competition*

INTRODUCTION

Okra (*Abelmoschus esculentus* L.) is one of the most widely known and utilized species of the family Malvaceae (Naveed *et al.,* 2009) and an economically important vegetable crop grown in tropical and sub-tropical parts of the world (Oyelade *et al.,* 2003; Andras *et al*., 2005). Okra is known by many local names in different parts of the world. It is called lady's finger in England, gumbo in the United States of America, guino-gombo in Spanish, guibeiro in Portuguese and bhindiin India (Ndunguru and Rajabu 2004). Okra is a multipurpose crop due to its various uses of the fresh leaves, buds, flowers, pods, stems and seeds (Mihretu *et al*., 2014). Crop growth and yield are generally reduced by poor fertility. Glaser *et al.* (2002) reported that to overcome the problems of poor soil fertility and low crop yield, it is important to adapt to new technologies such as using biochar as a soil amendment. Biochar is defined as charcoal obtained when organic materials (biomass and manures) are burned under low pressure and high temperature condition through prolysis process (under low or absence of oxygen) (Lehmann, 2007; Laird, 2008). Biochar improves soil fertility, crop yield and also sustains the environment for future use while mitigating climate change.

Weed infestation is a major problem in the production of okra (Rao, 1983). Uncontrolled weed growth throughout the life of okra could reduce pod yield by 39 to 84% (Adeyemi *et al*., 2015a). The extent of weed competition depends on the type of weed species, the severity of weed infestation, the duration of infestation and climatic conditions (Rao, 1983). One of the major factors that enhance weed infestation is the inability of the okra plants to compete with weeds at the early stage of growth due to poor canopy formation. Addition of soil amendements (biochar) has the benefits of harnessing the soil nutrient resources to boost crop growth and thus enhance the competitive bility of the crop against weeds. However, there are scanty research information on the integration of biochar with timely weed removal in okra.The study was therefore conducted to determine the effect of application of biochar under different weeding regimes on growth and yield of okra

MATERIALS AND METHODS

Description of experimental site

The field trials were conducted in 2020 (September to December) and 2021 (June to October) on the Teaching and Research Farm Directorate of the Federal University of Agriculture, Abeokuta, Nigeria in the forest savannah transition agroecological zone (7^0, 20'N, 3^0, 23'E). The details of physico-chemical properties of the soil before the commencement of the trials are contained in Table 1. The result of the analysis showed that the soil was sandy loam in texture in both years with soil pH of 6.54 and 6.71 in 2020 and 2021, respectively (Table 1).

Table 1: Soil physico-chemical properties of the experimental sites

Soil Composition	2020	2021
pH	6.54	6.71
Particle size analysis		
Sand (g/kg)	768.1	756.5
Silt (g/kg)	190.4	167.2
Clay (g/kg)	41.5	76.3
Textural class	sandy-loam	sandy-loam
Chemical composition		
Organic carbon (%)	1.74	2.21
Available P (mg/kg)	3.26	3.01
Total N (%)	0.12	0.2

Treatments and experimental design

The trial in both years were laid out in split-plot in a randomized complete block design in three replicates. In both years, the main plot treatments were three rates of biochar application at 0 t/ha, 10 t/ha and 20 t/ha. Four weeding regimes assigned to the subplots were; weeding at 3, 6 and 9 WAS, weeding at 3 and 6 WAS, weeding at 3 WAS and weedy check as control.

Cultural practices

The experimental site in each cropping season was ploughed and harrowed at two-week interval to destroy established vegetation, destroy weed seedlings and produced a level, smooth and weed-free fields. Before planting, application of 0 t/ha, 10 t/ha 20 t/ha of biochar (made from bamboo) were applied into appropriate plots, according to the treatments and incorporated into the soil. Okra seeds were sown at 0.6 m by 0.3 m at two seeds per hole and later thinned to one plant per stand at 2 weeks after sowing to give a total plant population of 55,555 plants/ha. Hoe weeding was carried out using West African hand hoe.

Data Collection

Weed cover score was done using a visual rating scale of 10 – 100; total weed dry matter production and weed count was also done.

Data analysis

Data on number of pods, pod yield, seed weight, weed cover score, weed density and weed dry matter production for the two years were pooled and analyzed using the GENSTAT procedures. Least significant difference (LSD) was used to separate significant means at a 5% level of probability.

RESULTS AND DISCUSION

Weed Parameters

Application of biochar generally caused reduction in weed cover score, weed density and cumulative weed dry matter. The lowest values of weed cover (29.3) and cumulative weed dry matter (3027 kg/ha) were recorded from the plots treated with application of biochar at 20 t/ha (Table 3). The reduction in weed growth parameters as a result of the application of high rates of biochar could be attributed to the fertilizing effect of biochar on okra which was able to boost its growth give it higher competitive advantage over the weeds. In addition Okra being a C4 plant having efficient photosynthesis (Mucube and Banda, 2017) could have developed enough canopy to suppress the growth of the weeds and reduce the weed ground coverage and biomass. This result is similar to those of Osunleti et al., 2021c who reported reduction in total weed count with application of organo mineral fertilizer.

Weeding twice at 3 and 6 and thrice at 3, 6 and 9 WAS resulted in lower weed cover score than weeding once at 3 WAS and no weeding (Table 3). No weeding and weeding thrice at 3, 6 and 9 WAS resulted in the highest and lowest weed count (5,793,200/ha and 379,600/ha) and cumuative weed dry matter (7487kg and 369 kg/ha), respectively (Table 3). The lowest weed cover score, weed density and dry matter production on the plots weeded at 3, 6 and 9 WAS could be as a results of regular weed removal which did not give room for weed accumulation as seen on plots left weed infested throughout and those weeded for only 3 weeks. This results coroborates earlier findings of Adeyemi *et al.,* 2015b who reported lower total weed weight when okra was weeded three times. Osunleti *et al*., 2021b also reported lower total weed biomass with timely weed removal

Table 3: Effects of biochar rates and weeding regime on weed cover score, weed count and weed dry matter

Treatments	Weed Cover Score at 9 WAS	Weed Count (x 000/ha) at 12 WAS	Cumulative Weed Dry matter (kg/ha)
Biochar Rates (B)			
0 t/ha	34.7	2703.7	4141
10 t/ha	31.2	1958.3	3339
20 t/ha	29.3	1979.1	3027
LSD (0.05)	3.21	210.74	284.8
p value	0.013	<.001	<.001
Weeding Regime (W)			
No weeding	69.7	5793.2	7487
Weeding at 3 WAS	31.6	2000.0	5433
Weeding at 3 and 6 WAS	13.3	682.1	722
Weeding at 3, 6 and 9 WAS	12.5	379.6	369
LSD (0.05)	2.91	208.28	153.3
p value	<.001	<.001	<.001
Interaction			
B × W	5.189	361.406	346.5

Yield and yield components

Okra yield and yield components increased with increasing in biochar rates. The highest number of pods, fresh pod yield and seed weight were recorded on plots treated with biochar at the rate of 20 t/ha (460,000 pods/ha, 3562 kg/ha and 564 kg/ha) respectively while the lowest was obtained from the control plots (250,000 pods/ha, 1870 kg/ha and 239 kg/ha) (Table 2). Weeding thrice at 3, 6 and 9 WAS resulted in the highest number of okra pods (530,000 pods/ha), okra yield (4,484 kg/ha) and okra seed weight (680 kg/ha) (Table 6). Also, weeding twice at 3 and 6 WAS resulted in higher yield and yield components than weeding once at 3 WAS and no weeding (Table 2).

The result from this study demonstrated the importance of biochar application for soil ammendments in okra production, as it showed a great influence on okra yield. Application of at least 10 t/ha of biochar resulted in 37.5% increment in okra yield compared to the control, with a further increase of 10.5% when 20 t/ha of biochar was applied. This shows that okra responded well to application biochar as it increased the yield of okra. Adamu and Junaidu (2021) had earlier reported that biochar addition to the soil increased the soil N, P, K, Ca, Mg and soil pH. It also played a major role in lowering exchange capacity (E.C) which enhances soil nutrient availability as well as serving as a liming agent by increasing the pH from 6.26 to 6.72 which is ideal for okra production. Regular weed removal on the plots at 3, 6 and 9 WAS reduced weed-crop competition to the bearest minimum and allowed the crop to make good use of both the soil and envoronmental resources thereby resulting in the maximum yield. Subsequent weed infestation beyond the first three weeks caused marked reduction in okra yield resulting in 87.3% pod yield reduction. Weeding beyond the first 3 weeks is therefore a necessity for optimum yield in okra production. This result agrees with earlier report of Oyewole and Obaweda (2020), who reported increase in okra yield with increase in weeding frequency.

Table 2: Effects of biochar rates and weeding regime on yield and yield components of okra

Treatment	Number of Pod (no./ha)	Fresh Pod yield (kg/ha)	Seed Weight (kg/ha)
Biochar Rates (B)			
0 t/ha	250000	1869	239
10 t/ha	380000	2993	456
20 t/ha	460000	3562	563
LSD (0.05)	104942.6	552.7	85.1
p value	0.005	<.001	<.001
Weeding Regime (W)			
No weeding	100000	571	77
Weeding at 3 WAS	350000	2420	341
Weeding at 3 and 6 WAS	470000	3758	581
Weeding at 3, 6 and 9 WAS	530000	4484	680
LSD (0.05)	70644.7	430.0	73.1
p value	<.001	<.001	<.001
Interaction			
B × W	141314.1	807.6	132.4

CONCLUSION

This study showed that okra yield can be increased by 45.5% by the application of 20 t/ha of biochar compared to the control. Weeding at 3, 6 and 9 WAS gave the highest okra yield. Uncontrolled weed infestation throughout crop growth resulted in 87.3% yield reduction in okra. It can therefore be concluded that weed suppression, growth and yield of okra can be enhanced by the application of biochar and timely weed removal.

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A REVIEW OF THE NUTRITIONAL, HEALTH AND MEDICINAL BENEFITS OF SELECTED ENDANGERED FOOD SPICE CROPS IN SOUTH EASTERN NIGERIA

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ABSTRACT
Many food spice crops are being endangered into extinction in Nigeria because of climate change as well as deforestation occasioned by population pressure and urbanization. This review was aimed at identifying the nutritional, health benefits and agronomic research gaps of these endangered aromatic food spice crops. Nine endangered food spice crops identified are: Guinea pepper (Piper guineensis), Utazi (Gongronema latifolium), Hoary or Thai lemon basil (Ocimum africanum), Mint basil (Ocimum gratissimum), whole country onions (Afrostyrax lepidophyllus), Jansa (Cussonia bateri), Negro pepper (Xylopia aethiopica), Ataiko or Orima (Afromomium danielli), Aidan (Tetrapleura tetraptera). This review discovered that these species are capable of improving the nutrition and health of the rural dwellers but yet, are minimally cultivated. The paper therefore recommends that agronomic packages be evolved in order to initiate and increase the cultivation and productivity of the selected endangered food spice crops.
***Keywords**: Review, Endangered, food spice crops, South Eastern Nigeria.*

INTRODUCTION

Endangered food spices are food flavouring crop species that are likely to go into extinction in the near future (https://en.wikipedia.org>wiki.endanderedspecies and https://www.fs.fed.usd/wildflowers>ethnobotany>food). Many food spice crops are being endangered into extinction in Nigeria. Some of the causes of biodiversity loss or extinction of species are human activities such as deforestation, damages to the habitats of many crop species occasioned by population increase, infrastructure development, urbanization, road construction, harvesting of wood from tree species, extraction of mature trees from timber species and bush fire (Barau *et al*., 2015; Oyetunji, Ibitoye, Akinyemi, Fadele and Oyediji, 2020). Forest degradation and habitat destruction are the major causes of global biodiversity loss. Plant species destruction are on the increase. All these exert pressure on the population of the wild species of crops such that the resultant effect is the extinction of useful plants. Yet, these crops have suffered neglect in terms of research and agronomic attention. The environment of the whole world is changing due to endless production of greenhouse gases. As the environment changes, some organisms like plant species can no longer thrive, thus causing crop losses worldwide, and reducing yields of crops by more than 50% (Chikezie *et al.*, 2015).

Presently, these food spice crops are made available in the markets in South eastern Nigeria through collections from the forests. If conscious efforts are not made to initiate the cultivation of these crops and to improve the productivity of these crops through increased research attention into their environmental and agronomic requirements, with time, losses of species from the wild will begin to occur. Efforts should be made therefore to preserve these crops bearing in mind their usefulness. Paucity of relevant literature materials necessitates that these useful plants harvested from the wild be given adequate research attention in order to evolve agronomic and cultural packages that can be utilized to sustain their productivity. It is against this background that this paper is written.

The objective of this paper was to:

1. Describe the selected endangered food spice crops widely consumed in Southeastern Nigeria

2. Identify the current status of the cultivation of the selected endangered food spice crops in Southeastern Nigeria
3. Identify the nutritional and health benefits of these selected endangered food spice crops in South eastern Nigeria. Make recommendations based on findings

Identification of selected endangered aromatic food crop spices in South Eastern Nigeria

In Nigeria, many plants used as spices have a lot of medicinal values (Edeoga *et al*., 2005). Medicinal plants, according to WHO, are plants that have substances that are capable of being used for treating ailments or plants that have parts are used for the production of drugs. Certain spice crops have been selected in this review that are crops that are commonly utilized in various ways in a variety of dishes and as medicinal plants in South eastern Nigeria.

Nine food spice crop species identified to be facing the danger of extinction in South eastern Nigeria include: Guinea pepper (*Piper guineensis*), Utazi (*Gongronema latifolium), Hoary or Thai lemon basil (Ocimum africanum)*, Mint basil (*Ocimum gratissimum*), Whole country onions (*Afrostyrax lepidophyllus*), Jansa (*Cussonia bateri*), Negro pepper (*Xylopia aethiopica*), Ataiko or Orima (*Afromomium danielli*), Aidan (*Tetrapleura tetraptera*) .

The following endangered food crop spices that are commonly consumed in South eastern Nigeria have been identified (Table 1). Many of these species (Guinea pepper/Ashanti pepper (uziza), Utazi, Thai lemon basil and Mint basil are commonly grown in home gardens but their agronomic requirements are yet to be investigated. The other species included in this review are: whole country onions, Jansa, negro pepper, ataiko and aidan are supplied from collections made from the forest.

Table 1: Identification of selected endangered aromatic food spice crops

S/N	Common name	Botanical Name / Family	Parts being utilized	Local name in South Eastern Nigeria
1	Guinea pepper	*Piper guineense* / Piperaceae	Leaves and fruits	Uziza
2	Utazi	*Gongronema latifolium* / Asclepiadaceae	Leaves	Utazi
3	Thai Lemon basil	*Ocimum africanum* / Lamiaceae	Leaves	Curry
4	Mint basil	*Ocimum gratissimum* / Lamiaceae	Leaves	Nchuanwu
5	Whole country onions	*Afrostyrax lepidophyllus* / Huaceae	Fruits	Control onions
6	Jansa	*Cussonia barteri* / Araliaceae	Fruits	Jansa
7	Negro pepper	*Xylopia aethiopica* / Annonaceae	Bark and Fruits	Uda
8	Ataiko/Orima	*Afromomum danielli* Zingiberaceae	Fruits	Orima
9	Aidan	*Tetrapleura tetraptera* / Fabaceae	Fruits	Uhiokirihio

Proximate composition of the selected endangered food spice crops in South Eastern Nigeria

Many of the aromatic spice plants contain nutritional substances that can boost human health. The proximate composition of some of these selected endangered food spice crops have been reported (Table 2), by Nwankwo *et al*., 2014, Imo *et al*., 2018a, Imo *et al*., 2018b, Besong *et al*, 2016, Adeyeye and Olaleye, 2020, Udousoro and Ekanem, 2013, Adewole, 2014.

Table 2: Proximate composition of selected endangered food spice crops in Southeastern Nigeria.

S/N	Plants	Moisture content %	Crude protein%	Crude fibre%	Fat%	Total ash%	Carbohydrate%
1	Guinea pepper	11.70	16.67	20.99	2.24	7.73	48.21

	leaves						
2	Guinea pepper seeds	12.35	12.99	8.79	9.89	6.33	65.64
3	Negro pepper	6.02	18.47	0.61	6.73	4.00	1.41
4	Utazi	9.5	26.0	12.4	13.3	8.5	39.0
5	Thai lemon basil	80.75	25.38	2.70	1.85	11.10	58.93
6	Mint basil	10.30	16.51	9.07	2.78	2.45	58.89
7	Country onion	NA	NA	NA	NA	NA	NA
8	Jansa	NA	NA	NA	NA	NA	NA
9	Ataiko/ Orima	NA	NA	NA	NA	NA	NA
10	Aidan	NA	NA	NA	NA	NA	NA

NA = Not Available

The current status of the production of the identified endangered food crop spices in South Eastern Nigeria

The current status of the production of identified endangered food spice crops and their economic importance were reviewed and findings are presented below:

1. Guinea pepper (Ashanti or Benin pepper) (*Piper guineense* Schumach*)*

Piper guineense, popularly known as (uziza) in Igbo, "Odusa" in Efik/Ibibio, is a West African culinary spice widely used in traditional medicine and has a lot of pharmacological properties. It is used locally to manage cough, bronchitis, and stomach ache. The plant is known as Guinea pepper or Ashanti pepper. It has anti-inflammatory, antioxidant and anti- sickle cell crisis properties (Dzoyeme *et al*, 2017). In South eastern Nigeria, it is known as *uziza*. It is used as a flavouring for stews and soups. It contains 5–8% of the chemical called Piperine which gives it the peppery taste. Research shows that Guinea pepper has preservative properties and it is effective in the preservation of smoke-dried cat fish (Kabari *et al*., 2011). Essential oils from the plant has been documented to have ovicidal properties against insect pests such as *Tribolium castaneum* and *Callosobruchus maculatus* (Arvind *et al*., 2020). Researches have shown that seeds are used traditionally as postpartum tonic (Echo *et al*., 2012).

Currently, there are no agronomic recommendations for the cultivation of Guinea pepper. It is minimally cultivated by a minute fragment of the inhabitants of South eastern Nigeria in home gardens. It deserves improved research attention in the areas of improved production since it has the potential to boost human health and it is underutilized (Alagbe *et al*., 2021; Ojimelukwe, 2021). The fruits of Piper guineense are shown in figs 1, 2 and 3.


Fig1


Fig 2


Fig 3

Figs 1, 2, 3 – Fruits of Piper guineense (Source- Google)

2. Negro pepper (*Xylopia aethiopica)*

Fruits of *Xylopia aethiopica* are widely used to spice soups especially for postpartum mothers. There are claims that almost all parts of *Xylopia aethiopica* possess medicinal values (Fetse *et.al*., 2016) and that infusions of the plant's bark can be used to treat bronchitis, dysenteric conditions and febrile pain. The cultural and agronomic requirements of the plant have not been reported. The fruits of Negro pepper (Xylopia aethiopica) are shown in Figs 4, 5, and 6.


Fig 4

Fig 5

Fig 6

Fruits of *Xylopia aethiopica* (Figs 4,5,6) . Source – Google

3. Utazi (*Gongronema latifolium*)

Utazi is a climbing shrub with bitter leaves. There are claims that Utazi promotes the flow of bile, stimulates appetite for food, increases the activities of the pancreas, enhances the functions of the liver, reduces blood sugar and hypertension, although these health benefits have not been proved through research analysis. There are no available documented reports on the cultural and agronomic requirements of Utazi in Nigeria.


Fig 7- Utazi leaves (Source- Google)

4. Thai Lemon Basil (*Ocimum africanum*)

Internet postings revealed that Thai lemon basil is a hybrid between sweet basil (*Ocimum basilicum*) and American basil (*Ocimum americanum*)(Wikipedia). The crop is widely cultivated in home gardens in the South eastern Nigeria. The plant produces natural sweet aroma which adorns the environment. The leaves are relished as a spice in stews and sauces. Medicinally, there are claims that the plants contain substances capable of lowering blood sugar although there is no research analysis that can provide the evidence. There are no available documented reports on the cultural and agronomic requirements of Thai lemon basil in Nigeria. A picture of the plant showing the leaves and flowers is shown in Fig 8.


Fig 8- Leaves and flowers of Thai Lemon Basil (Source- Google)

5. Mint Basil (*Ocimum gratissimum*)

Mint Basil or Scent leaf is a popular spice crop in South eastern Nigeria where it is used to prepare a variety of dishes. Scent leaf, botanically known as *Ocimum gratissimum*, is an aromatic, perennial, homegrown shrub, although it can be found in the wild, and is used mainly as a spice for cooking delicacies due to its aromatic taste. There are many claims on the health benefits of Mint Basil such as treatment of diarrhea, and has anti-fungal, anti-bacterial properties. There are no documented evidence of research attention on the agronomy of this mint basil. A picture of mint basil showing the shoot is presented in Fig 9.


Fig 9 – Mint basil shoot (Source-Google)

6. Whole Country Onions *(Afrostyrax lepidophyllus)*
   Whole country onions is a widely consumed spice crop which is harvested harvested from the wild. It is popularly called "Control onions "in South eastern Nigeria where is constitutes the major ingredient in preparing mixed spices for cooking stews and sauces. Medically, it has been reported useful in the treatment of appetite loss, frontal headache, management of mumps, asthma and spleen disorders (Egbe *et al*., 2012) There are no available documented reports on the cultural and agronomic requirements of whole country onions in Nigeria. Fruits of country onions is shown in Fig 10.


Fig 10. Fruits of country onions (Source- Google).

7. Jansa- *Cussonia barteri*
   Jansa is a deciduous tree which grows in Africa. Seeds are widely used to spice up stews, sauces and soup because of its pleasant aroma and sweet taste. It has been reported to have analgesic, anti-malarial, anti-inflammatory, anti - anemic, anti-diarrhea, anti-poison, anti -psychotic and anti-epileptic properties (Igbe *et al.,* 2018). There is no documented evidence of research attention on the agronomy of the crop and how to optimize production. A collection of Jansa seeds is shown in Fig 11.


Fig 11 – Fruits of Jansa (Source- Google).

8. Ataiko or Orima (*Afromomum danielli*)
   Seeds of Ataiko or Orima are small, spindle shaped. They are widely used as the main spice for cooking "Banga soup". It can be combined with other spices to make African cuisines. There are no documented reports on its medicinal values as well as its cultural and agronomic requirements. Pictures of seeds are shown in Figs 12 and 13.


Fig 12

Fig 13
Figs 12 and 13- Fruits of ataiko. (Source- Google)

9. Aidan (*Tetrapleura tetraptera*)

Aidan is a deciduous tree which produces sweet fragrance. Fruits are used to spice dishes. Internet postings reveal that fruits also serve for medicinal purposes such as cleansing the digestive system, has anti inflammatory, analgesic and hypoglycemic properties. (www.abs-biotrade info>value-chain>aidan-tree). There is no documented evidence of research attention on the agronomy of the crop and how to optimize production. The fruits of Aidan is shown in Fig 14.

Fig 14 – Fruits of aidan. (Source- Google)

CONCLUSION AND RECOMMENDATION

Attempts have been made in this paper to review the agronomy of these identified threatened food spice crops in the semi-urban South eastern Nigeria environment and findings showed that there is little research attention on them. Findings also revealed that these species are capable of improving the nutrition and health of the rural dwellers but yet, are minimally cultivated. Availability of these food spice crop species come from collections made from nearby bushes and forests. This paper therefore recommends that agronomic packages such as pre-planting, planting and post - planting requirements be investigated through researches and recommendations should be made based on the results of the researches in order to initiate and increase their cultivation as well as their productivity.

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KOLANUT PRODUCTION AND USE OF FARM POWER AMONG KOLA FARMERS IN CROSS RIVER STATE OF NIGERIA

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ABSTRACT
The study examined kolanut production and the use of farm power among Kola farmers in Cross river state, Nigeria. A sample size of 50 respondents were selected using a proportionate sampling technique. The study revealed that socioeconomic characteristics of kola nut farmers also had a significant influence on kola nut production (F-statistics=10.52; P<0.01); Farm power had significant effect on kola nut production (F-statistics=10.52; P<0.01) while human power was mostly used on the field. The study also found out that human power use on the farm has significant influence on the output of kola nut (t-statistics=4.22; P<0.01). Cost of ownership and maintenance of farm power was a constraint towards using farm power machinery on kola nut farm. It was concluded that there was a great dearth of information on use of appropriate farm power on kolanut supply-side. It was recommended that Kola nut farmers should adopt the use of efficient farm power that guarantee high yield and maximum profit; Youths who inherited kola nut farms from their parents should be encouraged to devote time to invest in kola nut production, Kolanut farmers should adopt the use of simple but efficient labour-saving devices as farm power that guarantee reduced drudgery and increase the land planted to Kola in the area to enhance the productivity and provide a basis for the development of the kola nut industry.
Keywords: *farm power, kolanut, Nigeria*

INTRODUCTION

Kola (a member of the family Sterculiaceae) is a tropical tree crop with over 140 species of which 50 species have been described in West Africa by Adebola, (2003) cited in Dadzie *et al*., (2013). C. acuminate Schott and Eudl. and C. nitida Schott and Eudl. are the most common species, but the later which originated from Ghana and Sierra Leone has gained much preference and become the more important of the two kola species Squire *et al.,* (2000) and Asogwa *et al*., 2012). Over 90% of the world's kola nut is produced in West Africa of which Nigeria contributes 50%, Cameroon 27%, Ivory Coast 16%, and Ghana 8% FAO (2013). Kolanut is of enormous medicinal benefits and great socio-cultural importance in many West African cultures. Nigeria is currently the world's fourth largest producer of Kola nut, after Ivory Coast, Indonesia, Ghana, and the third largest exporter, after Ivory Coast and Ghana (Oseni, 2011).

Farm power is an essential input in agriculture for timely field operations for operating different types of farm equipment and for stationary jobs like operating irrigation equipment, threshers/shellers/cleaners/graders and other postharvest equipment (Verma, 2016). During last 50 years, the average farm power availability has increased from about 0.25kw/ha in 1951 to about 1.35kW/ha in 2010 (FAO, 2015). Over the years, the shift has been towards the use of mechanical and electrical sources of power, while 1951 about 97.4% farm power was coming from animate sources where bulls, oxen, horses were used in tillage operations, planting, processing and transportation of goods to the market (Nwankwo *et al*., 2010). But in early 20th century the contribution of animal sources of power increased from 2.6% to about 82% (FAO, 2015). Tractors are invented to carryout farm operations like clearing and stumping, tillage, planting and others (CTA, 2012). These generations of farm power has made less utilization of other sources of farm power and has made work interesting reducing drudgery on the farm thereby increasing production opportunities (Hemen *et al*., 2016). This present study seeks to analyse the effect of farm power use on the production of kola nut in Boki Local Government Area of Cross River State. Farm power is used on the farm daily to carryout simple farm operations to complex ones. Human/Manpower is the most used on the farm to drive other farm powers. Field operations such as site selection, land clearing, planting and maintenance of kola nut are carried out with effective farm power (Dauda *et al*., 2012). Farm power is very important as it reduces drudgery and increase working time which avails the precision of work done on the farm and off farm that involves transportation and processing (CTA, 2012). Kola nut farmers are poor and have low investment in kola nut farm. Some of these kola nut farms have kola nut varieties that have been planted during the ancient days with little or no improved varieties of kola nut.

Many farmers hardly obtain high yield from kola nut due to lack of capita/money to invest in the farm properly. They need to get equipment for pruning dead branches, detecting pest and diseases attack on crops, employ more labour. This is not possible since the poor varieties of kola nut yield little and the yield does not quantify expenses to employ more hands and explore other production capabilities. One of the challenges is that not all farm power is used on the farm due to the non-availability or low purchasing power thus man power which is readily available but prone to drudgery is usually used. The use of manpower alone on the kola nut farm has made other farmers do better than others. Several studies have been carried out concerning the effect of farm power on crop production such as Akande (2016) on Effects of Agricultural mechanization on Environmental Management in Nigeria; Takeshima *et al*., (2020) on the effect of Agricultural Mechanization on economics of scope in crop production in Nigeria; and Abubakar (2011) Farm power utilization in Agriculture. But little or nothing is done concerning effect of farm power on kola nut production in Boki Local Government of Cross River State. The outcome of the study will be of significance to kola nut farmers, policy makers, agricultural engineers and researchers.

The following null hypotheses were tested in the study

Ho_1: Socioeconomic characteristics of kola nut farmers has not significant influence on kola nut production

Ho_2: Farm power has no significant effect on kola nut production

METHODOLOGY

Data collection was through the interview method through the use of structured questionnaire. This study was conducted in Boki Local Government Area of Cross River State, Nigeria. Boki Local Government Area in Cross River State of Nigeria. It has a population of about 300,000 (NPC, 2015) and a contiguous territories border with the Republic of Cameroon. Boki bears a national and international reputation for being a major commercial centre where forest and internationally quoted agricultural commodities such as kola nut, cocoa coffee, timber, palm products, etc. are sourced and supplied for international consumption. Boki Local Government Area is bounded in the west by Ogoja, north by Obudu, south by Ikom Local Government Areas while in the west, it is bounded by the Republic of Cameroun. With Boje its headquarters, Boki has about fourteen major communities including Bateriko, Bumaji, and Wula. The population of this study consisted of 200 registered kola nut farmers in Boki Local Government Area of Cross River State, Nigeria. A sample size of 50 respondents was selected using a proportionate sampling technique. A total of 146 registered kola nut farmers were found to be involved in kola nut production in the six (6) selected villages (Cross River Ministry of Agriculture, 2022). The distribution was proportionately done based on the number of farmers in the selected villages. The distribution of sample in the six (6) selected villages is presented in Table 1 below.

Table 1: Distribution of Sample in the 6 Selected Villages in the Study Area

s/no.	Wards	Villages	No. of Farmers	No. of Sample
1	Bateriko	Bateriko 1	47	16
		Bateriko 2	35	12
2	Wula	Angbaiso	23	8
		Ekumpo	18	6
3	Bumaji	Baggo	14	5
		Bunu	9	3
		Total	**146**	**50**

Source: Cross River Ministry of Agriculture, 2022

Model Specification
Ordinary Least square
Y=f(x)
Y= kola nut output in yield/kg/year
X= farm power
$Y= B_O + B_1X_1+B_2X_2 +B_3X_3 + B_4X_4 + B_5X_5 + e_I$
B_O-B_5= Regression Coefficients
X_1= animal power was measured as number of animals used
X_2 = human power was measured as the time of sun light per day in hours
X_3 = Mechanical power is measured as the time of mechanical traction on the farm in hours
X_4 = Electrical power was measured in the watts/ohms
X_5= human power
e_i= error term

RESULTS AND DISCUSSIONS
Effect of Farm Power on Kola Nut Production
The result of the multiple regression analysis is presented in Table 2. The result gave the coefficient of determination (R^2) of 50.14 which implies that 50.14% of the variation in Kola nut output is explained by the explanatory variable farm power. F-statistics of 10.52 was statistically significant at 1% level which implies that farm power affects the output of kola nut. Electrical power, Human power and animal power are significant at 1% level at their respective coefficient. Electrical power coefficient is positive (325351.3) and significant at 1% level which implies that 1-unit increase in the use of electrical power will reduce kola nut output by 325351.3. This is true because use of electrical power a priori expectation is to increase efficiency and thus output level. The largest use of electric power in the rural areas is for irrigation and domestic water supply. Its operation and maintenance needs less attention and care. It is clean, quiet and smooth running (Abubakar, 2011). Electrical power is used for water pumping for irrigation, storage, farm product processing. Nowadays electricity has become a very important source of power on farms in various states of the country; Electrical power is used mostly for running electrical motors and for pumping water among others. Human power coefficient is positive (1662531) and significant at 1% level which implies that 1-unit increase in the area of human power will increase the output of kola nut by (1662531). This is expected. Human power is an important source for operating small implements and tools stationary work like chaff cutting, lifting water, threshing, winnowing and many other such works are done using manual labour. Animal power is negative (-1469507) and significant at 1% level which implies that an increase in 1 animals power will decrease kola nut output by (-1469507).
Balogun and Ogheneruemu (2012) opined that there was disequilibrium in resource use, as the number of family members engaged in farming, land area cultivated on kola nut, cost of durable inputs, cost of non-durable inputs, amount of money spent on labour were used efficiently as against hired labour that was inefficiently used. Lamidi and Akande (2013) carried out a research review on challenges and prospects of agricultural mechanization in Osun State of Nigeria. Results identified shortage of capital, land tenure,

small farm holding and fragmented land, poor infrastructural facilities, poor attitudes toward adoption of new innovation and non- availability of storage means as problems. Infrastructural problem was identified by 60 percent of the respondents. The deprivation in abundance amongst farmers in the state and in their produce is partly due to inability to mechanize agriculture to improve its efficiency, cost effectiveness, diversity and competitiveness. Omoare *et al.* (2006) in their study to compared kola nut farmers' knowledge and attitude to trainings on good cultural management practices in Ogun and Ondo States, Nigeria identified major constraints to kola nut production and CMP in the study areas as poor feeder roads (100%), irregular supply of agro-inputs (90.0%), and instability in government policy (88.4%). The study concludes that majority of the kola nut farmers carried out Cultural Management Practices to obtain good yield, and has positive attitude towards CMP trainings as it is highly beneficial to their kola nut farming.

Amos (2017) carried out a study on analysis of productivity and technical efficiency involved in kola nut production in Nigeria and relied upon primary data generated during the 2003/2004 production season. The study observed that there was an opportunity for increase in farmers' efficiency and concluded that policies that would directly affect these identified variables should be pursued vigorously. David (2011) presented a report on Nigerian Kola nut Production Increases and reported average kola nut yield in Nigeria does not exceed 500 kilograms per hectare. Popoola *et al*., (2015) investigated the profitability of kola nut enterprise, the technical efficiency, and drivers of efficiency among kola nut farmers, in southwest Nigeria. The study revealed that yield of kola nut per year in the southwestern states were: Ondo- (1337.53kg/year), Osun (078.27kg/yr) and Ekiti (2217.07kg/yr). The majority of kola nut farmers were relatively technically efficient in their use of resources, with a mean technical efficiency of 0.8126. Farmers in Ekiti state are most technically efficient with a mean of 0.8922 followed by Ondo state with a mean of 0.8132 while Osun state has the least mean of 0.7323. Education was positively and significantly associated with efficiency, while area of land and age of kola nut trees negatively affects technical efficiency. This indicates that public investments in education have complementary and synergistic effects on improved kola nut technical efficiency, and younger kola nut trees should be planted by farmers in southwest Nigeria.

Adewale *et al*., (2016) in their report on Kola nut Seed Garden: a means to disseminating improved planting materials for enhanced national productivity reported that the country is currently experiencing low and declining yields due to inconsistent production patterns, disease and pest attack. Low levels of mechanization with dependence on cutlass and hoe agriculture and ageing of kola nut fields play a role in decreased productivity, especially in southwest states that contribute nearly 80% of national kola nut yields. Although reports are conflicting, annual kola nut yields for Nigeria are generally estimated at an average of between 300 to 350,000 tons. Reports also set production per hectare at 0.38 tonnes but these are reported to have declined to less than 0.3tonnes per hectares mostly due to reduced rainfall.

Table 2: Multiple regression analysis of Effect of Farm Power on Kola nut Production

Yield	Coefficient	Std. Error	p-value
Constant	1204253	1169178	0.78
Gender	119507.4	519597.4	0.65
Age	30439.72	15069.17	0.051*
Marital status	251604.2	218786.3	1.02
Household size	114337.8	54707.09	0.020**
Farm size	314734.4	97140.26	0.008***
Farming experience	130231	62913.55	0.022**
Education level	296666.5	137984.4	0.031**
Income	0.694054	0.2129	0.002***
Electricity	325351.3	328637.7	0.007***
Mechanical	127606.6	386686.7	0.20
Human	1662531	486120.1	0.007***
Animal	-1469507	530508.2	0.037**
R^2	50.14		
F-statistics	10.52		0.000***

Source: Field Survey, 2022Note: ***significant at 1%; ** significant at 5%; * significant at 10%;

Null hypothesis 1 which states that: "Socioeconomic characteristics of kola nut farmers has no significant influence on kola nut production" was rejected with F-statistics of 10.52 significant at 1% level and the alternative hypothesis accepted that socioeconomic characteristics of kola nut farmers has significant influence on kola nut production**.** Null hypothesis 2 which states that "Farm power has no significant effect on kola nut production" was rejected with F-statistics of 10.52 significant at 1% level and the alternative hypothesis accepted that socioeconomic characteristics of kola nut farmers has significant influence on kola nut production.

Challenges of Using Farm Power

Result on challenges of using farm power is presented in Table 3. Multiple responses on the challenges faced in using farm power are presented in Table3. The challenges were ranked in order of importance from the first to last. The result showed that cost of owing farm power (78.0%) is high. This is true because to manage a source of power on the farm is capital intensive. Other challenges include: technical know-how 62.0%, irregular supply of agro-inputs (60.0%), instability of government policy (52.0%), poor feeder roads (44.0%) and lack of spare parts (68.0%). This is in line with Oluyole and Sanusi (2019) who reported that technical know-how prevents farmers from using efficient method of production. Ebi (2019) reported lack of spare parts to repair the machinery during break down. FAO (2017) reported that lack of feeder roads prevents innovation in rural arrears.

Table 3: Challenges of Using Farm Power

s/no	Items	Multiple Response (%)
a.	Costs of ownership of farm power	78
b.	Technical know how	62
c.	Poor feeder roads	44
d.	Irregular supply of agro-inputs	60
e.	Instability in government policy	52
f.	Lack of spare parts	68
g.	Abundance of small scale kola nut farmers	40

Source: Field survey, 2022

CONCLUSION

Based on the findings of the study, the study also found out that human power, wind power and mechanical power are mostly used on the field; mechanical power, human power are mostly used in the processing system while human power, wind power are mostly used in the storage. The study also found out that farm power use on the farm has significant influence on the output of kola nut. The study concludes that cost of ownership/maintenance of farm power is a constraint towards using farm power machinery on kola nut farm. Nonetheless, there is a great dearth of information on kola nut supply-side practices and constraints that can provide a basis for the development of the industry. Based on the findings of the study, the following recommendations are made: Youths who inherited kola nut farms from their parents should be encouraged to devote time to invest in kola nut production, Kolanut farmers should adopt the use of simple but efficient labour-saving devices as farm power that guarantee reduced drudgery and increase the land planted to Kola in the area. Agricultural Extension workers should introduce kola nut technologies to farmers and train them on how to use machinery innovations effectively so as to enhance. To the kola nut farmers, the outcome of the study has revealed the different kinds of farm power used in kola nut production and helped other farmers to choose from many options unknown to them. To the policy makers, the outcome of the study was to make them formulate the exact policy that will favour the use of farm power in kola nut production in other to provide credits and incentives thereby reducing cost of production. Also, to the agricultural engineers, the outcomes of the study have exposed them to the right farm power needed in kola nut production and in turn employ many engineers to go into production of farm power machineries to enhance production.

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FOOD SECURITY IMPACT OF SMART AGRICULTURE AND INNOVATION IN NIGERIA

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ABSTRACT
Globally, increasing lack of access to safe, nutritious and affordable food has been part of the greatest challenge of the world economies. Solution to this global challenge has been part of main focus of the United Nations Sustainable Development Goals (SDGs). In order to achieve SDG-2, which is to "end hunger, achieve sustainable food security, improved nutrition and promote agriculture by 2030", there has been global call for climate smart and innovative agriculture. Hence, this study examined food security impact of smart agriculture and innovation on food security in Africa using evidence from Nigeria. The study utilized time series data from 1960 – 2019, sourced from World Development Indicators – WDI (2019) and Food and Agricultural Organization of the United Nations (2020) data set and applied econometric approach based on OLS technique. It was found by the study that with respect to smart agriculture, it was found that fertilizer intensity (fertintern) has negative significant impact on food security (foodsec) by about 1.378546% on the average, while that of tractor intensity (tractintern) revealed that it has positive significant impact on food security (foodsec) by about 0.0050153%. On innovation, the results on number of internet subscribers (internetsub) revealed that it has positive but insignificant impact on food security (foodsec) by about 0.074778% on the average. The study therefore recommended among others that government and its agencies on food security should encourage people more to use natural manure or organic fertilizer instead of inorganic fertilizer. This can be done by boosting crop yields through numerous practices and technologies such as nutrient management practices and technologies geared towards organic fertilizer.
Keywords: *Food, Security, Smart Agriculture, Innovation, Africa, Nigeria, Econometric Approach*

INTRODUCTION
Globally, increasing lack of access to safe, nutritious and affordable food has been part of the greatest challenge of the world economies (FAO, IFAD and WFP, 2015). Solution to this global challenge has been part of main focus of the United Nations Sustainable Development Goals (SDGs). In order to achieve SDG-2, which is to "end hunger, achieve sustainable food security, improved nutrition and promote agriculture by 2030", there has been global call for climate-smart and innovative agriculture. Due to poor agricultural productivity occasioned by lack of smart agriculture and innovation, Africa has been the epic center of this global menace of food insecurity and malnutrition, with about 26% of 153 million adult populations suffering severe food insecurity (FAO report, 2016). Furthermore, the United States Department of Agriculture (USDA) prediction suggests that Sub-Sahara Africa (SSA) would remain the region with the highest level of food insecurity up to the year 2025 (Tandon *et al*., 2017). In African region, Nigeria is feared to be one of the countries said to be most at risk, due to her heavy food import-dependent, with an estimated value of food importation worth of 22billion US dollar (Ogundiran, 2019). This has been linked to lack of agricultural technology adoption and heavy subsistence farm participation of greater populace in Nigeria.
More so, World Bank's records revealed that 90% of agricultural production in Nigeria is made up of inefficient output of small scale farmers (Matemilola, 2017). Hence, farmers only succeed to produce enough food to sustain their household members. Consequently, high level of food insecurity prevalence

resulted to frequent high food prices and exposure to global commodity market shocks. The precarious state of food insecurity in Nigeria is also evident in the Global Hunger Index (GHI). Nigeria is ranked 98th out of the 107 countries with a score 29.2, which falls in the serious category (Global Hunger Index report, 2020). This reveal also that Nigeria is far from track in attaining the SDG-2 target. More so, Global Food Security Index (GFSI) score and rank as shown in figure 1 below indicates that Nigeria's ranking has continued to worsen since 2013 with a rank of 86 among 107 countries with 33/100 score and a rank of 94 among 113 countries with a score 48.4/100 in 2019, behind her African counterparts like Ethiopia, Niger and Cameroon (Economist Intelligence Unit [EIU], 2019).

Source: EIU (2019)

However, evidence has shown that existing, new and emerging agro technologies can go a long way to address different dimensions of food security in Nigeria and Africa in general (Adeagbo, 2012). These technologies, such as irrigation technology could assist in food availability, while post-harvest and agro-processing innovation can promote food accessibility. Tapping into these existing and emerging smart agricultural technologies for food security requires investments in physical and human capital. Sadly, most farmers in Nigeria are smallholder participants with low agro-tech knowledge and also lack access to affordable cultivating and harvest equipments (Mapfumo *et al*., 2015). Thus, most farmers depend on manual labour for farm activities (Matemilola *et al*., 2017).

Despite the high rate of tele-density witnessed in couple of decades in Nigeria, with over 203.5 million active telecommunications subscribers, Nigeria have not effectively harness the full potential of e-agriculture (Agrobusiness times report, 2021). Unlike countries such as India (Reuters Market Light), Ghana (mFarms), Kenya (MPesa, iCow), that have utilized ICT innovations to increase their agricultural outputs. Reuters Market Light (RML) in India for instance has improved farmers' productivity by 14-16 % with farmers trading even more profitably (IFPRI, 2002). The adoption of the emerging innovation by smallholder farmers in Nigeria has been slow and low (Jack, 2013).

Though concerted efforts have been made by private investors as well as the government to promote innovation and give a new face to agriculture in Nigeria. Like the adoption of 130 farmers in Jigawa state into the National Adopted Village for Smart Agriculture program by the Nigeria's Federal Ministry of Communications and Digital Economy. The program was targeted at providing farmers a means to showcase their farm produce to digital world market. Other efforts by successive governments to promote agricultural production include establishment of agencies and several policy intervention initiatives like Operation Feed the Nation, Lower River Basin Development Authorities, National Seed Policy and Seed Development Plan, Green Revolution and regulatory bodies such as the Directorate of Foods, Roads and Rural Infrastructure (DFRRI), Agricultural Transformation Agenda and National Agricultural and Land Development Authority (NALDA) among others. Yet these concerns and efforts by the Nigerian government have not translated into effective policy interventions and implementation. Nigeria still depends on massive importation of food and could not solve the long term food insecurity challenges.

Hence, this study seeks to investigate the effects of smart agriculture and innovation on food security in Nigeria. The rest of this paper is structured as follows; section 2 discussions on literature review, section 3 captures the methodology and data sources, while section 4 and 5 is the result discussion and policy recommendations.

LITERATURE REVIEW

Smart Agriculture is referred to as the application of modern technological techniques/skills into agriculture in order to increase productivity (Spandana & Pabboju, 2019). Smart Agriculture can furnish the farmers with daily/weekly updates with respect to the soil quality, crop health and energy consumption level within the farm (Spandana & Pabboju, 2019). Also it can assist farmers in the following farm activities; smart irrigation, crop monitoring, crop disease detection, green house management, plant growth monitoring and energy management among others (Iorliam, Iorlian & Blum, 2021). According to Jack (2013) agriculture innovations could enhance yields in Africa. This view is also corroborated by Senz *et al*. (2017) that indicated that smallholder farmers can feed Africa if the regions' small-scale producers adopt intensified agro practices with seeds and fertilizers.

In line with these views, factors that aid adoption of agricultural technologies have remained rather inconclusive. At both micro and macro level a number of studies have found different determinants as important in making adoption decisions by farmers (Arslan *et al*., 2014; Kabunga *et al*., 2012; Mariano, Villano, & Fleming, 2012; Pannell *et al*., 2014). Past literature indicates that there are several barriers to technology adoption, ranging from lack of insurance and limited access to credit to price risk, and majorly focuses on the effect of production risk on overall output (Kassie *et al*., 2008; Di Falco *et al*., 2011; Di Falco *et al*., 2014).

While some other empirical studies have focused on the implications of climate-smart agriculture on food security using micro data obtained from use of questionnaires (Hassan *et al*., 2018; Amadu, 2018; Wekesa *et al*., 2018; Jelagat, 2019). Their findings revealed that climate-smart agriculture practices significantly influenced food security. Amadu (2018) noted also that available knowledge on agricultural innovations was not available to small-scale farmers and therefore farmers continued practicing unsustainable farming in Southern Malawi.

Furthermore, literature expanded on the impact of ICT on crop production. Some of the studies in this area used macro data (Vanek *et al*, 2010; Aker, 2011; Armstrong. & Gandhi, 2012; Asenso-Okyere & Mekonnen, 2012; Chavula, 2013; Salampasis & Theodoridis, 2013; Adamides & Stylianou, 2013); Vosough *et al,* 2015; Zhang, *et al*, 2016), while others utilized micro data (Hassan *et al*, 2011; Chukwunonso, Abubakhar & Obidi, 2012; Ramli *et al.*, 2013). Most of these empirical studies revealed that ICT adoption and internet utilization have positive impact on agricultural output. Though these studies also indicate that most of the framers are not acquainted with these ICT tools and they are easily accessed by farmers in the communities studied (Ejemyovwi *et al*., 2017; Ugboh & Tibi, 2008). Therefore, recommended that ICT facilities be made accessible in most rural areas in various localities (Ugboh & Tibi, 2008).

In addition to ICT and internet utilization implications on agricultural output, quality of labour has also been identified in the literature as a key factor that affects agricultural output. A study in West Africa on the role of ICT on agriculture; labour and capital were elastic, which implies that any change in labour and capital would proportionately increase agricultural output (Akimuda, 2014).

Empirical literature on the impact of smart agriculture and innovation on food security abound in developed and developing countries. Most scholarly works have found a positive relationship between food security and smart agriculture, while other studies found inverse relationship. However, this current study would build on the existing knowledge by further assessing how smart agriculture and innovation impact on food security in Nigeria. Thus, this current study would utilize time series data from FAO and WDI, unlike most previous studies in Nigeria that used primary data.

METHODOLOGY

In order to investigate the effects of smart agriculture and innovation on food security in Nigeria, this study adopted econometric approach based on Ordinary Least Squares (OLS) technique. The functional form of the econometric model states that food security is a function of smart agriculture and innovation. This can be seen in equation one specified below:

$$foodsec = f(smtagric, innov) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.1)$$

where;

foodsec = food security (proxied by food production index)

smtagric = smart agriculture (proxied by fertilizer intensity, and tractor intensity)

innov = innovation (proxied by number of internet subscribers/number of individuals using the internet (% of population)).

f = functional notation

However, there are other variables that could influence food security other than smart agriculture and innovation, such as employment in agriculture % of total employment), and foreign direct investment (FDI) inflows. For example, foreign direct investment (FDI) inflows have been shown to exhibit some impact on food security in Nigeria since Nigeria is an import dependent country. Therefore, modifying the functional form of the econometric model to capture each variable, and capturing the effects of employment in agriculture and that of FDI as control variables in the model, the study specifies the mathematical form of the model as given below:

$$foodsec = \alpha_0 + \alpha_1 fertintern + \alpha_2 tractintern + \alpha_3 internetsub + \alpha_4 empagric + \alpha_5 fdi \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.2)$$

where;

foodsec = food security (proxied by food production index)

fertintern = fertilizer intensity,

tractintern = tractor intensity,

internetsub = number of internet subscribers/number of individuals using the internet (% of population) (proxy for innovation)

empagric = employment in agriculture % of total employment

fdi = foreign direct investment inflows

α_0= the constant term

$\alpha_{i's}$ = the parameters of the model, for i = 1, 2, …, n.

Hence, in line with the mathematical specification of the model, the econometric specification of the model is given as:

$$foodsec = \alpha_0 + \alpha_1 fertintern + \alpha_2 tractintern + \alpha_3 internetsub + \alpha_4 empagric + \alpha_5 fdi + \mu_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.3)$$

where; the variables remained as defined above. μ_t = stochastic error term.

Data and Data Sources

The study data for the study is a time series data from 1960 – 2019, sourced from World Development Indicators – WDI (2019) and Food and Agricultural Organization of the United Nations (2020) data set. While food production index (proxy for food security), , number of internet subscribers/number of individuals using the internet (% of population) (proxy for innovation), employment in agriculture % of total employment, and foreign direct investment (FDI) were sourced from WDI (2019) data set, fertilizer intensity, and tractor intensity (proxies for smart agriculture) were sourced from FAO (2019) data set. The study performed some pre-estimation tests such as the descriptive statistics, unit root test and cointegration test.

RESULTS AND DISCUSSIONS

Before analyzing the model, the study looked at pre-estimation tests like the summary statistics, unit root test and the cointegration test, in order to inspect the nature and time series characteristics of the variables of the model. These are examined in the sub-sections that follows as given below:

Summary Statistics

The summary statistics results presented in the table 4.1 shows the raw data level forms of the model variables. It also reveals the nature and characteristics of the model variables inspected in a bid to observe whether the variables vary sufficiently in their mean, standard deviation, and minimum and maximum values. Consequently, the study presents the summary statistics of the variables applied in the model as given below in table 4.1:

Table 4.1: Summary Statistics Results of the Model Variables

Variable	Obs	Mean	Std. Dev.	Min	Max
foodsec	60	61.40779	35.63483	22.91	125.77
fertintern	60	3.42925	2.846379	.01	11.27
tractintern	60	9875.917	7009.825	500	24800
internetsub	60	5.548633	12.85764	.008833	57.9175
empagric	60	47.11308	4.624483	36.384	50.172
fdi	60	1.728601	1.136197	-1.150856	5.790847

Source: Author's computation from available data

The summary statistics results indicate that all the variables of the model revealed sufficient variations in their mean, standard deviations, and their minimum and maximum values respectively. The results show that there 60 observations corresponding to data generated from 1960 – 2019 for all the model variable.

Unit Root Test

The study applied the Augmented Dickey-Fuller (ADF) test for unit root in order to examine the level of integration or level of stationarity of the variables. Hence, the ADF test for unit root can be seen summarily as presented in table 4.2 given below:

Table 4.2: The Summary Results of Unit Root Test

	Level		First Difference		Oder of Integration
Variable	ADF t-Statistics	5% Critical Values	ADF t-Statistics	5% Critical Values	
foodsec	0.780	-2.923	-11.634	-2.924	Oder one (i.e.I(1))
fertintern	-0.919	-2.923	-8.984	-2.924	Oder one (i.e.I(1))
tractintern	5.243	-2.923	-7.467	-2.924	Oder one (i.e.I(1))
internetsub	3.741	-2.923	-8.183	-2.924	Oder one (i.e.I(1))
empagric	3.245	-2.923	-5.070	-2.924	Oder one (i.e.I(1))
fdi	-3.900	-2.923			Oder zero (i.e.I(0))

Source: Author's computation from available data

The results of the unit root test presented in table 4.2 indicate that all the variables of the model food security (foodsec), fertilizer intensity (fertintern), tractor intensity (tractintern), number of internet subscribers/number of individuals using the internet (% of population) (internetsub), and employment in agriculture % of total employment (empagric), are all integrated of order one (i.e.I(1)), except for foreign direct investment (fdi) which was found to be integrated of order zero (i.e.I(0)).

Cointegration Test

The study applied the two-step Engel cointegration test in order inspect if there exist long run relationship among the variables of the model. If there is evidence of cointegration among the variables of the model, the study would implement the error correction model (which is also known as the short run model), otherwise, the study would utilize the long run econometric model based on OLS for its analysis. The cointegration test results can be seen in table 4.2.1 as follows:

Table 4.2.1: The Cointegration Test Results

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	0.613	-3.567	-2.923	-2.596

MacKinnon approximate p-value for Z(t) = 0.9879

Source: Author's computation from available data

The cointegration test results show that there is no cointegration among the variables of the model since the absolute value of the ADF t-statistic, 0.613, is less than its 5% critical value, -2.923 in absolute terms (that is; /0.613/</-2.923/). Therefore, there is no need for constructing error correction model or short run model. This implies that the long run econometric model based on OLS would suffice for the study's analysis and interpretations of results.

The Empirical Results of the OLS Econometric Model

In line with the findings of the pre-estimation test and cointegration test, the study adopts the long run econometric model based on OLS for the study's analysis and interpretations of results as presented in table 4.3 below:

Table 4.3: The Summary Results of the Econometric OLS Model

foodsec	Coef.	Std. Err.	t	P>|t|
fertintern	-1.378546	0.5467624	-2.52	0.015
tractintern	0.0050153	0.0003763	13.33	0.000
internetsub	0.074778	0.1619835	0.46	0.646
empagric	0.8534069	0.6684604	1.28	0.207
fdi	3.016793	0.7615282	3.96	0.000
_cons	52.0109	34.25205	1.52	0.135

Source: Author's computation from available data

Table 4.3 indicates that from the econometric regression model, fertilizer intensity (fertintern) has negative significant impact on food security (foodsec). This implies that a unit increase in fertilizer intensity significantly reduces food security by about 1.378546%. This result is surprising since it is expected that a rise in fertilizer intensity would significantly increase food production and as such, contribute significantly to food security in Nigeria. The implication of this result is that in Nigeria, fertilizer intensity reduces food security significantly due largely to the use of inorganic fertilizers which may contain some chemicals that are very harmful to the land used in the food production, microorganisms, and some crops/plants. This therefore shows that natural manure or organic fertilizer should be applied instead of inorganic fertilizer. Again, the problem of land tenure system could also militate against smart agriculture emanating from fertilizer intensity in Nigeria and as such, makes food security to fall. This finding is in consonance with the finding by Stewart & Roberts (2012), and Yousaf, Li, Lu, Ren, Cong, Fahad, & Li (2017) who found that in order to boost crop yields, numerous practices and technologies such as nutrient management practices and technologies geared towards organic fertilizer, among others, should be adopted instead of using inorganic fertilizers.

Results on tractor intensity (tractintern) revealed that it has positive significant impact on food security (foodsec). This implies that a unit increase in tractor intensity would significantly encourage food security by about 0.0050153%. This result is not surprising since it is expected that a rise in tractor intensity (tractintern) would significantly increase food production and as such, contribute significantly to food security in Nigeria. The implication of this result is that in Nigeria, the more intensive tractors are used for food production, the more food production would increase and hence, bring about significant rise in food security.

On innovation, the results on number of internet subscribers (internetsub) revealed that it has positive but insignificant impact on food security (foodsec). This implies that an improvement in innovation (internetsub) would positively but insignificantly influence food security by about 0.074778% on the average. The implication of this result is that with a continuous innovation, food security will improve in economy although, insignificantly. This study's finding is in line with the finding by Ejemeyovwi *et al*. (2017) who found that internet utilization is positively but insignificantly related to food security.

It was also found by the study that a percentage increase in employment in agriculture as a percentage of total employment (empagric) has positive and insignificant impact on food security (foodsec). This implies that a percentage increase in employment in agriculture (empagric) would positively but insignificantly impact food security by about 0.8534069% on the average. The implication of this result is that whenever employment in agriculture rises, food security would improve, although insignificantly.

Foreign direct investment (fdi) results also indicate that a unit increase in foreign direct investment would significantly increase food security (foodsec) by about 3.016793% on the average. This result is not surprising since it is expected that a rise in investment inflows would significantly increase food production, food inputs, and as such, contribute significantly to food security in Nigeria. The implication of this result is that in Nigeria, the inflows of foreign investments would on the average increase food security significantly in Nigeria.

Controlling for other factors that could affect food security in Nigeria (_cons), it was found by the study that the constant term positively but insignificantly affect food security.

CONCLUSION AND RECOMMENDATION

This study examined food security impact of smart agriculture and innovation in Africa using evidence from Nigeria. The study utilized time series data from 1960 – 2019, sourced from World Development Indicators – WDI (2019) and Food and Agricultural Organization of the United Nations (2020) data set and applied econometric approach based on OLS technique. With respect to smart agriculture, it was found that fertilizer intensity (fertintern) has negative significant impact on food security (foodsec) by about 1.378546% on the average, while that of tractor intensity (tractintern) revealed that it has positive significant impact on food security (foodsec) by about 0.0050153%. On innovation, the results on number of internet subscribers (internetsub) revealed that it has positive but insignificant impact on food security (foodsec) by about 0.074778% on the average. On the control variables, it was found that employment in agriculture has a positive and insignificant impact on food security (foodsec) by about 0.8534069% on the average, while foreign direct investment (fdi) results also indicate that a unit increase in foreign direct investment would significantly increase food security (foodsec) by about 3.016793%.

Based on the findings of the study, the study recommends that:

1. Government and its agencies on food security should encourage people more to use natural manure or organic fertilizer instead of inorganic fertilizer. This can be done by boosting crop yields through numerous practices and technologies such as nutrient management practices and technologies geared towards organic fertilizer.

2. Again, government should try to solve the problem of land tenure system in a bid not to militate against smart agriculture, especially, that which emanates from fertilizer intensity in Nigeria which makes food security to fall.
3. Innovation was found to have positive but insignificant impact on food security, hence, government and all agencies responsible for food security should strive more to innovate the more in a bid to have a significant contribution from innovation on food security. This would held in increased production and a significant rise in food security.
4. Employment in agriculture was found to have positive and insignificant impact on food security, thus, there is need to mechanize agriculture, adopt improve seedling, crops that can withstand harsh climatic conditions. This would help to improve the positive effects of employment in agriculture and possibly, make it significant in affecting food security in Nigeria.
5. Foreign direct investment was found to significantly encourage food security in Nigeria, consequently, government and its agencies responsible for food security should try harder to create more conducive environment that would attract more foreign investments in the sector. However, there should be some form of controls in order to avoid some risks of unintended consequences of FDI inflows in the country.

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PERFORMANCE OF SUNFLOWER (*Helianthus annus* L.) AS INFLUENCED BY WEEDING REGIME AND PHOSPHORUS FERTILIZER RATES AT AFAKA, KADUNA, NIGERIA.

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ABSTRACT
Field experiment was carried out during the wet season of 2021/2022 and 2022/2023 at the experimental farm site of Federal College of Forestry Mechanization, Afaka, Kaduna. To determine the most suitable weeding regime and the optimum phosphorus fertilizer rates on growth and yield of sunflower production. The experiment was laid out in a Randomized Complete Block Design (RCBD) replicated three times. From the result, plant height for the first year and second year were significantly influenced by weeding regime and phosphorus fertilizer rates. For the first year and second year, weed dry weight, number of leaves per plant and seed yield of sunflower were significantly influenced by weeding regime only. The plots with hoe weeding every three weeks, the weed free treated plots and the plots with 50kgha^{-1} phosphorus fertilizer rates could be suggested for farmers planting sunflower in the study area for better production of sunflower in the study area.
***Keywords**: Sunflower, weeding regime, phosphorus fertilizer rates.*

INTRODUCTION

Sunflower (*Helianthus annus* L.) is an oil seed crop that belongs to the family *compositae.* It can be easily distinguished from other crops by it's prominent head that bears the seeds. Sunflower is grown principally for it's seeds that contain oil (36 to 52%) and protein (28 to 32%) as reported by Rosa *et al*., 2009). The crop originated in North America (Anonynmous, 2016). Sunflower is a crop that is cultivated throughout the world (Groove et al., 2005). FAO (2010) reported that the current world area under sunflower cultivation was 22.3 million hectares, while seed production and average yield stood at 27.7 million tons per hectare respectively (Sani *et al*., 2014). The major growing countries in the world are Russia, Ukraine, Argentina, China, USA, India and Turkey. Today it has become naturalized in many locations of the Tropics and it's widely cultivated in Africa. Although statistic level hectares in Nigeria are not available (Adebayo et al., 2010). It can be used as an edible oil in form of margarine, salad dressing oil, and cooking oil (Qahar *et al*., 2010). Sunflower can be used as silage for animal feed, which is richer in nutrients than corn (Qahar *et al*.,2020).

Weed significantly affect sunflower yield and reduce the quantity and quality of karnel during harvest. According to report, loss due to weeds, may be reached up to 44 – 96% at the global level (Mohammed, 1994). Monaco (2002) reported that 41 – 100% yield reduction due to weed competition in sunflower if the first weeding is delayed. Weeds drastically reduce sunflower yield from 70 – 80 percent lost (Anonymous 1998). Fertilizer application either organic or inorganic therefore becomes a major condition towards yield increase. Phosphorus (p) is a majoy requirement for the growth of sunflower. It's deficiency results in stunted growth, purplish discolouration of leaves. It also affects flowering, fruit production and seed production (Aduayi *et al*., 2002). Flower size is reduced to half it's normal size, head Is decrease to one – third. Uptake of major nutrients elements by sunflower has also been reported to be facilited when phosphorus was applied at the rate of 40 – 60kgha^{-1} in the forest zone (Fagbayide and Adeoye, 1999). Based on the above views, this study was initiated with the objective of determining the performance of sunflower as influenced by weeding regime and phosphorus fertilizer rates.

MATERIALS AND METHODS

Field experiment was carried out at the experimental farm site of Federal College of Forestry Mechanization, Afaka, Kaduna (latitude 10^037N and longitude 7^017E). The physical and chemical properties of the soil at the experimental site was taken for analysis prior to land preparation. The treatments consisted of weeding regime (hoe weeding every 3 weeks, hoe weeding every 4 weeks, hoe weeding every 6 weeks, weed free and weedy check) and three rates of phosphorus fertilizer at 0, 40 and 60kgha^{-1}. The treatments were arranged in a Randomized Complete Block Design (RCBD) replicated three times. The gross and net plot sizes were 3.375m^2 (1.5m × 2.25m) and 1.125m^2 (1.5m × 0.75m). The sunflower seeds were planted in situ, with 2 to 4 seeds per hole and thinned to one plant seedlings per stand after establishment. Harvesting of sunflower was done when the sunflower head turned yellowish brown. The sunflower heads were cut from their stems and sun dried and a small stick was used to stick the back of the sunflower head to remove the sunflower seeds. Data collected include weed dry weight, plant height, number of leaves per plant and seed yield. All the data collected were subjected to analysis of variance (ANOVA) as described by Snedecor and Cochran, 1967. The significant differences between the means were compared using Duncan Multiple Range Test (DMRT) (Duncan, 1955).

Weed dry weight

Weeding regime significantly influenced weed dry weight. From table x, for both years the weedy check plots recorded significantly higher weed dry weight than the other weed control treatments. The weed free treated plots gave the least significant weed dry weight compared to the other weed control treatments. This result is so, as it goes in line with the work of Jabran *et al*., 2008, who reported that weeds left unmanaged causes massive yield losses in sunflower field crop. For the first year phosphorus fertilizer rate significantly influenced weed dry weight. The 40 and 50kgha^{-1} phosphorus fertilizer rates recorded significantly higher weed dry weight than the 0kgha^{-1} phosphorus fertilizer rates.

Plant height

Weeding regime and phosphorus fertilizer rates significantly influenced plant height of sunflower for both years. For both years the weed free treated plots gave significantly taller plants than the other weed control treatments, this was followed by the plots with hoe weeding every 3 weeks. The weedy check plots recorded the shortest significant plant height compared to the other weed control treatments. This result could be as a result of phosphorus not being deficient for both years, as reported by Aduayi *et al*., 2002.

Number of leaves per plant

For both years weeding regime did not have any significant effect on number of leaves per plant. Phosphorus fertilizer rates significantly influenced number of leaves per plant. For both years the 50kgha^{-1} phosphorus fertilizer rate produced significantly higher number of leaves per plant than the other phosphorus fertilizer rates. This result could be as a result of phosphorus been applied at the right rate, as reported by Fagbayide and Adeoye, 1999. The least phosphorus fertilizer rates was recorded by the 0kgha^{-1}.

Seed yield

For both years weeding regime significantly influenced seed yield of sunflower; and the weed free treated plots recorded significantly higher seed yield of sunflower than the other weed control treatments. Weed check plots gave significantly lower seed yield. This result could be as a result of weeds being controlled effectively, irrespective of the presence of phosphorus.

Table 1: Effect of weeding regime and phosphorus fertilizer rates on weed dry weight and plant height of sunflower (*Helianthus annus* L.) during 2021/2022 and 2022/2023 rainy season at Afaka.

Treatments	Rate (kgha^{-1})	Weed dry weight 2021/2022	2022/2023	Plant height 2021/2022	2022/2023
Weeding regime					

Hoe weeding every 3 weeks		22.82b	22.67a	96.74b	116.05a
Hoe weeding every 4 weeks		23.58b	22.33a	88.38c	106.05a
Hoe weeding every 6 weeks		29.03ab	23.33a	89.30bc	102.16b
Weed free		12.66c	11.89b	105.99a	119.87b
Weedy check		30.74a	23.33a	86.40c	42.67c
SE±		1.550	0.644	1.971	2.033
Phosphorus rates					
0	$Kgha^{-1}$	24.38a	19.07b	87.58b	92.43b
40	,,	23.97a	20.93a	95.20a	97.25ab
50	,,	22.95a	21.24a	97.31a	102.47a
SE±	,,	1.200	0.499	1.527	1.575

Means in the same column of treatments followed by unlike letter(s) are significantly different at p ≤0.05 using Duncan Multiple Test (DMRT).

Table 2: Effect of weeding regime and phosphorus fertilizer rates on number of leaves per plant and seed yield of sunflower (*Heliantus annus* L.)

Treatments	**Rate ($kgha^{-1}$)**	**Number of leaves per plant 2021/2022**	**2022/2023**	**Seed yield 2021/2022**	**2022/2023**
Weeding regime					
Hoe weeding every 3 weeks		55.00a	33.33a	707.5b	367.67ab
Hoe weeding every 4 weeks		48.11a	32.78a	591.6c	367.22 ab
Hoe weeding every 6 weeks		55.11a	32.00a	357.8d	245.33b
Weed free		49.83a	32.22a	776.7a	450.44a
Weedy check		47.11a	32.78a	213.1e	63.11c
SE±				16.17	
Phosphorus rates $kgha^{-1}$					
0		42.50b	30.47c	512.0a	347.20a
40		54.60a	32.93b	529.3a	266.13a
50		56.00a	35.07a	546.7a	282.93a
SE±				12.53	

Means in the same column of treatments followed by unlike letter(s) are significantly different at p≤0.05 using Duncan Multiple Range Test (DMRT).

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PERFORMANCE OF GREEN BEANS (*Phaseolus vulgaris* L.) AS AFFECTED BY FRUIT SETTING HORMONES AND TIME OF APPLICATION IN MINNA, NIGERIA

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ABSTRACT
This study evaluated the performance of green beans (Phaseolus vulgaris L.) as affected by fruit setting hormones and time of application in Minna, Suthern guinea savanna Nigeria. The treatments were three levels of fruit setting hormones (Control, Cytokinin and Beta Naphth Oxy-acetic Acid (BNOA)) and four periods of application (seed priming for 8 hours + application at vegetative and flowering stage, application at vegetative and flowering stage only, application at flowering stage only and application at two weeks interval throughout the experiment). These were factorially H combined to give twelve treatments combinations which were arranged in a randomized complete block design with three replicates. Data were collected on growth, flowering and yield parameters. Data collected were subjected to analysis of variance using General Linear Model procedure of Minitab software. Differences between the means were separated using least significant difference (LSD) at 5% level of probability. The results revealed that seeds primed with cytokinin were the fastest to emerge while those primed with BNOA did not emerge. Plants that received BNOA at 2 weeks interval and plants that received Cytokinin both at vegetative + flowering stage had the longest vine, fattest stem and largest leaf area. Plants that received BNOA were the earliest to approach 50% flowering (33 days) compared to other treatments (34-40 days). Plants that received Cytokinin at two weeks interval throughout the experiment had the longest pod, fattest pod, heaviest fresh and dry pod weights as well as the highest number of pods per plant. Application of cytokinin at 2 weeks interval throughout the growth stages of green beans can therefore be recommended to improve the productivity of the crop.
Keywords: *Fruit setting hormone, time of application, Cytokinin, Beta Naphth Oxy-Acetic Acid, green beans*

INTRODUCTION

Green Bean (*Phaseolus vulgaris* L.) is an annual vegetable of the legume family (Fabaceae). Fabaceae ranks second in economic importance after the Poaceae family (Husham and Ali, 2020). They serve as major source of protein, minerals and vitamins for many households in Nigeria. *Phaseolus*is a large genus of annual plants that can be grown in many different climates (Savita, 2020). China is the world largest producer of green beans (14 million metric tons), followed by Indonesia (1.4 million metric tons) and Turkey (0.6 million metric tons) (FAOSTAT, 2021b). It is an important vegetable crop in Nigeria, providing a significant source of nutrition and income for farmers. Nigeria produced apparently 178,550 metric tons of green beans in 2020 (FAOSTAT, 2021a). It is predominantly grown in Jos, plateau state and in Kaduna states (Rashida *et al.,* 2022).

Fruit setting hormones (FSHs) are synthetic hormones that are applied to enhance fruit setting and yield in crops. They are also known as plant growth regulators (PGRs). They play an essential role in the development and ripening of fruit. There are several types of hormones involved in fruit setting, including auxins, cytokinins, gibberellins, abscisic acid and ethylene. Auxins play a crucial role in the early stages of fruit development by controlling cell division and differentiation in the ovary (Huang *et al.,* 2020). Beta Naphth Oxy-Acetic Acid (BNOA) stimulates the growth of reproductive organs and promotes fruit development. Gibberellins are involved in the regulation of fruit size, shape, and quality (Pan *et al.,* 2020). Cytokinins are involved in the regulation of cell division and enlargement, and they play a critical role in determining fruit size and shape (Osorio *et al.,* 2020) .

Many crops experience sub-optimal yields and low fruit quality due to inadequate pollination, low fruit set and poor crop nutrition (De Silva *et al.,* 2022). Fruit yields can be constrained by the percentage of flowers that are pollinated and fertilized, the percentage of fruit that develop to maturity, and the mass of the fruit components that contribute to yield (Alcaraz & Hormaza, 2021). The final size of the remaining fruit that reach maturity can be affected by environmental conditions, crop nutrition and fruit paternity (De Silva *et al.,* 2022). Despite the potential of green beans, the average yield obtained by African farmers (1.48 tons/ha) is much lower than the potential yield (2.5-3 tons/ha) (Melkamu *et al.,* 2023). Low fruit setting have been identified as one of the major factor responsible for the poor yield in green beans (FAOSTAT, 2021a).

One approach to increase crop yield is the use of plant growth regulators such as fruit setting hormones (FSHs). Oloyede *et al.* (2021) investigated the effect of FSHs and planting dates on yield and yield components of two cowpea cultivars in southwest Nigeria. The author reported that application of FSHs at flowering stage significantly increased yield and yield components of the bean cultivars. Previous studies have suggested that fruit setting hormones such as gibberellins, auxins and cytokinins can enhance fruit set and yield in various crops like oil palm (Edison *et al.,* 2021), tomatoes (Satoshi, 2012; Yoshihito *et al.,* 2020), pear (Caixi *et al.,* 2008) etc. However, the effectiveness of these hormones may depend on the timing of their application. This study therefore aimed to evaluate the effect of FSHs at different time of application on the performance of green beans.

MATERIALS AND METHODS

The experiment was conducted at the Horticultural Nursery, Federal University of Technology, (9.^{0}46.8' N, 6^{0}57.9' E) Minna, Niger State in the southern Guinea savanna of Nigeria under rain fed condition. The climate of Minna is sub humid with mean annual rainfall of about 1284 mm and a dry season of about 5 months duration occurring from November to March. The mean maximum temperature (about 33.5 ^{o}C) remains high throughout the year (Adediran *et al.,* 2019)

The treatmentsconsisted of three levels of fruit setting hormones (control, Cytokinin (100ppm) and Beta Naphth Oxy-Acetic Acid (200ppm)) and four periods of application (seed priming for 8 hours + application at vegetative and flowering stage, application at vegetative and flowering stage only, application at flowering stage only and application at two weeks interval throughout the experiment). These were factorially combined to give twelve treatmentscombinations which were arranged in a randomized complete block design replicated three times.Net plot size was consisting2m x 2m (4m^{2}) consisting of three ridges, with 75 cm between rows. Inter and intra row spacing of 75cm x 40 cm was maintained by three seeds per hole which was later thinned to two plants per stand. Data were collected from five randomly tagged plants at six weeks after planting on vine length, stem diameter, leaf area, number of leaves, pod length, pod weight, pod diameter and number of pods/plant. Data collected were subjected to analysis of variance using General Linear Model procedure of Minitab software. Where significant interaction exists between hormone and time of application, tables of main effects are not presented. Differences between the means were separated using Duncan Multiple Range Test (DMRT) at 5% level of probability.

RESULTS

Vine length

The vine length was significantly affected ($P<0.01$) by hormone, time of application and interaction between the two (Table 1). Plants that received Cytokinin at vegetative + flowering stage had the longest vine (31.77 cm) and were at par with plants that received BNOA every two weeks throughout the experiment (32.26 cm) and plants that received cytokinin every two weeks throughout the experiment (29.87 cm). The shortest vine was recorded from plants that received Cytokinin at priming + vegetative + flowering stages (23.56 cm) similar to the control plants (24.35 cm) (Table 2)

Table 1: Mean square values for response of green beans to fruit setting hormone and time of application

Source of variation	Vine Length (cm)	Stem Diameter (mm)	Leaf Area (cm^2)	Number of Leaves	Number of Branches
Hormone (H)	120.37**	0.08**	92.87*	46.06**	31.74**
Time of application (T)	162.39**	0.10**	2793.25**	64.00**	24.65**
H X T	262.39**	0.06**	1294.63**	123.65**	33.00**
SME ±	2.34	0.0002	26.87	3.43	0.34

*, **- significant at 5 and 1 percent probabilitylevel respectively

Table 2: Vine length (cm) of green beans as affected by fruit setting hormone and time of application

Hormone	Priming+ Vegetative + Flowering	Vegetative + Flowering	Flowering	Every two weeks
Control (no hormone)	24.35de	24.35cde	24.35de	24.35de
Cytokinin	23.56e	31.77a	24.28de	29.87ab
BNOA	0.00f	26.25cd	27.04c	32.26a
SE±		0.883		

Means followed by similar alphabets are not significantly different at P = 0.05 using DMRT

Stem diameter

The stem diameter was significantly (P<0.01) affected by hormone, time of application and interaction between the two (Table 1). The fattest stem was obtained in plants that received cytokinin at vegetative + flowering stages (0.59 mm). The least value (0.50 mm) was obtained in plants the received BNOA only at flowering similar to the control plants (0.51 mm). (Table 3)

Table 3: Stem diameter (mm) of Green beans as affected by fruit setting hormone and time of application

Hormone	Priming+ Vegetative + Flowering	Vegetative + Flowering	Flowering	Every two weeks
Control (no hormone)	0.51cd	0.51cd	0.51cd	0.51cd
Cytokinin	0.54b	0.59a	0.54b	0.50cd
BNOA	0.00e	0.54b	0.50d	0.54b
SE±	0.009			

Means followed by similar alphabets are not significantly different at P = 0.05 using DMRT

Leaf area

The leaf area was significantly affected (P ≤ 0.01) by the hormone, time of application and interaction between the two (Table 1). The highest leaf area was recorded in plants that received Cytokinin at vegetative + flowering stages (84.57 cm^2) which was at par with values obtained in plants that received BNOA every two weeks throughout the experiment (84.09 cm^2), and those that received BNOA at vegetative + flowering stages (76.53 cm^2). The least leaf area value was obtained in plants that received BNOA at flowering alone similar to the control plants (Table 4).

Table 4: Leaf area (cm^2) of green beans as affected by fruit setting hormone and time of application

Hormone	Priming + Vegetative + Flowering	Vegetative + Flowering	Flowering	Every two weeks
Control (no hormone)	49.57de	49.57de	49.57de	49.57de
Cytokinin	59.86bc	84.57a	46.47e	50.23de
BNOA	0.00f	76.53a	58.28bcd	84.09a
SE±	2.99			

Means followed by similar alphabets are not significantly different at P = 0.05 using DMRT

Number of leaves

The number of leaves was significantly affected ($P \leq 0.01$) by the hormone, time of application and interaction between the two (Table 1). The interaction between hormone and time of application in respect of number of leaves is shown in Table 5. The highest number of leaves was recorded in plants that received BNOA at flowering stage only (20.87 leaves). This was statistically similar to the other treatments except those primed in the hormones and control plants which produced the least number of leaves (16.87) (Table 5).

Table 5: Number of leaves of green beans as affected by fruit setting hormone and time of application

Hormone	Priming + Vegetative + Flowering	Vegetative + Flowering	Flowering	Every two weeks
Control (no hormone)	16.87c	16.87c	16.87c	16.87c
Cytokinin	17.73bc	18.53abc	18.67abc	20.07ab
BNOA	0.00d	20.13ab	20.87a	19.20abc
SE±	1.07			

Means followed by similar alphabets are not significantly different at P = 0.05 using DMRT

Table 6: Mean square values for response of green beans to fruit setting hormone and time of application

Source of variation	Pod Length (cm)	Pod Diameter (mm)	Fresh Pod Weight (g)	Dry Pod Weight (g)	Number of Pods
Hormone (H)	32.72**	0.15**	667.23**	100.26**	30.94**
Time of application (T)	33.63**	0.14**	54.14**	11.16	3.02
H X T	40.06**	0.18**	260.41**	29.63**	14.74**
SME ±	0.42	0.002	60.69	4.28	3.40

*,**- significant at 5 and 1 percent respectively

Pod length

Highly significant difference ($P \leq 0.01$) exists between the hormone, time of application and interaction between the two in respect of pod length (Table 6). The longest pod was recorded in plants that received cytokinin at two weeks intervals throughout the experiment similar to other treatment combination except those primmed in the hormone which had the shortest pod similar to control plants (Table 7).

Table 7: Pod length (cm) of green beans as affected by fruit setting hormone and time of application

Hormone	Priming + Vegetative + Flowering	Vegetative + Flowering	Flowering	Every two weeks
Control (no hormone)	11.05bc	11.05bc	11.05bc	11.05bc
Cytokinin	10.91c	12.01ab	11.96abc	12.67a
BNOA	0.00d	12.07ab	12.13ab	12.21a
SE±	0.372			

Means followed by similar alphabets are not significantly different at P = 0.05 using DMRT

Pod diameter

The pod diameter was significantly (P<0.01) affected by response to hormone, time of application and interaction between the two (Table 6). Table 8 shows the interaction effect of hormone type and time of application on pod diameter. Plants whose seeds were primed in the hormone prior to sowing produced significantly slimmer pods than plants which received the hormones at vegetative, flowering and those who received at two weeks interval throughout the growth period (Table 8).

Table 8: Pod diameter (mm) of green beans as affected by fruit setting hormone and time of application

Hormone	Priming + vegetative + flowering	Vegetative + flowering	Flowering	Every two weeks
Control (no hormone)	0.77ab	0.77ab	0.77ab	0.77ab
Cytokinin	0.70b	0.82a	0.81a	0.83a
BNOA	0.00c	0.79a	0.84a	0.78a
SE±	0.027			

Means followed by similar alphabets are not significantly different at P = 0.05 using DMRT

Fresh pod weight

Highly significant difference (P ≤ 0.01) exists between the hormone, time of application and interaction between the two in respect of fresh pod weight (Table 6). The interaction effect of hormone and time of application on fresh pod weight is presented in Table 9. The result shows that plant that received Cytokinin at two weeks interval throughout the experiment had the heaviest pod (33.33 g). This was similar to the values obtained in plants that received cytokinin at vegetative + flowering stage (25.24 g), at flowering stage alone (21.76 g), and plants that received BNOA at two weeks interval throughout the growth period (20.30 g). The least pod weight was recorded in plants that received BNOA at flowering only (11.27 g) similar to the control plant (15.67 g) (Table 9).

Table 9: Fresh pod weight (g) of green beans as affected by fruit setting hormone and time of application

Hormone	Priming + vegetative + flowering	Vegetative + flowering	Flowering	Every two weeks
Control (no hormone)	15.67bcd	15.67bcd	15.67bcd	15.67bcd
Cytokinin	11.46de	25.24abc	21.76abcd	33.33a
BNOA	0.00e	12.33cde	11.27de	20.30abcd
SE±	4.50			

Means followed by similar alphabets are not significantly different at P = 0.05 using DMRT

Number of pods/plant

Highly significant difference (P ≤ 0.01) exists between the hormone, time of application and interaction between the two in respect of number of pod/plant (Table 6). The interaction between hormone and time of application in respect of number of pod per plant is presented in Table 10. The highest pods were recorded in plants that received Cytokinin at every two weeks throughout the experiment (8 pods/plant). This was at par with the number of pods recorded in other cytokinin treated plants except those whose seeds were primmed in the hormone prior to planting (3.40 pods/plant) and also similar to plants that received BNOA at two weeks interval throughout the experiment (5.83 pods/plant). The least pods/plant was recorded in plants that received BNOA at flowering stage only (2.87 pods/plant).

Table 10: Number of pods/plant of Green beans as affected by fruit setting hormone and time of application

Hormone	Priming + vegetative + flowering	Vegetative + flowering	Flowering	Every two weeks
Control (no hormone)	4.53bcd	4.53bcd	4.53bcd	4.53bcd
Cytokinin	3.40cd	5.73abcd	6.13abc	8.00a
BNOA	0.00e	4.10bcd	2.87de	5.83abcd
SE±	1.06			

Means followed by similar alphabets are not significantly different at P = 0.05 using DMRT

DISCUSSION

This study found that FSHs significantly affected the growth and yield of green beans. This is in agreement with the findings of Oloyede *et al.* (2021) who investigated the effect of FSHs and planting dates on yield and yield components of two cowpea cultivars in southwest Nigeria. The authors reported that the application of FSHs significantly increased the growth, number of pods and seeds per plant as well as the total seed yield of cowpea. The growth components (vine length, stem diameter, leaf area and number of leaves) were highest in plants that received Cytokinin at vegetative and flowering stages. This was followed by plants that received BNOA at vegetative and flowering stages had a higher growth component than the control (no hormone). Cytokinin increases cell division and enlargement. Osorio *et al.* (2020) similarly reported that cytokinins improved the development of tomato fruits resulting in larger fruits. Oloyede *et al.* (2021) reported that application of FSHs at flowering stage significantly increased yield and yield components of cowpea cultivars. Investigation on the effect of BNOA on the growth and yield of two cowpea cultivars in Nigeria by Adekiya *et al.,* (2020) Shows that the application of BNOA significantly increased the plant height, number of branches, number of pods and seeds yield of the cowpea cultivars. These studies suggest that the application of fruit setting hormone at the appropriate time can significantly improve the performance of bean production in Nigeria. BNOA stimulates the growth of reproductive organs and promotes fruit development. Furthermore, Debi (2022) reported that foliar application of growth regulators and chemicals at the flowering stage may improve the physiological efficiency and may play a significant role in raising the productivity of crop. Wamiq *et al*., (2020) studied the effect of GA3 and NAA on yield of bottle gourd (*Lagenaria siceraria*) (MGH-4) and reported that application of 40 ppm gibberellin at 2, 4 leaf stage was found most effective in terms of number of female flowers per vine, fruit per plant, fruit yield per plant, fruit yield per hectare.

The yield components were higher in plants that received Cytokinin at every two weeks throughout the experiment. Zhang *et al.* (2021) reported that the application of cytokinin increased fruit set and yield in cowpea, while also improving the quality of the fruit. This was followed by plants that received BNOA at every two weeks throughout the experiment which had a higher yield component than the control (no hormone). This was in line with the study of Manish *et al*., (2020) who concluded that foliar application of Ethrel at 300 ppm sprayed at different stages of growth i.e., at two true leaf stage, four true leaf stage and flower initiation stage was beneficial for higher seed yield and better growth of bottle gourd.

CONCLUSIONS AND RECOMMENDATION

The study revealed that hormones and time of application significantly influenced green beans growth and yield. Plants that received cytokinin at vegetative + flowering stages had the longest vine, fattest stem and largest leaf. Plants that received BNOA at flowering stage only had the highest number of leaves. Plants that received cytokinin at two weeks interval throughout the growth stageshad the longest pod, fattest pod, highest number of pods/plant as well as highest pod yield. Based on the result of this study, it is recommended that farmers should apply cytokinin at two weeks intervals for maximum pod yield.

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STUDENTS' ATTITUDE TOWARDS SCHOOL GARDENING ACTIVITIES IN NIHORT ADOPTED SCHOOLS, IBADAN, OYO STATE

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ABSTRACT
School garden could be explored to develop attitude of students in horticulture to enhance diversification of the Nigerian economy. The study assessed the attitude of 100 senior secondary school students from two NIHORT adopted secondary schools within 5km radius of the Institute's headquarter office in Ibadan to school gardening activities. Data were collected using well-structured questionnaire and analyzed with descriptive statistics. Results revealed that most of the students were males (51.0%), aged 16-18 years (55.0%), 74.0% participated in home gardening activities with 55.0% having between 1-3 years of gardening experience. Fifty-five percent strongly agreed that school gardening activities should be made compulsory in secondary school curriculum while 49 percent strongly agreed that these activities help increase students' sense of ownership and responsibility. Forty-four percent strongly disagreed that getting involved in school gardening activities will have negative influence on their academic performance. Most of the students reported seasonality in agriculture (51.0%) and lack of organized regular tours to agricultural institutes (50.0%) as severe constraints to participating in school gardening activities. Thus, it is imperative that school gardening activities be made part of secondary school curriculum to initiate students' interest in horticulture and by extension agriculture as a career.
***Keywords**: School gardens, Secondary school students, Attitude, curriculum, sense of ownership*

INTRODUCTION

A school garden is a powerful environmental education tool. School garden is an innovative teaching tool and strategy that lets students incorporate hands-on activities in a diversity of multidisciplinary, standards-based lessons. School gardens is an interesting and effective way to create engaging learning environment (Passy, 2012). Through gardening, students become responsible caretakers as they have an opportunity to engage in agricultural practices on a small scale, learning about the responsibilities and impacts of land cultivation. They explore the web of interactions among living and nonliving components of life. By doing so, they develop a greater understanding of the natural world. Students also learn the importance of caring for natural resources. The garden engages students by providing a dynamic environment in which to observe, discover, experiment, nurture, and learn. School gardens not only improve students' health but also add to the attractiveness of the educational spaces and encourage experimental learning (Utter et al., 2016).

NIHORT adopted secondary schools (Agricultural Research Outreach Centers) are an avenue through which the Institute reaches out to students by increasing their awareness of horticultural practices. These schools are meant to showcase horticultural technologies developed in NIHORT. This is in a bid to initiating their interest in horticulture as a career and means of livelihood. With this background the present study was conducted to assess the attitudes of secondary school students towards school gardening activities.

Objectives of the study

1. Describe the personal characteristics of the students in the study area
2. Ascertain the attitude of students on school gardening activities in the adopted schools

3. Identify the constraints faced by students participating in school gardening activities in the study area.

METHODOLOGY

The study area was NIHORT Adopted schools (Oba Abass Grammar School, Eleyele, and Anwar -Ul-Islam Grammar School, Eleyele), both within 5km radius of the headquarter office of the National Horticultural Research Institute, lbadan, Oyo state. Two-stage sampling technique was used to select respondents to arrive at the population of the students used for the study respondents for the study; the first stage involving a purposive selection of the two school from the adopted schools because the Institute through her extension programme had trained the students on school gardening activities. At the last stage, 50% of the students from Senior Secondary School 2 and 3 were randomly selected given a total of 100 students involved in the study. A well-structured questionnaire was used to elicit information from the students. Descriptive statistics such as frequencies and percentages were used to analyze the data collected.

RESULTS AND DISSCUSSION

Personal Characteristics of Students

The result in Table 1 shows that 51.0% of the students sampled were male. This could be associated with the prominent roles male children play in the society as they were powerful young teens full of strength and vigor. Hence, they will be able to carry out school gardening activities more. More than half (55.0%) of the students were within 16-18 years old, 90.0% of the students have home garden while 74.0% were participating in home gardening activities. More than half (55.0%) of the students have 1-3years gardening experience while 62.0% were involve in planting vegetables. Gardening offers students opportunities for outdoor exercise while teaching them useful life skills such as handling of tools, planting and post-planting care (Cairns, 2017). Eighty percent of the students got their knowledge from Agricultural teachers on school gardening activities while (97.0%) needs more training on school gardening activities.

Attitude of students on school gardening activities

As regard the attitude of students in school gardening activities, Table 2 shows that half of the students strongly agreed that school gardening activities should be made a compulsory part of secondary school curriculum, 49% also strongly agreed that the school gardening activities help increase their sense of ownership and responsibility while 48% reported that engaging in school gardening activities improve their social behaviour. Moreover, 53% agreed that school gardening activities help achieve group cohesion and improved interpersonal relationships among students and teachers. Studies have shown that students who are allowed to learn in an outdoor environment such as a garden have improved in environmental attitudes, positive work ethics, increased students' self-esteem, among others (Kallhoff and Schörgenhumer, 2017). On the other hand, 44% strongly disagreed that getting involved in school gardening activities will have negative influence on their academic performance. This implies that school garden is a perfect tool to provide hands-on learning experiences for any academic subject (Williams, 2018). Moreover, 39 percent of the students respectively strongly disagreed to the statements that say "I do not like gardening activities because it is a hard work" and "I do not like gardening activities because it is a dirty job".

Constraint faced by students participating in school gardening activities

The result in table 3 shows that most of the students opined that seasonality in agriculture (51.0%), regular tours to agricultural institute not organized (50.0%), and non-availability of nursery tools (47.0%), were severe constraints to their participation in school gardening activities. This implies that seasonality in agriculture could hinder students' participation in gardening activities due to the timing of the school calendar. Lack of regular tours to agricultural institutes and non-availability of nursery tools could be as a result of lack of planning on the part of the school administration.

CONCLUSION AND RECOMMENDATIONS

The secondary school students surveyed expressed overwhelmingly positive attitudes about school gardening activities, seeing benefits like increased responsibility, social skills, and group cohesion. The majority of respondents were male students in their late teens who had some previous gardening experience at home, indicating an engaged demographic eager to learn through hands-on gardening. However, several constraints were identified including seasonality of gardening, lack of agricultural institute tours, and insufficient tools, pointing to logistical limitations in implementing school gardening programs. Hence, the results highlight students' motivation and interest in gardening alongside barriers of resources and planning. Targeted support from school administrations, such as securing adequate gardening supplies and incorporating tours, could help optimize the impact of school gardening initiatives. With enthusiastic students ready to learn, addressing key logistical constraints can help school gardening activities flourish.

Table 1: Distribution of selected student's socio-economic characteristics (n=100)

Variable	Frequency	Percentage
Age		
13-15 years	43	43.0
16-18 years	55	55.0
19-21 years	2	2.0
Sex		
Male	51	51.0
Female	49	49.0
Do you have a home garden?		
Yes	90	90.0
No	10	10.0
Do you participate in home garden activities?		
Yes	74	74.0
No	26	26.0
Years of gardening experience		
1-3 years	55	5.0
4-6 years	45	45.0
Crops planted		
Vegetables	62	62.0
Maize	20	20.0
Sweet potato	11	11.0
Cocoyam	2	2.0
Fruits	5	5.0
Source of Knowledge on school gardening activities		
NIHORT	5	5.0
Agricultural science teacher	80	80.0
Parents	15	15.0
Need more training on school gardening activities		
Yes	97	97.0
No	3	3.0

Source: Field Survey, 2023

Table 2: Distribution Student's Attitude to school gardening activities (n=100)

Attitude Statements	Strongly Agree Freq (%)	Agree Freq (%)	Disagree Freq (%)	Strongly Disagree Freq (%)
Engaging in school gardening activities improve my social behavior	48 (48.0)	44 (44.0)	7 (7.0)	1(1.0)
Engaging in school gardening activities enhances my consciousness of environmental issues	41(41.0)	48 (48.0)	8 (8.0)	4 (4.0)
Participation in school gardening activities helps improve my attitude towards the school vegetable garden	43(43.0)	51(51.0)	3(3.0)	3(3.0)
School gardening activities help achieve group cohesion and improved interpersonal relationships among students and teachers	31(31.0)	53 (53.0)	12 (12.0)	4(4.0)
School garden activities increases my family relationships and student-teacher-parent	24(24.0)	44 (44.0)	32 (32.0)	-
Participating in school gardening activities has increased my scores in agricultural science and other science related subjects	45(45.0)	39 (39.0)	10 (10.0)	6(6.0)
School gardening activities should be made a compulsory part of secondary school curriculum	50(50.0)	44 (44.0)	4 (4.0)	2 (2.0)
School gardening activities help increase my sense of ownership and responsibility	49 (49.0)	45 (45.0)	4 (4.0)	2 (2.0)
I do not like gardening activities because it is a hard work	8 (8.0)	6 (6.0)	47 (47.0)	39(39.0)
I do not like gardening activities because it is a dirty job	8 (8.0)	6 (6.0)	47 (47.0)	39(39.0)
Getting involved in school gardening activities will have negative influence on my academic performance	11 (11.0)	10 (10.0)	35(35.0)	44 (44.0)
It is difficult for me to learn about the growing of crops in the school gardening activities	8(8.0)	19 (19.0)	42(42.0)	31(31.0)
I lose interest in growing vegetables in the school gardening activities once it is not successful	15 (15.0)	23(23.0)	30(30.0)	32(32.0)
I believe that increased spending on agricultural related activities in secondary school is a waste of time and money	6 (6.0)	10 (10.0)	44(44.0)	40(40.0)

Source: Field Survey, 2023

Table 3: Distribution of constraints faced by student participating in school gardening activities (n=100)

Constraints	Severe constraint Freq (%)	Mild constraint Freq (%)	Not constraint Freq (%)
Low interest in horticultural activities	40(40.0)	31(31.0)	29(29.0)
Peer pressure	36 (36.0)	33(33.0)	31(31.0)
Non availability of nursery tools	47 (47.0)	30(30.0)	24 (24.0)
Seasonality in Agriculture	51 (51.0)	25(25.0)	24(24.0)
Teachers lackadaisical attitude	26 (26.0)	40(40.0)	34(34.0)
Inadequate information	37(37.0)	40 (40.0)	23(23.0)
Poor maintenance culture	34 (34.0)	37(37.0)	29(29.0)
Regular tours to agricultural institute are not organized	50 (50.0)	28(28.0)	21(21.0)
Irregular classes	25(25.0)	29(29.0)	46(46.0)
Inadequate knowledge in the use of different machineries	40(40.0)	34(34.0)	25(25.0)
Inadequate knowledge in gardening activities	36(36.0)	34(34.0)	30(30.0)
Lack of funds	37(37.0)	40(40.0)	23(23.0)
Technical know-how	36(36.0)	39(39.0)	24 (24.0)

Source: Field Survey, 2023

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BIOACCUMULATION OF HEAVY METALS ON SWEET CORN GROWN FROM MUNICIPAL SOLID WASTE DUMPSITE-DERIVED SOIL

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ABSTRACT
The use of residues from human consumption, farming and municipal waste will improve the physical and chemical properties of the soil, as well as add fertility to the soil and development. Due to their fertile soils, urban dump sites are frequently employed for agriculture, despite the dangers posed by poisonous heavy metals. Without considering the potential health risks that the heavy metal levels of such soil type may present, farmers use soil from dumpsites. To determine their fate, the concentrations of these heavy metals must be determined. The build-up of heavy metals in agricultural soils is a growing source of worry due to issues with food safety, potential health risks, and negative effects on the environment of the soil. This development required investigation into the relationship between the quality of the dumpsite-soil metal and the rate of plant bioaccumulation, as well as the impact of municipal and rural dumpsites on the levels of underlying soil metals. Using data collected, collation, and analysis, this study intends to investigate the ability of sweet corn to accumulate heavy metals and evaluate the bioaccumulation factor (BAF). The study was carried out in Delta State, Nigeria. The municipal solid waste dumpsite selected are the area with heavy domestic and industrial waste which were over-populated. With the aid of a soil Augar, soil samples were taken from the vicinity of the selected municipal solid waste dumpsites and farms in Delta State, Nigeria, at a depth of 0–60 cm. The statistical analysis of variance software SPSS 17 for Windows (SPSS Inc., USA) was used to evaluate the data gathered (ANOVA). The results of the soil samples' physicochemical analysis showed that the soils from municipal solid waste dumpsites were moderately acidic, had sizable amounts of organic matter, and contained some ionisable inorganic compounds. The study's findings also showed that plants grown on plots with amended dumpsite soils bio-accumulated had more metals than those grown on plots with typical agricultural soils. It was also noted that different plant parts of the same plant differed in their capacity to bio-accumulate these metals. However, the plant accumulated elevated concentrations of heavy metals in their shoot, when compared with other part of the plant. The findings of this study will be very helpful to academics and environmental regulators in developing nations.
Keywords: *Bioaccumulation, Heavy Metals, Sweet Corn, Dumpsite, Soil*

INTRODUCTION
Urban areas with a high concentration of industrial activity produce more pollutants and are consequently at risk from the indiscriminate dumping of both domestic and industrial waste. Due to the high volume of waste produced as the population grows without adequate facilities in urban areas of Delta State, which is located in the center of Nigeria's oil-rich Niger Delta, open waste disposal practices have continued to be the only option for managing waste in our towns and cities. Almost all human activities produce garbage, and how this waste is handled, stored, collected, and disposed of can have negative effects on the environment and the general public's health (Zhu *et a*l., 2008). Earth is quite good at recycling waste, but when there are more wastes produced than the earth can handle, pollution results, posing a serious threat

to life. Recycling organic waste and nutrients that remain on farmland is a practical and desired idea. Because compost's organic matter content can offset the natural decline in intensively farmed soils, compost application to soil is utilized to preserve and enhance soil structure (Lillenberg *et al.,* 2010). The decomposition of these solid wastes releases chemicals that can alter the soil's natural balance of nutrients available for plant growth and development, increasing the concentration of heavy metals in the soil and reducing species diversity and agricultural outputs. Some waste products may contain non-essential elements, persistent organic compounds, and microbes that may be hazardous to plants in addition to the potentially useful nutrients found in waste materials (Chukwujindu *et al.,* 2005). According to Ayari et al. (2008), the presence of harmful heavy metals in municipal solid waste composts (MSWC) raises severe concerns about the unfavorable environmental impact of their excessive application to land used for agriculture. Both organic substances and geological sources, as well as human activities and anthropogenic sources, contribute heavy metals to soils.
Agricultural activities (fertilizers, sewage sludges, pesticides, and irrigation water; energy and fuel production), Mining and Smelting (tailing, smelting, refining, and transportation), Automobiles (combustion of petroleum fuels), Urban/industrial Complexes (incineration of wastes and waste products), and Natural Sources (soil parent material, volcanic eruptions, marine aerosols, and forest fires) are just a few of the According to Chukwujindu *et al.* (2005), high and excessive buildup of heavy metals in soil and other media may eventually poison the food chain for both humans and animals. Those metals with a specific gravity more than or equal to 5 g/cm are referred to be heavy metals. Copper, nickel, chromium, lead, cadmium, mercury, and iron are the most prevalent heavy metals. If present in low concentrations, certain heavy metals like iron and nickel are necessary for the survival of all forms of life (Leah et al., 2004). According to Awokunmi *et al.* (2010), exposure to heavy metals can result in neurological damage, lower mental capacity, renal damage, blood, bone, and bone diseases. Lowered energy levels, altered blood chemistry, harm to the liver, kidneys, lungs, and other crucial organs are all possible effects of heavy metal toxicity. Plants may absorb heavy metals from mobile ions in the soil solution through their roots or through foliar absorption when they are cultivated on soil that has been contaminated with home, industrial, or municipal trash. Plants' roots, stems, fruits, grains, and leaves bio-accumulate these absorbed metals (Fatoki, 2000). The capacity of plants to absorb metals and possibly other contaminants varies depending on the type of plant species and the type of metal contamination. Strong contaminant accumulates include cereals like Zea mays L (maize).

Sweetcorn (*Zea mays saccharata L.*) is becoming a popular horticultural product in Nigeria and it is highly demanded due to its sweeter taste when consumed. Sweet corn is a horticulture crop with the potential to help Nigeria achieve food security. In contrast to other corn varieties, sweet corn has a sweet flavor and a delicate, syrupy texture that makes it ideal for fresh consumption. The cultivation of sweet corn is commonplace worldwide. Sweet corn will have a maximum degree of market maturity when it has 5-6% sugar, 10-11% starch, 3% water soluble polysaccharides, 70% water, and reasonable quantities of protein, vitamin A, and potassium (Oktem & Oktem, 2005). Ajibola et al. (2020) argue that the production of sweet corn is extremely low because of the poor fertility of the soil and the inadequate application of an amendment at the required rate. Supplementing the soil with organic and inorganic fertilizer is one method of enhancing soil fertility and the quality and quantity of agricultural production (Pangaribuan & Hendarto, 2018). According to Nascimento and Xing (2006), sweetcorn has the capacity to continuously phytoextract metals from polluted soils by moving the metals from the roots to the shoots. The deposition of some heavy metals by the sweetcorn plant has even been demonstrated to exceed the thresholds for metal hyperaccumulation. Máthé-Gáspár and Anton (2005) categorized sweetcorn as an accumulator and a metal tolerant plant based on its capacity to absorb heavy metals and sensitivity to excessive metal pollution. The percentage of heavy metals that are easily mobilized in the soil environment and absorbed by plant roots is referred to as the bioavailable fraction. In general, absorption is higher in plants cultivated in places with more contaminated soil. Heavy metals' bioavailability to plants is influenced by a variety of physical and chemical substances in the soil. According to Peijnenburg and Jager (2003), these include soil characteristics such as pH, organic matter content, redox potential, cation exchange capacity (CEC), sulphate, carbonate, and hydroxide, soil texture, and clay concentration. The bioaccumulation factor (BAF) is used to assess the effectiveness of plants in accumulating and transporting metals, as well as to estimate the bioaccumulation influence of plants on the soil absorption of heavy metals. As a result, research on the transmission and accumulation of heavy metals from urban solid fluids in soil-plant systems has become crucial. The purpose of this study was to analyze the capacity of sweet corn to accumulate heavy metals and to determine the bioaccumulation factor (BAF) by gathering, compiling and analyzing data on the concentration of heavy metals in sweet corn.

MATERIALS AND METHODS

Study Area

The study was conducted at the Federal College of Education (Technical)'s demonstration farm in Asaba, Delta State, Nigeria. With a population of 4,098,291 (male: 2,674,306; female: 2,024,085), Delta State is one of Nigeria's oils and agriculturally productive states. It is situated in the South-South geopolitical area of the Niger Delta region. Asaba, the state's capital, is located at the northern end of the state and has a roughly 762 square kilometer (294 square mi) area. Ogwashi-Uku, the state's economic hub and most populous city, is located at the southern end of the state. Due to its tropical location, Delta State experiences a changing climate that ranges from tropical humid in the south to sub-humid in the northeast. An increasingly noticeable dry season follows the northward drop in humidity. The average annual rainfall in coastal regions is about 266.5mm, while in the far north, it is 1905mm. Three (3) senatorial districts—Delta central, Delta south, and Delta north—make up the state's legislative structure. Twenty-five local governments make up Delta State at the moment. The state's economy is mostly based on agriculture, with yams, cassava (manioc), rice produced by oil palm trees, and corn (maize) planted for consumption locally.

Soil Sample Collection

For this study, soil was randomly chosen from two (2) municipal solid waste dump sites spread over the Asaba Metapolitician Area of Delta state. Umuagu and cable point quarters in Asaba (Delta North Senatorial District) are the locations of the dumpsites. The dumpsites were selected taking into account the quantity and type of trash, the closeness to agricultural areas, and their age. Twenty (20) soil samples were obtained from the chosen dumpsites after the covering waste had been removed, with ten (10) samples from each dumpsite being necessary to adequately represent the area. at the Federal College of Education (Technical) Demonstration Farm in Asaba, Delta State (where there was no dumpsite or other human activity that could produce wastes) to serve as the control samples. With the help of a soil auger, soil samples were taken from each location at the soil profile (depths) of 0-15, 15-30, and 30-45 cm at a radius of 5 cm. Rocks and pebbles were removed before using a mortar and pestle to pulverize the surface soil samples, which had been air-dried. The crushed soil samples were run through a 2mm filter sieve to achieve uniform particle size. The sampling bags were stored within sanitized plastic containers to prevent contamination. The soil samples were scooped into air tight containers labelled according to the name of the area from which the samples were collected as well as the sampling point depth.

Laboratory Analysis

Twenty-five (25) different soil samples were taken to the lab for analysis. The locations, towns, and notations used to identify the soil samples are listed in table 1. Cd, Cu, Fe and Pb are the heavy metals that were examined in the soil and plants. Plant samples were collected from the field, rinsed under running water, and then split into parts including roots, stems, leaves, fruits, and shoots in order to remove clinging soils. The samples were dried in an oven for 48 hours (hr) at 80 degrees Celsius. The dried samples were crushed, sieved to 2 mm, and put into polyethylene bags for storage until further analysis using an agate mortar and pestle. The soil samples were mechanically ground and sieved to a size of 2 mm in diameter after being air-dried for two weeks at room temperature. Atomic absorption spectrophotometers (AAs VGB 210 System) were used to examine the soil and plant samples.

Table 1: Soil Sample Identification

Sample	Location	Town	Notation
1-10	Umuagu	Asaba	UAS1 – UAS10
11-20	Cable Point	Asaba	CAS11– CAS20
21-30	Control	Farm	CLF21-CLF30

*UAS – Umuagu Area in Asaba, CAS – Cable Point in Asaba, CLF – Control in the Farm

Experimental Design

The field experiment was carried out at the Federal College of Education (Technical) Demonstration Farm, Asaba, Delta State, Nigeria, where a 1296sqm (36m x 72m) land area (Uncultivated) was first disc-ploughed and then harrowed after a week of plowing. Using a plot size of 2.57 m x 5.14 m, growth patterns were arranged in an area of 1296 sq m for the various treatments in the experiment using a 5 x 2 factorial, randomized complete block design (RCRD), where five treatments were reproduced twice (2). Each plot was separated from the others by 1.0m to make it simple to identify them. At least 15 cm of topsoil from the experimental field was removed, and the soil from the municipal solid waste dumpsite was physically mixed in thoroughly at regular intervals. The soil was plowed deeper than the typical high soil depth in order to cover the complete rooting depth of sweet maize in the field while maintaining the soil's strength from the waste dumpsite (Nigussie et al., 2012). Three sweet corn seeds were inserted into each hole at a depth of 3 to 4 cm. Due to the seed's rate of germination, the sweet corn was trimmed to one plant per hole after it had grown for 15 days.

Determination of Bioaccumulation Factor of Heavy Metals

The Bioaccumulation factor (BAF) is the ratio of heavy metal concentrations in plants and soils. It's a measure of a plant's ability to absorb heavy metals (Borga, 2008). The BAF was calculated (Wang *et al*., 2017):

$$BAF_I = \frac{P_I}{S_I}$$

where, Pi is the concentration of a heavy metal in plants (mg/kg−1);
Si is the concentration of the same heavy metal in the soil where the plant grows (mg/kg−1).

Statistical Analysis

All statistical analyses were carried out using SPSS 17 for Windows (SPSS Inc., USA). One- way (ANOVA) was used to compare the difference of means from various sampling. Pearson's correlation coefficients of heavy metal elements in dumpsite soil and sweet corn. Comparison of sweet corn yield and heavy metal contents in sweet corn between the dumpsites were subjected to analysis of variance (ANOVA) using the SPSS version 10 with randomized complete block analysis. Correlation/regression analyses were carried using SPSS to determine the relationship between soil chemical properties, sweet corn yield and heavy metal contents in sweetcorn grain. The level of significance was set at $P > 0.05$ (two-tailed). In order to quantify the relative differences in bioavailability of metals to plants or to identify the efficiency of a plant species to accumulate a given heavy metal.

RESULTS AND DISCUSSION

Accumulation of Heavy Metals in the Soil

This study has attempted to identify the concentrations of heavy metals in the various soil samples since it is crucial for healthy crop development to assess the concentration levels of harmful components in dumpsite soils. The study takes into account both essential/non-essential heavy metals that are hazardous to plants when present in soil at concentrations beyond the tolerance limit, such cadmium and lead, as well as micronutrient metals like copper and iron as shown in table 1. The results indicated that the mean copper (Cu) concentrations in the dumpsite and farm soil samples ranged from 0.91 mg/kg to 4.98 mg/kg, with the lowest values at the CLF and the highest values at the CAS. The fact that Cu does not travel very far after being released, its speciation, and other geochemical properties in soil may be responsible for the high concentration of Cu in soils (Ezeh & Chukwu, 2011). This is because organic matter, in particular, binds copper so tightly that its availability in organic soils can be very low (Osakwe *et al.,* 2012). The low amount of Cu found in CLF soil, however, may be a result of its mobility in weathering environments and capacity to adsorb onto the surfaces of soil elements through ion exchange processes (Wuana & Okieiman, 2011). The concentration of copper exceeded the allowable limit in every dumpsite. This could be caused by the careless disposal of waste containing copper at the dump sites. According to Awokunmi et al. (2010), a biodegradable waste released metallic copper into soil at a level just a little beyond the levels found naturally in soils. Regardless of depth, it was discovered that the mean Pb concentration in the dumpsite was higher than that in the farmlands. The CLF had the lowest lead levels while the UAS dumpsite had the highest. This concentration was greater than the permitted level of 1 mg/kg established by SPCR (2001). The presence of hospital wastes, non-biodegradable metallic, and automobile and other non-food wastes throughout the dumpsites may be the cause of the elevated levels of Pb discovered in samples taken from the area. In comparison to other studies, lead levels were also high in this study (Akintan *et al.,* 2019). This shows a potential for the environmental metal (Pb) to bio accumulate in plant roots, stems, fruits, and leaves, rendering them unfit for consumption because doing so would expose people to the associated health risks if they ate them (Opaluwa *et al.,* 2012). There was significant difference between the concentrations of lead in soil in all locations on each dumpsite ($p < 0.05$).

Table 2: Mean Concentration of Heavy Metals in the Soil Samples at Different Depth

Sampl	Depth	Cu(mg/k	Pb(mg/k	Fe(mg/kg)	Cd(mg/k
UAS	0 – 15	2.89	12.75	9.92	4.80
	15 –30	2.31	11.75	8.93	3.30
	30 -45	1.87	11.35	8.19	2.90
CAS	0 – 15	4.98	10.67	8.68	5.00
	15 –30	4.18	10.20	8.46	4.50
	30 -45	2.78	7.60	7.32	4.40
CLF	0 – 15	1.11	3.60	6.00	3.15
	15 –30	0.98	2.31	4.31	2.10
	30 -45	0.91	0.81	3.21	1.08

The mean iron (Fe) concentration at the dumpsites under investigation in this study ranges from 7.32 to 9.92 mg/kg, while it is 3.60 mg/kg at the control site. Fe levels are greater in the waste dumpsite soil than in the control soil. The type of garbage put there may have contributed to the waste dump's high Fe concentration. The soil surrounding such waste dumpsites will unquestionably contain more Fe than control soil if the waste dump contains more metal scraps from mechanic workshops and welder's workshops than household wastes, which will have more spoilt food, wood from broken furniture, ashes, broken glasses, and plastics, etc. The UAS dumpsite has the greatest iron concentrations. This quantity of Fe, which was obtained from soil samples for this investigation, is still within the range of the 150 mg/kg criteria established by the WHO and FAO (2016). It's possible that the elevated iron levels found in all soil samples are not due to waste. According to reports, natural soils include significant concentrations of iron, indicating that other natural sources of iron must also be taken into account for the ecosystem to be fully protected from iron contamination that comes from waste items (Osakwe & Okolie, 2015). In addition, it has previously been claimed that iron is the element that is most prevalent in Nigerian soil (Amusan et al, 2005).

There was no significant difference between the concentration of iron at all the dumpsites ($p < 0.05$) but concentration of iron varies significantly at $p < 0.05$ in the control site. the average cadmium (Cd) content in the dumpsites ranged from 2.90 to 5.0 mg/kg, which was greater than the concentration in the control site (farmland). The CAS dumpsite soil contains a mean concentration of Cd of 5.0 mg/kg, whereas the control site's mean concentration is 1.08 mg/kg, demonstrating a greater concentration of Cd in the dumpsite. This investigation agrees with the findings of Akintan *et al.* (2019), who found higher levels of cadmium in the study area and explain possible routes of this metal into soil, including batteries, plating, pigments, and plastics from household wastes as well as the application of phosphates in agricultural areas. This finding of a higher Cd concentration is in agreement with works of Ndana *et al*. (2010), who looked at the presence of heavy metals in the soils of auto repair shops and waste disposal sites in different areas of Makurdi, Central Nigeria. The amounts of heavy metals in the soils taken from the dumpsite compared to the control site in this study varied significantly ($P < 0.05$). This is consistent with Adelekan and Alawode (2011) findings that the levels of metals in dumpsites were higher than the levels at the control site (farm land), which showed that the solid waste deposited at the site contained a high number of substances containing heavy metals.

Heavy Metals Concentration in Plant tissue from Amended Plots

This study was limited to the concentration of heavy metals in the tissues of sweet corn, such as the roots, stems, and leaves, fruit, and shoots, to make it easier to evaluate the metal transfer ratio from the soil to the plants as described in fig. 1. Crops' growth media, which the roots absorb from, are the principal suppliers of heavy metals for the crops. When compared to other parts of the plant, the results showed that heavy metals were predominantly accumulated in the plant's shoot. Pb concentrations ranged from 0.58 to 4.67 mg/kg while Fe concentrations ranged from 1.01 to 3.88 mg/kg in the plants shoot. In addition to essential nutrients, harmful metals are predominantly absorbed by plants through their root systems.

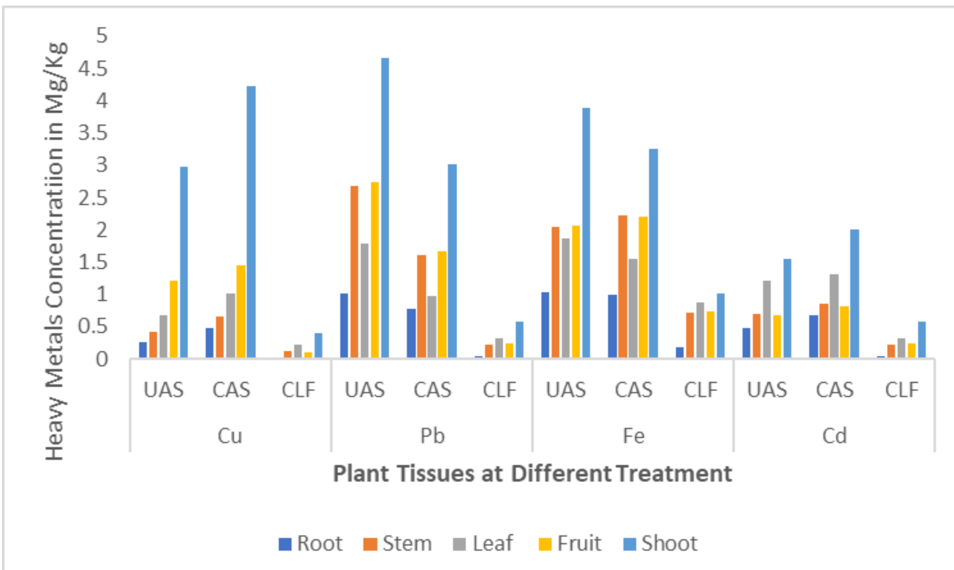

Figure 1: Mean Concentration of Heavy Metals (mg/kg) in the Tissue of Sweet Corn

When compared to other dumpsites, the plant from the plot treated with soil from the UAS dumpsite has the highest concentration of heavy metals; this could be because the garbage at the dumpsite has a relatively higher organic matter content. The findings of Awokunmi *et al.* (2015), who show high heavy metals accumulating ability for maize planted on the dumpsite soils in south western Nigeria, are compatible with the findings of this study. The findings revealed a significant difference ($P < 0.05$) in the content of heavy metals in plant tissues grown on plots treated with soil from dumpsites. Compared to plant tissues from the control site, plant tissues collected from plots treated with soil from dumpsites had greater quantities of heavy metals (Amusan *et al.,* 2005). This might be explained by the high levels of heavy metals in dumpsite soil that eventually get accumulated by the plants that grow there. The heavy metal concentrations in plants depend on the concentrations of the same metals in the soil where they normally occur, according to research by Udosen *et al.* (2006). The results are also consistent with those of Awokunmi *et al.* (2012) and Sun *et al.* (2009), who found that while maize's accumulating traits or efficacy have recently been used in environmental restoration, peasant farmers are discouraged from growing the plant on dump sites for consumption because heavy metals may eventually enter the food chain. Due to the effectiveness of their detoxification mechanisms, plants may become tolerant to naturally occurring heavy metals. It is well known that grains like maize and sweet corn are effective contaminant accumulators (Afolayan, 2018). Metal content and chemical forms in soil affect how much heavy metal is absorbed and accumulated in plant tissue (Shen *et al.,* 2000). Organic matter, soil pH, plant roots, and other soil conditions are factors in the bioaccumulation of metals.

Uptake of Heavy Metals by Sweet Corn Cultivated with Different Treatment

The results of the heavy metal content in sweet corn grown under different conditions are shown in Fig. 2. It was found that the plant bio-accumulated the metals in the following order: Pb > Fe > Cd > Cu, which may be an indication of the metal concentrations in the soil. The FAO/WHO (2001) recommended limit and measured quantities of heavy metals in sweet corn were compared to determine the extent of food contamination. The sweet corn grown on a plot with UAS dumpsite soil had the highest concentration of Pb (9.27 mg/kg), followed by the UAS dumpsite soil with highest concentration of Fe (7.09 mg/kg) and the CLF treatment (with the lowest concentration of Cu (0.67mg/kg). Mining, pesticides, production, the chemical industry, and metal pipes in the dumpsite soil that was utilized to grow the sweet corn could be the main causes of Cu contamination in the maize. However, CAS has a high Cu content since it is a region that is extremely close to industrialization. Its overdose in the human body could harm the kidneys and irritate the stomach and intestines if it is ingested or breathed (Malomo *et al.,* 2013). Malomo *et al.* (2013) found that although Cu is not poisonous to people, it is toxic to plants. As a result, some nations have placed limits on the amount of copper that can be found in soil. This is especially important since a larger concentration of these substances prevents the growth of plants, lowers land productivity, and restricts access to food. Comparing the Pb accumulation of sweet corn in this study to similar research by Malomo *et al*. (2012) and it was high. Lead is a well-known metal that harms a man's liver, kidneys, brain, central nervous system, and reproductive system and has no known necessary human function. Paint, pesticides, smoking, vehicular emissions, mining, and coal combustion are the main contributors of lead pollution. In general, Fe concentrations was high in all the treatment plots, which may be related to its capacity to transport oxygen for the synthesis of protein and the creation of chlorophyll (Kashif *et al.,* 2009). Except for the sweet corn produced on CLF treatment, the heavy metal accumulation by the plot treated with dumpsite soil in this study is significantly higher than the advised limit. According to Amusan *et al.* (2005), sweet corn cultivated in heavy metals-contaminated soils had higher amounts of heavy metals than sweet corn grown in soils without contamination.

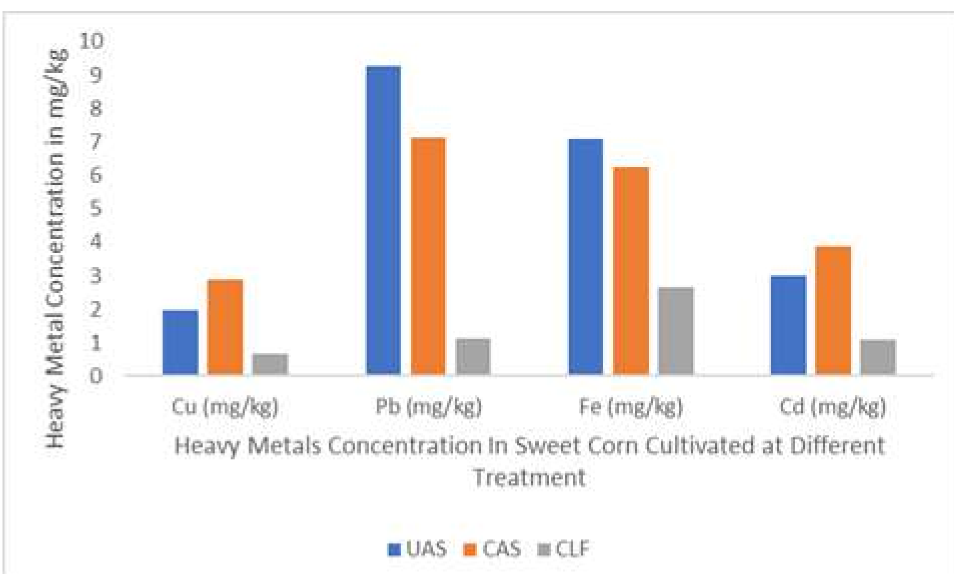

Figure 2: Mean Concentration of Heavy Metals in the Sweet Corn at Different Treatment

Plant species, particular metal concentrations, chemical forms, soil chemistry, and pH all show how hazardous metals are to plants (Malamo *et al.,* 2013). The findings of this study were consistent with those of Singh and Bhati (2005) and Aghabarati *et al.* (2004), who found that plants at the plot treated with dumpsite soils had much higher concentrations of these heavy metals than plants at the control site. Furthermore, in this study, a variety of soil variables, including pH and organic matter, combined to affect how well plants absorbed heavy metals. Heavy metals are known to be more easily mobilized in soil that is more acidic, which increases their absorption.

Bioaccumulation Factor of Heavy Metals into Sweetcorn

The ratio of the overall metal concentration in the soil environment to the level of metal in the plant parts is known as the bioaccumulation factor (BAF). Pb> Cu> Cd> Fe > were the reported trends for BAF in sweet corn as illustrated in fig. 3. This soil-to-plant factor is one of the most important elements of how humans are exposed to metals through the food chain. The values show the amounts of metals in the edible sections of the sweet corn as a percentage of the total metal concentration in the soil. These findings suggest that sweet corn has a higher potential for Pb accumulation than Zn accumulation. Despite the possibility that environmental parameters including pH, ECEC and binding capabilities contributed to the slow transfer rates between the soil and the sweet corn (Udosen *et al.,* 2006). High BAF values have been described as indicators or symptoms of soil heavy metal levels that are relatively high in reactivity, liability, and biological availability. In accordance with the findings of Oluyemi *et al*. (2008), the difference in the variation in values obtained for these heavy metals in the soil and crop plant samples at the plot treated with dumpsite compost as compared to the values obtained in the control site is an indication of their mobility from the dumpsites to the farmlands.

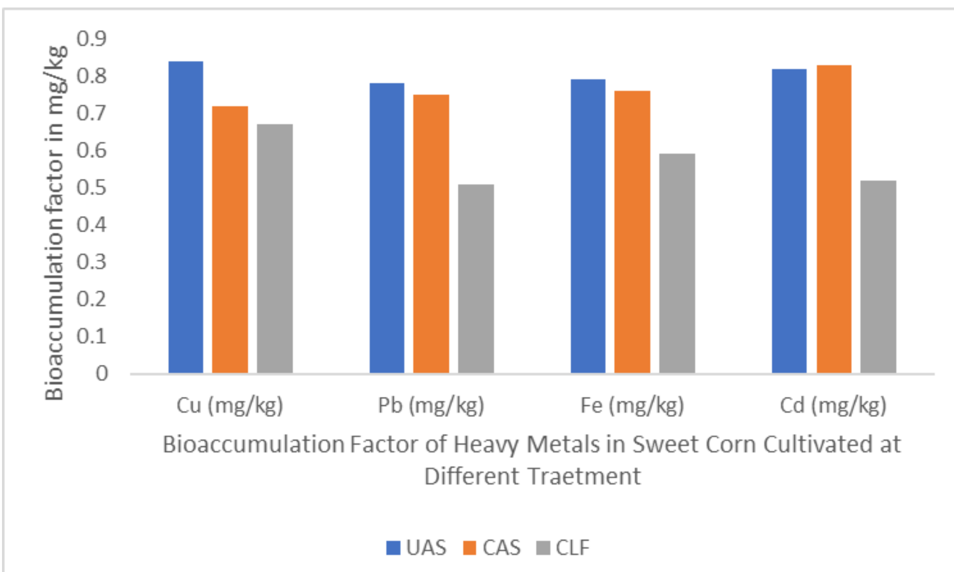

Figure 3: Bioaccumulation factor of Heavy Metals in the Sweet Corn at Different Treatment

The control site (CLF) had the lowest BAF values, ranging from 0.67 mg/kg for copper, 0.51 mg/kg for lead, 0.59 mg/kg for iron, and 0.52 mg/kg for cadmium. It was initiated that the bioaccumulation factors for the heavy metal in the plot treated with dumpsites were considerably different from those for control sites. The BAF found in this study gives an indicator of the likelihood that heavy metal present in the dumpsite soil may enter the food chain if an animal or a human consumes an edible plant of the sweet corn. Varied heavy metal concentrations in the soil and different plant absorption of different elements may be the cause of variation in the bio concentration factor among different roots and leaves of plants (Zheng et al., 2007). The discovery of trace metals in plant tissues and samples were not unexpected as plants are known to absorb and store trace metals from contaminated soil. Consuming plants with high levels of heavy metals on a regular basis could result in accumulation and have negative health effects, especially for Pb and Cd (Opabunmi, & Umar, 2003).

CONCLUSION

The study utilized sweet corn (Zea mays L. saccharum) cultivated on soil from a municipal solid waste dumpsite and a control site in Delta State, Nigeria. The study found that the soils from the dumpsites and control site contained heavy metals (Cu, Pb, Cd and Fe). Additionally, it was also found that some dumpsites had larger concentrations of these metals than others; this may be influenced by the geological formation of the locations and the presence of waste containing more of these heavy metals. The sequence of the heavy metal concentrations in the study's soil was Pb > Fe > Cd > Cu. The mobility of heavy metals (Cu, Pb, Cd, and Fe) from soil to plant tissues suggests that all of these elements were mobile from soil to plant components. It was discovered that sweet corn plant's shoots in all farm sites accumulated heavy metals the most. It was also discovered that the plant bio-accumulated the metals in the following order: Pb > Fe >Cd > Cu, which may be an indication of the metal concentrations in the soil. Lead (Pb) had the highest concentration in the plant sample, while copper (Cu) had a lesser concentration. They were all found in sweet corn grown on soils taken from dump sites. The bioaccumulation factor (BAF) of the metals revealed considerable Cd, Cu, and Pb accumulation in the sweet corn grown in soil from dumpsites. High soil heavy metal levels with high levels of reactivity, lability, and biological availability have been associated with high BAF values as indications or symptoms. On the basis of this, it was believed that eating sweet corn produced on soil derived from such dumpsites would be harmful to human health. Results of this study showed that plants cultivated on dumpsite soils acquire more toxic metals than plants grown on typical agricultural soils.

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SUSTAINANING INDIGENOUS KNOWLEDGE ON THE USES OF MEDICINAL PLANTS IN SOUTH-WEST, NIGERIA

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ABSTRACT

No plant is useless, it is just that their uses are not yet known. Knowledge on the use of medicinal plants is under threat in our society. Only few people value the plant species around them due to inadequate knowledge of their usefulness. So many tropical plants are grossly underutilized medicinally due to lack of adequate medicinal information on their uses. Indigenous knowledge is an understanding, skill and philosophy developed by societies with long histories of interaction with the natural and cultural environment within local level of decision making. For the nation to exploit and maximize the huge therapeutic, wealth and economic potentials of the rich biodiversity, its uses must be known and sustained. Hence, there is need for sustaining the indigenous knowledge through conservative efforts for the endangered species and proper documentation of their potentials to salvage the natural heritage "Medicinal Plants" from going into extinction.

Keywords: *Indigenous Knowledge, Medicinal Plants, Documentation, Sustainability*

INTRODUCTION

Herbal remedy otherwise known as ethno-medicine is a vital form of traditional medicine. Dependence on herbal medicine among the teaming populace is especially predominant in areas where orthodox medicine is often unavailable or simply too expensive in modern time (Odugbemi, 2008). In many areas, knowledge of the plant species used and method of preparing and administering the medication resides mostly with traditional healers and other knowledgeable members of the society (Odugbemi, 2008 and Sofowora, 2006). This knowledge is generally transmitted or passed from one generation to another orally through community, family and individual until implemented. It does not require formal education or specialized training in a field of study before it could be transmitted. During the early years of human existence, many plants by instinct, intuitions or trials by error were used to combat ailments. As ideas of difference tribes, communities, and culture developed, the use of various plants became wide spread in accordance with their belief (Odugbemi, 2008 and Sofowora, 2006). Unfortunately, there is decreasing number of herbalists or knowledgeable members of the society on the use of herbs for treatment of aliments with transfer of indigenous knowledge. This review paper is therefore necessitated by the need to sustain the indigenous knowledge on the use of medicinal plants with their potencies for the curing of diseases or sicknesses in the south-western region of Nigeria.

Meaning of Medicinal Plant and Herbal Medicine

A medicinal plant is any plant in which one or more of its tissues contain substances that can be used for therapeutic purposes or which are precursors for the synthesis of useful drugs (Oyebola 2010). Herbal medicines generally include all botanical medicines in form of decoction, infusion, maceration and tinctures (Falade, 2021). Herbal medicine is the most ancient method of curing disease and it has been said that botanical medicines are the very first and only true natural medicines ever used (Soladoye *et al,* 2010). The use of medicinal plants as remedies of certain illnesses is not only common practice but fundamental to health care regime of millions of people all over the world. In Asia and Africa, over 80% of the populace relied on traditional medicine for primary healthcare needs (Samuel *et al.,* 2018).

However, people used different combinations of plants to treat different types of ailments which vary from one community to another and in different ecosystems (Etukudo, 2000). Consequently, virtually all plant species found in natural ecosystems are of great values to man for medicine. According to Oyebola (2010), all plants are medicinal and for every health disorder, there is always a plant.

Origin and Evolution of Medicinal Plants

The origin of medicinal plants is supported by the Holy Books. For instance, the Holy Bible offers description of approximately 30 healing plants. In Ezekiel 47:12 "*And by the river upon the bank thereof, on this side and on that side shall grow all trees meal, whose leaf shall not fade, neither shall the fruits therefore be consumed: it shall bring forth new fruits according to his months, because their water they issued out of the sanctuary: and the fruits therefore shall be for meal and the leaves for medicines"* From the text quoted from the Holy Bible, it could be seen that God ordained the use of plants for medicine (Odugbemi, 2008). It is estimated that there are 1.5 million species of plants on earth (Cowan, 1999), a greater percentage of which are used for medicinal purposes as only 1-10% is used as foods by animals. This was established by Osai (1998) that medicinal plants used in the treatment and curing of sickness and diseases have been in existence for well over fifty centuries which until the last two and a half centuries was the main source of treatment to man and his domestic animals.

History of Medicinal Plants in South-Western Nigeria

According to legend, the first man to practice the art of healing through the use of herbal medicine in Yoruba speaking part of Nigeria was Orumila who was endowed with the knowledge from God (Oladumoye, 2018). Orumila had a younger brother Osanyin who gained the knowledge of medicinal herbal practice by assisting his brother to compound the medicines. The intertribal wars caused the separation of the two brothers which led to the rapid spreading of this knowledge among the Yoruba people and beyond (Oladumoye, 2018). A record of medicinal plant practices in earliest period in Nigeria was virtually not available because there was no record for their isolation, selection and preparation (Sofowora, 2006 and Oladumoye, 2018). Knowledge about potent herbs was passed orally from generation to generation. Early men could have gained some knowledge by washing the effect produced by various plants when consumed by domestic animals. In Nigeria, hunters have been reported as the original custodian of some effective traditional herbal recipes. Traditional practitioners also claimed that when in trance, it is possible to be taught the properties and futures of plants by the spirit of an ancestor who practices herbalism (Sofowora, 2006 and Oladumoye, 2018).

It was also believed that incantation enhances the efficacy of herbal medicines. Incantations are expressions of words delivered orally in poetic form apparently to conjure up forces into medicinal plants either during collection or usage. For instance: *Ohun ti a ba wi fun ogbo logbo ngbo, eyi ti aba wi fun ogba logbangba. Eyi timo ba wi fun iwo ewe yiloni ni ki o se o.* Meaning that the herb should do exactly what is requested to do. Some traditional preparatives can only be effective when an incantation is recited due to its evocative power (Oladumoye, 2018).

Values of Medicinal plants

The values of medicinal plants are the reasons for its uses. According to Oluwalana *et al,* (2008 and Falade, 2021), the use of medicinal plants has always been part of human action as some plant poses therapeutic properties which can and have been utilized in the treatment of human and some animal diseases. Our fore-fathers depended on plants for treatment of various diseases before the introduction of orthodox medicine. The increasing interest in herbal medicine using for the treatment of various diseases steered people to collection of medicinal plant materials from the forest (Oluwalana *et al,* 2008). Man can hardly do without medicinal plants for survival. Medicinal plants species are useful for curing human disease because of the presence of phytochemical compounds (Wadood *et al,* 2013). They are cheap and available especially in the rural area. Hence, herbal collectors have gainfully employed in the rural areas. WHO (2001) stated that, 80% of the world population or roughly two thirds of the world's population rely almost exclusively on herbal medicines mostly derived from wild plants for the treatment of diseases. However, according to Falade (2021) many of these medicinal plants are eaten as fruits, nuts and vegetable leaves in the course of treating or preventing sicknesses as shown in Table 1.

Table 1: The Table Showing some Medicinal Plants and the Ailments Cured in South-West, Nigeria.

Local Name	Common Name	Scientific Name	Family Name	Flora Type	Part collected	Mode of Preparation	Ailment/Disease cured
Ahon Ekun	Leopard's tongue	*Acanthus montanus*	Acanthaceae	Herb	Leave	Paste, Pounded, grinded	Poultices on boil, Fever, Rheumatism
Peregun	Peregun	*Dracaena arborea*	Agavaceae	Tree	Root	Decoction	Abdominal pain, Blood glucose
Iyeye	Hog plum	*Spondia mombin*	Anacardiaceae	Tree	Leave, Bark,fruits	Decoction	Ghonorrhea, cough, toothache
Ajekobale	Hushveld	*Croton gratissimus*	Euphorbiaceae	Shrub	Leave, Bark	Leave decoction	Anti-hypertension, Fever,Convulsion
Orogbo	Bitter Cola	*Garcinia kola*	Apiaceae	Tree	Seed, Bark	Chewing	Liver disorder, Diarrhoea, Chest cold, cough
Ahun	Stool wood	*Alstonia boonei*	Apocynaceae	Tree	Bark, Leaves	Bark decoction	Malaria, Asthma, dysentery, ulcer
Asofeyeje	African snakeroot	*Rauwolfia vomitoria*	Apocynaceae	Shrub	Leave and Root	Powdered root, leave decoction	Diarrhea, Snakebite, skin diseases,
Ogbo	Ogbo	*Parquetina nigrescens*	Periplocaceae	Climber	Leave	Infusion, Decoction	anaemia, wounds, burns hypotension
Ewe atura	Black benniseed	*Sesamum radiatum*	Pedaliaceae	Herb	Leave	Infusion, Decoction	Catarrh, Facilitatechildbirth

Source: Falade, 2021.

Plant materials such as barks, roots and leaves contain different active ingredients, which are extracted for medicinal purposes. Some of the methods of extraction include decoction, infusion, maceration and tinctures (Adebisi, 1999 and Falade, 2021). Most conventional drugs have their origins from plants or modeled compounds derived from plants with some modifications (Etukudo, 2000). Chemical compounds of plants like alkaloids, tanins, saponins, glycosides, anthraquinones etc are the basis for their therapeutic (Oladumoye, 2018 and Samuel *et al.,* 2018).

Need for Sustaining Indigenous Knowledge on the Use of Medicinal Plants

Indigenous knowledge on the use of medicinal plants is under threat. Though, medicinal plants have been observed to be very effective in the treatment of ailments in both rural and urban areas in developing countries, but only few people value the plant species around them due to inadequate knowledge of their usefulness (Etukudo, 2000 and Falade, 2021). Some tropical plants are grossly underutilized medicinally due to lack of adequate medicinal information on their various uses (Borokini *et al,*. 2013). Therefore, there is need to carry out research on the use of medicinal plants with a view to do proper documentations of the their various medicinal uses so as to prevent the loss of the indigenous knowledge with succeeding generations and also create awareness and enhance appropriate utilization.

Ways of Sustaining Indigenous Knowledge on the Use of Medicinal Plants

In other to improve health care of both the rural and urban people, there is need to discover and document plants of high medicinal value that could serve as alternative to modern medicines. To sustain the indigenous knowledge of ethno-medicines in south-western Nigeria, it is suggested that government should put in place policy frame work that will promote ethno-therapy among the general populace as alternative to orthodox medicine in Nigeria despite the availability of orthodox medicine. Concerted efforts should be made by botanists and other plant scientists to appropriately identify the medicinal plant species. This includes their local names, scientific names, medicinal uses, parts used, mode of preparation and chemical properties for proper record and documentation. The document will form part of the comprehensive inventory for medicinal plants in Nigeria towards promotion of traditional medicine for national economic growth and sustainable developments.

CONCLUSION AND RECOMMENDATION

According to the adage that says "Any festival not celebrated before children will soon go into extinction"; the extinction and genetic loss of some medicinal plants in this region is due to the lack of detailed information in this regard. Furthermore, cultivation of identified commonly used but endangered medicinal plant species is recommended. It can be done through on-farming system or the establishment of botanical gardens by both individual and group of people including government to save our precious medicinal plants and its indigenous knowledge from going into extinction.

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AGRONOMIC PERFORMANCE OF NEW TOMATO (*Solanum lycopersicum* L.) BREEDING LINES UNDER OPEN FIELD RAINFED CONDITION IN SOUTH WEST NIGERIA

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ABSTRACT

Fresh market tomato is a very important horticultural cash crop in Nigeria. Production has increased over the past few years based on land area under cultivation with minimal improvement in fruit yield and other associated yield related traits. In this study, eight advanced (F_6) tomato breeding lines were evaluated with three check varieties under open field rainfed conditions at NIHORT, Ibadan Nigeria for yield and yield associated traits. The study identified promising high yielding tomato entries suitable for high humid (rainy season) tomato production in Nigeria. Tomato accession NHTO10-2 had the highest fruit yield (6119.52g), while NHTO105-1 was the earliest (57 days). The high significant positive association between yield and number of fruits shows the feasibility of indirect selection in favour of tomato lines with high yield potential.

Keywords: *Agronomic, Breeding lines, Tomato, Variability, Yield.*

INTRODUCTION

Tomatoes (*Solanum lycopersicum* L.) is one of the most important vegetables commercially produced in Nigeria and also harvested in home gardens (unpublished data). It is mostly produced during the late seasons in the northern states of Nigeria with minimal production from the southern states. Tomato contains minerals, vitamins, polyphenol, and lycopene which have health benefits for humans (Islam *et al*., 2022). Tomato yield in Nigeria is below world averages resulting from use of unimproved local cultivars with poor fruit quality (Agele *et al*., 2002; Oladitan and Akinseye, 2014). Ironically, most of the improved imported tomato varieties with desired fruit qualities exhibit poor adaptation to the diverse tomato growing environments in the country. Furthermore, these imported tomato varieties (mostly hybrids) are not only exorbitant but are not readily available and accessible to the poor resourced tomato farmers that are mostly domicile in the rural communities.

To mitigate these challenges and ensure increased productivity and availability of tomato varieties with desired fruit quality and adaptation, it is paramount to develop high yield, adapted superior varieties mainly for open filed rainfed production that is prevalent among farmers in Nigeria. Planning and execution of a breeding program for improvement of quantitative attributes such as yield depends to a great extent upon the magnitude of genetic variability and the extent to which desirable characters are associated in a breeding population (Islam *et al*., 2022). Limited access to the best-adapted tomato varieties to the local conditions, pests and diseases are the major limiting factors for improving productivity. This study presents the preliminary yield evaluation of new promising advanced tomato breeding lines under open field rainfed cultivation in south west Nigeria.

MATERIALS AND METHODS

The trial was carried out at the National Horticultural Research Institute (NIHORT), Ibadan, Nigeria, located in the humid forest savannah transition zone (210 masl, 7°30′N, 3°54′E). Experimental materials comprised of eight (8) new tomato breeding lines (F_6) developed by crossing selected parents comprising of popular tomato landraces/cultivars in Nigeria and exotic advanced breeding lines from AVRDC. These landraces (parents) were collections from farmers' field across different tomato growing regions in Nigeria and had undergone over 4 generations of selfing and selections. They are maintained in the Institute's tomato genetic improvement programme.

For the field experiment, seeds were sown in perforated plastic trays containing sterilized loamy soil in the screen house (soil was sterilized by steaming). Developing plants were watered using 75 cl of water for each tray 3 times a week to 30 days after sowing. The field was arranged in a Randomized Complete Block Design (20 stands per plot) with plant spacing of 0.5 m within row and 0.6 m between rows with 3 replications. Fertilizer was applied 3 weeks after planting at 140 $kg \cdot ha^{-1}$ of N and 25 $kg \cdot ha^{-1}$ of P. Manual weeding was carried out at 3 and 8 weeks after transplanting, while staking and trellising of plants was done at one week prior to the onset of flowering. Data were obtained on Total fruit weight, Total number of fruits per plot, DTF= Days to 50% flowering and average number of fruits per cluster. Analysis was with PB Tools (ver. 1.1.0, http://bbi.irri.org/products) and STAR statistical software.

RESULTS

The descriptive statistics (mean and range) of traits are presented in Table 1. High significant differences was observed for all the traits ($P \leq 0.01$). The highest mean and maximum range was recorded for total fruit weight while minimum range was observed for average number of fruits per cluster. The mean of the 9 new tomato breeding lines (F_6) tomato breeding lines for fruit yield, total number of fruits, days to flowering and number of fruits per cluster are presented in Table 1. Breeding line NHTO10-2 was the top performing genotypes for yield (6119.52g) while NHTO105-1 produced the highest number of fruits per plot (177 fruits) and was the earliest to reach 50% flowering (57 days). Advanced breeding line NHTO15-3 recorded the highest number of fruits per cluster (Table 1).

High significant positive association was recorded for yield and average number of fruits per plot while number of fruit per cluster associated positively with average number of fruits per plot (Table 2). Days to flowering had moderate negative significant association with average number of fruits per plot.

DISCUSSION

Tomato is an important cash crop in Nigeria and other west Africa regions where it can be produced during the rainy and dry seasons. However, tomato production and availability in the market is more successful and costs less during the dry season from November to December (Kelly *et al*, 2005). Due to different biotic and abiotic production constraints, farmers usually abandon tomato production during the unfavourable conditions (high rainfall months), thus, fresh market tomatoes are costlier and less available during the peak of rainy seasons (May to October) in Nigeria. In the current study, eight (8) new breeding tomato lines and three checks Roma VF+ (open pollinated), Cobra 26 and Platinum F1 (hybrid varieties) were evaluated for yield and yield contributing traits under open field rainfed conditions at the peak of the rains. The results showed varying yield potentials for each of the tomato genotypes.

Significant differences were observed in yield and other yield related traits among the tomato genotypes. The high significant variation observed for all the traits in this populations shows the feasibility of their improvement through selection. This supports the work of Bationo-Kando *et al.* 2015 and Bihon *et al.*, 2022 that reported high significant variation among traits considered in tomato. Maximum yield of 6119g was recorded by one of the new advanced tomato breeding lines NHTO10-2 indicating higher yield potential over the three checks Platinum F1 (5610.91g), cobra 26 (3845.12g) and the OP check Roma VF+ (1999.76g). The differences between the tomato genotypes in this trial might be attributed mostly to their varying inherent genetic makeups. Earliness is an important trait that controls returns to investment in tomato production since it determines how soon the farmer can take his produce to the market compared to his colleagues. The use of short duration genotypes is desirable as it allows a shorter stay in the field reducing exposure to biotic and abiotic constraints such as diseases and drought stress respectively (GatutWahyu *et al*., 2014).

New tomato breeding line NHTO105-1 despite been the earliest also exhibited yield potential comparable to the top performing hybrid check (Platinum F1). The top performing breeding lines for earliness

(NHTO105-1) and yield (NHTO10-2) are promising candidates that could be nominated for release to farmers or used as parents for creating new gene combinations for early maturing high yielding tomato varieties for tomato farmers in Nigeria. Selection for most complex traits such as yield and its component traits are influenced by interaction of genotype and environment and its selection efficiency can be improved through indirect selection of correlated traits based on correlation coefficient in a breeding programme (Hassan *et al*., 2021). The significant positive association observed between yield and total number of fruits in this populations shows that selection in favour of breeding lines with high number of fruits will favour genotypes with high yield potential. This is in accordance with Ghosh *et al.* (2010) who reported positive significant association between total fruit weight and number of fruits in tomato. Selecting very early maturing tomato genotypes will favour tomato breeding lines with reduced number of fruits while selecting genotypes with increased number of fruits per cluster will favour indirect selection of breeding lines with increased number of fruits in this population.

CONCLUSION

This study identified tomato entries and varieties, which provided better yield and earliness during the peak of rainy season in south western Nigeria. Top performing breeding lines for earliness (NHTO105-1) and yield (NHTO10-2) were identified as promising candidates that could be advanced for further evaluation towards nomination for release to farmers in Nigeria.

Table 1: Mean Yield of Advanced Tomato breeding lines and Checks

	Genotypes	YLD	NoF	NoC	DTF
1	Cobra 26	3845.12	67.76	3.00	67.86
2	NHTO10-2	6119.52	137.36	4.00	61.33
3	NHTO105-1	5440.23	177.13	4.00	57.60
4	NHTO15-1	2958.37	68.67	5.00	70.66
5	NHTO15-2	4985.10	150.47	5.00	66.93
6	NHTO15-3	4994.94	170.80	6.00	65.06
7	NHTO15-4	1051.42	20.76	3.00	71.13
8	NHTO30-2	2028.85	51.49	3.00	66.00
9	NHTO7b-4	3725.77	118.38	3.00	62.73
10	Platinum F1	5610.91	129.68	5.00	69.26
11	Roma VF+	1999.76	42.00	3.00	66.93
	Mean	3887.27 **	103.14**	4	65.95**
	Min	1051.42	20.76	3	57.6
	Max	6119.52	177.13	6	71.13
	StdDev	1695.49	54.8	1.1	4.1

YLD = Yield per plot; NoF = Average Number of fruits per plot; NoC = Number of clusters per plot; DTF = Days to 50% flowering

Table 2: Phenotypic correlation for traits among tomato genotypes

	YLD	NoF	NoC	DTF
YLD	1	0.904..	0.5865	-0.5479
NoF		1	0.6497.	-0.6549
NoC			1	0.0517
DTF				1

YLD = Yield per plot; NoF = Average Number of fruits per plot; NoC = Number of clusters per plot; DTF = Days to 50% flowering

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EFFECTS OF ORGANIC FERTILIZER RATES AND GROWTH MEDIA ON THE EARLY GROWTH AND NUTRIENT UPTAKE OF OIL PALM SEEDLINGS

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ABSTRACT
This experiment was conducted at Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso, Nigeria in 2018 to determine the effects of organic fertilizer rates and growth media on the early growth and nutrient uptake of oil palm (Elaeis guinneensis) seedlings. The treatments involved five rates of organic fertilizer (0, 50,75,100, 125kg/ha) and three growth media (soil, soil + sawdust, soil + manure). These were arranged in a factorial experiment and fitted into a complete randomized design with three replicates. Data were collected on the early vegetative growth, nutrient uptake, leaf area and dried plant weight. These were subjected to Analysis of Variance (ANOVA) at 5% probability level. The results showed that growth media and fertilizer rates significantly (P ≤ 0.05) influenced plant height, number of leaves, nutrient uptake, leaf area and dried plant weight assessed. The interaction effect between growth media and fertilizer rates had significant influence on the nutrient uptake of oil palm seedlings. The highest values were produced at 125kg/ha, closely followed by 100 kg/ha fertilizer application rate with the use of soil + manure as growth media while the lowest value was produced at 0kg/ha application rate with the use of soil only. In conclusion, the results obtained showed that for early growth and nutrient uptake of oil palm seedlings, the use of soil + poultry manure as growth media with organic fertilizer applied at 100kg/ha could be recommended in Ogbomoso, Southwestern Nigeria.
***Keywords**: Oorganic fertilizer, fertilizer rates, growth media, nutrient uptake, oil palm, seedlings*

INTRODUCTION

Oil palm (*Elaeis guineensis*) is one of the important economic crop in the tropics. (Ayanwu; Anyanwu and Anyanwu, 1982). It belongs to the family *palmae* (having 225 genera with over 2600 species), and the subfamily *cocoideae* of which it is the most important member (Opeke, 1987). It is a versatile tree crop with almost all parts of the tree being useful and of economic value. Oil palm is one of the tree crops of the nation that has contributed to the growth of Nigeria before the advent of the civil war in 1966 it is one of the most rapidly expanding crops in the tropics National Institute for Oil Palm Research (NIFOR, 2003). Oil palm requires acidic soils with a pH of 5.5-5.7, cultivated oil palm seedlings begins bearing of fruits at the 3rd and 4th years after planting and attains peak fruits bearing at 12-15 years. Its continue bearing fruits for 40-50 years yielding 35-50kg oil plant per year (4.5 tonnes of oil per years) it is allogamous and propagated via seeds.

The principal product of oil palm is the palm fruit, which is processed to obtain three commercial products. These include palm oil, kernel oil and palm kernel cake. The uses of palm oil are many and varied (Adegbola *et al.,* 1979). Locally, it is used for cooking, soap making, metal plating and lamp oil. The palm kernel oil however, is used for soap making, as a source of glycerine, for manufacturing margarine, cooking fats and for making lubricants. The residue obtained after extraction of oil is called kernel cake, which is useful in livestock feed production. The midribs and rachis of oil palm are used for making brooms and roofing materials. The thicker leaf stalk is used for making the walls of village huts.

The bark of the frond is peeled and woven into baskets while the trunk (main stem) can be split and used as supporting frames in buildings.
Soilless medium helps to prevent root infecting pathogen related problem. This is due to its superior physicochemical characteristic coupled with lower infestation rate of pathogenic pests at the initial stage. Strangle weathered and sedimentary soils which are classified as ferralsols, nitosols, and acrosols, (oxisols and ultisols are mostly used for planting perennial crops including oil palm in Malaysia (Sabri, 2009). Thus, better performance of many plantation crops is achieved in Malaysia when it is planted in ultisols and oxisols soils which possess some of those qualities and could be found in most oil palm planting areas in the country (Salisu *et al.,* 2013*)* however these soils still heavily depend on fertilization and planting of cover crops for better plant yield (Rantala, 2006). This could be attributed to its low cation exchange capacity (CEC) and high aluminum content Yaacob *et al.,* (1992).

The objectives of this study were to:

i. Determine the appropriate Organic fertilizer rate required for the optimum growth and nutrient uptake of oil palm seedlings.
ii. Determine the best growth media for the growth and nutrient uptake of oil palm seedlings.

MATERIALS AND METHODS

The experiment was conducted at the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso in the year 2018. Ogbomoso is on the latitude 8^0 10N and longitude 4^0 10 E (Olaniyi, *et al.,* 2000). The seedlings were obtained from NIFOR (Nigerian Institute for Oil Palm Research) Benin City, Edo state, Nigeria. Oil palm seedlings, polythene bags, topsoil, poultry manure, sawdust and organic fertilizer. The Organic fertilizer was applied at the rate of 0g, 50g, 75g, 100g and 125g and 3 growth media (soil, soil +manure and soil + sawdust) were used. Data collection commenced 4weeks after planting, and continues at four weeks interval. Parameters assessed include plant height, number of leaves, leaf area (multiplying length and breadth by correction factor of 0.55) and nutrient uptake i.e. leaves were been collected from various plant in each of the treatment, then sundried before they were taken to the laboratory to test for Nitrogen, Phosphorus, Potassium, Magnesium, and calcium concentrations. Nutrient uptake was calculated using formula: plant nutrient uptake x plant dried weight (g/plant). Data collected were subjected to Analysis of Variance (ANOVA) and significant mean were separated using least significant difference (LSD) at 5% level of probability.

RESULTS

Plant height

The effects of growth media and fertilizer rates on the plant height of oil palm seedlings are presented in (Table 1). Growth media significantly influenced ($P \leq 0.05$) plant heights at all the sampling period while fertilizer rates had no significant effect ($P > 0.05$) on the height of oil palm seedlings between 2 and 12 WAP. The tallest plants (18.94 cm) at 2 WAP was produced by soil at 125 kgN/ha of fertilizer while the shortest plants (11.72 cm) was produced by soil only at control fertilizer application. At 4 WAP, soil + manure produced the tallest plants (17.8 cm) at 125 kg/ha but at 6, 8 and 10 WAP, soil alone recorded the tallest plants of 21.44, 21.27 and 26.28 cm, respectively while the shortest plants between 4 and 10 WAP (12.58, 13.16, 12.72 and 16.70 cm, respectively) was consistently produced by soil only at control fertilizer application At 12 WAP, soil + manure produced the tallest plants (30.71 cm) while the shortest plant (18.39 cm) was produced from soil only at control fertilizer application. The interaction between the growth media and the fertilizer rates was not significant ($P > 0.05$) at all the sampling periods (Table 1).

Table 1: Effects of growth media and fertilizer rates on the mean plant height (cm) of oil palm seedlings

		PLANT HEIGHT(CM)					
Growth	**rates**	weeks	after	planting			
Media	**(kg/ha)**	2	4	6	8	10	12
Soil	0	11.72	12.58	13.16	12.72	16.70	18.39
Soil	50	12.16	13.12	13.83	15.88	18.80	22.21
Soil	75	13.55	15.77	17.89	20.50	24.35	27.04
Soil	100	14.33	15.93	18.11	20.83	24.57	28.38
Soil	125	18.94	16.89	21.44	21.27	26.28	29.70
Soil + sawdust	0	12.22	13.55	15.05	16.72	19.56	21.38
Soil + sawdust	50	12.33	13.72	15.21	17.50	20.60	22.92
S	75	12.78	14.61	15.50	19.22	23.50	25.92
Soil + sawdust	100	14.00	15.05	15.94	20.44	24.30	27.08
Soil + sawdust	125	16.50	17.33	20.72	16.15	25.13	29.00
Soil + manure	0	12.05	14.72	15.16	14.55	18.04	21.05
Soil + manure	50	13.66	15.00	15.50	16.89	19.88	21.78
Soil + manure	75	14.44	15.22	17.00	17.38	22.21	24.73
Soil + manure	100	15.61	16.78	18.33	19.89	23.50	26.65
Soil + manure	125	16.28	17.83	19.22	21.11	25.67	30.71
LSD media		2.52	3.06	4.03	3.13	2.99	2.78
LSD FERTILIZER		Ns	Ns	Ns	Ns	Ns	Ns
LSD MEDIA x FERTILIZER		Ns	Ns	Ns	Ns	Ns	Ns

Number of leaves

Growth media had significant effect ($P \leq 0.05$) on the number of leaves of oil palm seedlings all through the sampling period except at 2 weeks after planting (WAP), while fertilizer rates significantly influenced ($P \leq 0.05$) number of leaves of oil palm seedlings at 2, 4, 6 and 12 WAP (Table 2). The highest number of leaves at 2 WAP (3.11) was produced by soil as a growth medium at 100 kgN/ha of organic fertilizer while the lowest number of leaves (2.11) was produced by soil + manure as the growth medium at 100kg and 125 kgN/ha of organic fertilizer rate.

Soil steadily produced the highest number of leaves at 4, 6, 8 and 10 WAP (3.78, 4.22, 4.22 and 5.87, respectively) at organic fertilizer rate 125 kgN/ha while soil + sawdust produced the lowest number of leaves at 4 and 6 WAP (2.11 and 2.22, respectively) between control and 50 kg/ha of fertilizer, soil + manure produced the lowest number of leaves at 8 and 10 WAP (2.44 and 4.58, respectively) at 0 kg/ha of fertilizer. At 12 WAP however, soil + manure produced the highest number of leaves (7.40) at 125 kg/ha of fertilizer while the lowest (5.32) was produced by soil only at control of fertilizer. The interaction effect between the growth media and fertilizer rate was not significant at all the sampling occasions (Table 2).

Table 2: Effects of growth media and fertilizer rates on the mean number of leaves of oil palm seedlings

		NUMBER OF LEAVES					
Growth			weeks	After	Planting		
Media	**rates (kg/ha)**	2	4	6	8	10	12
Soil	0	2.65	2.89	2.89	2.89	3.89	5.32
Soil	50	2.66	3.22	3.33	3.33	5.00	5.62
Soil	75	2.89	3.25	3.55	3.55	5.26	5.67
Soil	100	3.11	3.78	3.55	3.55	5.78	6.02
Soil	125	3.11	3.78	4.22	4.22	5.87	6.69
Soil + sawdust	0	2.22	2.11	2.66	2.55	4.68	5.88
Soil + sawdust	50	2.33	3.00	2.22	3.02	4.69	5.88

Soil + sawdust	75	3.00	2.55	2.55	3.33	4.78	6.35
Soil + sawdust	100	2.55	2.66	3.44	3.33	5.37	6.88
Soil + sawdust	125	2.55	2.77	3.33	3.55	5.71	7.15
Soil + manure	0	2.44	2.44	2.55	2.44	4.58	5.70
Soil + manure	50	2.22	2.66	2.44	2.55	4.89	5.93
Soil + manure	75	2.44	2.66	3.77	3.22	5.33	6.32
Soil + manure	100	2.11	2.66	4.22	3.77	6.18	6.70
Soil + manure	125	2.11	2.66	4.63	3.99	6.19	7.40
LSD media		Ns	0.58	0.71	0.6	0.59	0.6
LSD FERTILIZER		0.44	0.45	0.55	ns	Ns	0.46
LSD MEDIA x FERTILIZER		Ns	Ns	Ns	ns	Ns	Ns

The leaf area and dried plant weight

The leaf area of oil palm seedlings was significantly influenced ($P \leq 0.05$) by both the growth media and the fertilizer rates (Table 3). The highest leaf area (225.87cm^2) was produced by soil + manure at 125 kgN/ha of fertilizer while the lowest leaf area (71.86cm^2) was produced by soil only at control fertilizer application. The interaction between growth media and fertilizer rates did not significantly ($P > 0.05$) influence the leaf area of the oil palm seedlings. Similarly, the dried plant weight of the oil palm seedlings was significantly ($P \leq 0.05$) influenced by the growth media however the fertilizer rates did not have a significant effect ($P > 0.05$) on the dried plant weight of the seedling (Table 3). The highest dried plant weight (4.0 g) was recorded from the three growth media at 100kgN/ha and 125kgN/ha of fertilizer while the lowest dried plant weight (2.0 g) was produced by all the growth media at no fertilizer application. The interaction between the growth media and the fertilizer rates had no significant effect on the dried plant weight of the seedlings.

Table 3: Effects of growth media and fertilizer rates on the leaf area and dried plant weight of oil palm seedlings.

Growth Media	F rates (kg/ha)	Leaf area (cm^2)	Dried plant weight (g)
Soil	0	71.86	2.00
Soil	50	122.1	3.00
Soil	75	130.53	3.00
Soil	100	153.63	4.00
Soil	125	168.12	4.00
Soil + sawdust	0	159.13	2.00
Soil + sawdust	50	155.83	3.00
Soil + sawdust	75	201.12	3.00
Soil + sawdust	100	224.77	4.00
Soil + sawdust	125	225.87	4.00
Soil + manure	0	79.2	2.00
Soil + manure	50	94.6	3.00
Soil + manure	75	127.6	3.00
Soil + manure	100	160.97	4.00
Soil + manure	125	225.87	4.00
LSD media		98.28	0
LSD FERTILIZER		76.12	Ns
LSD MEDIA x FERTILIZER		Ns	Ns

Nutrient uptake

The effects of growth media and fertilizer rates on the nutrient uptake of oil palm seedlings were presented in (Table 4). The uptake of all the evaluated nutrient element was significantly affected ($P \leq$

0.05) by growth media, fertilizer rates and their interactions. The highest value of nitrogen in the tissue of the seedlings (5.40) g/mg was produced by soil + sawdust at 100 kgN/ha of Fertilizer application rates while the lowest nitrogen content in the tissue (1.38) g/mg was produced by soil + sawdust and soil + manure at control fertilizer application. The highest phosphorus absorbed (5.08) g/mg occurred on plants on soil + sawdust at 125 kg/ha of fertilizer while the least phosphorus absorbed (0.60) g/mg occurred on soil + sawdust at control fertilizer application rates (Table 4). In terms of Potassium uptake, soil + sawdust produced the highest (1.44) g/mg potassium uptake at 75 kg/ha of fertilizer whereas soil + manure resulted in the lowest (0.31) g/mg of potassium at no fertilizer application. Soil + sawdust still resulted in the highest calcium uptake (5.04) g/mg at 100 kg/ha of fertilizer while soil + sawdust and soil + manure produced the lowest calcium uptake (1.26) g/mg at no applied fertilizer and for magnesium uptake, soil + sawdust resulted in the highest uptake (1.84) g/mg at 75 kg/ha of fertilizer while soil + sawdust and soil + manure produced the lowest magnesium uptake (0.32) g/mg at no applied fertilizer.

Table 4: Effects of growth media and fertilizer rates on the Nutrient uptake of oil palm seedlings.

Growth Media	Frates (kg/ha)	N	P	K (g/mg)	Ca	Mg
Soil	0	2.13	0.96	0.48	1.94	0.56
Soil	50	2.46	1.51	1.04	2.22	1.35
Soil	75	2.97	2.24	1.12	2.64	1.56
Soil	100	4.28	3.84	0.78	3.52	0.96
Soil	125	3.76	2.61	0.60	3.68	0.84
Soil + sawdust	0	1.38	0.60	0.34	1.26	0.32
Soil + sawdust	50	2.61	1.08	1.32	2.46	0.72
Soil + sawdust	75	3.06	2.61	1.44	2.82	1.84
Soil + sawdust	100	5.40	5.04	0.83	5.04	0.87
Soil + sawdust	125	5.00	5.08	0.69	4.96	1.56
Soil + manure	0	1.38	0.99	0.31	1.26	0.32
Soil + manure	50	2.43	1.08	0.61	2.43	0.72
Soil + manure	75	2.52	1.79	1.11	2.43	0.75
Soil + manure	100	4.32	3.36	0.65	4.08	1.40
Soil + manure	125	3.40	2.40	0.88	3.28	1.12
LSD media		0.22	0.66	0.04	0.04	0.03
LSD FERTILIZER		0.17	0.51	0.03	0.03	0.03
LSD MEDIA x FERTILIZER		***	**	***	***	***

DISCUSSION

Increasing fertilizer rates also resulted in better growth of the seedlings across the evaluation period. This reveals that fertilizer application is essential for early growth of oil palm seedlings. The highest values of the growth parameters was obtained between 100kg/ha and 125 kgN/ha of fertilizer application rates, this indicates that ample nutrient supply will guarantee good performance among oil palm seedlings. With regards to the nutrient uptake of the seedlings as determined by growth media, sawdust consistently gave the highest N, P, K, Ca and Mg uptake by the seedlings. This may be as a result of the fable state of the media that enhance ready root penetration to access the nutrients available; also being an organic material t will also decompose to release its inherent nutrient for the use of the growing seedling. The release of nutrients from organic materials has been reported to be gradual and could meet the demands of the plants (Adamtey, 2011). Similarly, fertilizer rates 100 kg/ha and 125 kg/ha still had the highest nutrient uptake that can be attributed to early growth of the seedlings that may have resulted in early root development that aided more nutrient uptake. Kumah (2011) have reported that nutrient supply aids early growth that eventually enhances early root development by plant in similar research conducted on substrates in Ghana.

CONCLUSION

In conclusion, the results obtained from the experiment shows that for early growth and nutrient uptake of oil palm seedling, the use of soil + poultry manure growth media with fertilizer applied at 100 kg/ha could be recommended in Ogbomoso, Southwestern, Nigeria.

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EFFECTS OF NEEM LEAF MULCH RATES ON GROWTH AND YIELD OF PADMA 108 VARIETY OF TOMATO IN AWKA, ANAMBRA STATE.

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ABSTRACT
Tomato farming serves as a good source of income for farmers. In southeastern Nigeria, high relative humidity, pests, diseases, low soil fertility and absence of resistant varieties have limited the success farmers achieved in the business. An experiment was conducted in Awka, Anambra state to determine the effects of neem leaf as mulch material on the growth and yield of Padma 108 variety of tomato. Awka is in a rainforest agro-ecological zone with a bimodal rainfall pattern, characterized by high relative humidity which creates enabling environment for pests and disease pathogens of many crop diseases. The experiment had five (5) levels of neem leaf mulch which were 0kg/Ha, 2775kg/Ha, 5550kg/Ha and 8338kg/ha and three (3) replications. Treatment 5550kg/ha had the highest number of fruits while 8338kg/ha recorded significantly high fruit size and weight. Therefore, 8338kg/ha is recommended for farmers in Awka and areas with similar climatic and edaphic conditions.
Keywords: *Neem Leaf, Mulch, Fruit Yield, Padma Variety, Tomato*

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) is a staple fruit vegetable, one of the most important vegetables worldwide (Saeed-Awan *et al.,* 2012) considered as an important cash and industrial crop in many parts of the world (Ajagbe *et al.*, 2014) that has become popular over the last century. Tomato is a tender and compression-sensitive fruit (Babarinsa and Ige, 2014) it is a member of the Solanaceae family botanically known as berry (Abdullah *et al.*, 2014). It is the second most important vegetable crop next to potato (Abdullah et al., 2010). Despite the overwhelming importance of tomato, the production has suffered huge setback in southeastern Nigeria due largely to high rainfall, high relative humidity, inherent pest and diseases and edaphic factors such as soil pH, poor soil nutrient status, etc.

MATERIALS AND METHOD

The experimental site was located at the Teaching and Research Farm of the Department of Crop Science and Horticulture, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria. Awka is characterized by tropical rainforest with temperature range of 27°C - 30°C. It is located at 52 metres above sea level, between latitude 06^0 15^1 N and longitude 07^0 08^1. The average annual rainfall ranges from 1650-2775mm. The variety of tomato used was the PADMA 108 F1. The tomato seedling received four treatments of varying rates of Neem leaf as mulch material. The treatments include: 0kg/ha, 2775kg/ha, 5550kg/ha and 8338kg/ha applied at the rates of 0kg/plot, 2.22kg/plot, 4.44kg/plot and 6.67kg/plot three (3) replications. The plots were raised beds with measurements of 4m x 2m and a 1m space between them. The total land area used for the experiment was $210m^2$, and there were four plots.

A media comprising of top soil, poultry manure and sharp sand in the ratio 3:2:1 respectively was used to raise the seedlings in nursery trays after decomposition. Healthy and good quality seedlings were selected and transplanted at the field at three weeks after planting. Transplanting was done in the evening at a spacing of 40 x 40cm giving a plant density of 62,500plants per hectare. Weeding was done at two weeks intervals by hand weeding and use of hoe while staking was done using ropes tied to wooden poles.

Data collection

Data collection started three weeks after transplanting, and lasted throughout the duration of the experiment to assess the effect of the neem mulch on the growth and yield of the tomato plants. The data collected were: Percentage establishment (%), Plant height (cm), Leaf area (cm^2), Number of leaves, Plant girth (cm), Number of Fruits, Fruit Weight, Fruit Length, Circumference and Diameter

All the data collected were subjected to analysis of variance (ANOVA) for a factorial experiment in RCBD using the Genstat version 4 analytical software. Mean separation was done using the Least Significance Difference at 5% level.

RESULTS

Effects of Neem Leaves as Mulch Material on the growth parameters

Table 1 shows the effect of the different Neem leaf mulch rates on the heights and girths of tomato at the different weeks after transplant. The mean of the plant heights at the different levels of Neem leaf mulch showed no significant difference at 4WAT, 5WAT and 6WAT, but showed significant difference at 3WAT. Treatment 5550kg/ha recorded the highest mean plant heights at 5WAT and 6WAT (71.40cm and 76.60cm respectively). In plant girth, there was no significant difference between the Neem leaf mulch rates at 3WAT, 4WAT and 5WAT, but was significantly different at 6WAT. Treatment 5550kg/ha also recorded the highest plant girth at 4WAT, 5WAT and 6WAT (3.23cm, 3.40cm and 3.59cm respectively).

Table 2 shows the result of the mean values of Tomato leaf area and number of leaves per plant. The tomato leaf area shows significant difference at all the stages of observation. Treatment 8338kg/ha recorded the highest at 4WAT, 5WAT and 6WAT (24.70cm^2, 27.10cm^2 and 27.10cm^2 respectively) while 2775kg/ha Neem Leaf Mulch rate recorded the least leaf area mean at 4WAT, 5WAT and 6WAT. The Number of Leaves shows significant difference between the rates at all the weeks, with 2775kg/ha Neem Leaf Mulch rate recording the least number of leaves at 3WAT, 4WAT, 5WAT and 6WAT (86.7, 113., 132 and 170) and 5550kg/ha Neem Leaf Mulch rate recording the highest number of leaves at 3WAT, 4WAT, 5WAT and 6WAT (181.2, 344, 468 and 561).

Effect of Neem Leaf as Mulch on yield parameters

Table 3 shows significant difference in the fruit circumference, fruit length and fruit weight between the different Neem Leaves Mulch Rates. Treatment 8338kg/ha recorded the highest mean fruit circumference (15.83cm), fruit length (8.49cm) and fruit weight (54.3g). However, 5550kg/ha recorded the highest mean number of fruits (16.70), while 0.00kg/ha recorded the least number of fruits (4.90)

Table 1: Effects of Neem Leaves as Mulch Material on the Plant Height, Plant Girth and number of flowers of Tomato at Different Weeks after Transplant.

Treatment	PLANT HEIGHT				PLANT GIRTH				NUMBER OF FLOWERS			
	Weeks after planting				Weeks after planting				Weeks after planting			
	3	4	5	6	3	4	5	6	3	4	5	6
0.00kg	37.6	50.1	60.9	62.4	2.15	2.28	2.71	2.8	2.55	5.11	4.1	2.89
2775kg	31.3	46.7	60.7	61.9	2.21	2.63	2.71	2.74	0.78	3.11	3.6	0.78
5550kg	34.1	54.3	71.4	76.6	2.79	3.23	3.4	3.59	3.56	7.44	14.6	8.44
8338kg	50.1	61.3	65.8	72.6	2.8	2.91	3.05	3.07	1.67	5	8.8	9.45
$LSD_{0.05}$	**14.15**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.771**	**NS**	**NS**	**7.45**	**5.79**

Table 2: Effects of Neem Leaves as Mulch Material on the Number of Leaves and Leaf Area of Tomato at Different Weeks after Transplant

	Number of Leaves				Leaf Area			
Treatment	3WAT	4WAT	5WAT	6WAT	3WAT	4WAT	5WAT	6WAT
0.00kg	114.6	189	229	229	10.43	17	19.3	20.9
2775kg	86.7	113	132	170	10.8	12.1	13.8	15.4
5550kg	181.2	344	468	561	16.75	22.1	24.8	26.9
8338kg	85.4	187	222	281	**11.93**	24.7	27.1	27.1
$LSD_{0.05}$	**39.63**	**119.6**	**180.9**	**214.4**	**5.937**	**8.28**	**9.12**	**9.88**

Table 3: Effect of Neem Leaf as Mulch on the Fruit Circumference, Fruit Length, Fruit weight and number of fruits at the harvest period

Treatments	Fruit circumference (cm)	Fruit length(cm)	Fruit weight(t/ha)	Number of fruits
0.00kg	12.44	7	0.207	4.9
2775kg	13.87	7.6	0.249	5.4
5550kg	14.7	7.91	0.286	16.7
8338kg	15.83	8.49	0.339	11.1
$LSD_{0.05}$	**1.233**	**0.975**	**10.07**	**10.81**

DISCUSSION

Mulch is generally used to enhance the growth of plants. In this experiment, we demonstrated the most effective much rate that could improve the growth and yield of tomato. This result agrees with previous studies which showed the superiority of mulched plants over the unmulched plants (Awodoyin and Ogunyemi, 2005), and the report that tomato benefited from mulching (Hochmuth et al., 2001). The increased growth and tomato fruit yield under the mulches may be attributed to the conservation of moisture and reduction of temperature of top soil and suppression of weed growth. The experiment also revealed that the different growth parameters of tomato recorded variation due to the different levels of Neem leaf mulch Rates. The highest increase in the growth parameters of Plant girth, number of branches and number of leaves by the 5550kg/ha Neem Leaf Mulch rate could be due to the water conserving effect of the mulch in addition to the release of nutrients from its decomposition, adding to the available nutrients in the soil. The high plant height observed in the 8338kg/ha NML rate is as a result of soil water conservation and gradual nutrient release, the low plant height recorded by same rate at the first 3weeks could be as a result of transplant stress/shock and increase in temperature due to decomposition of the fresh leaves.

The result on Leaf Area showed that Neem leaf mulch rates significantly affected the length and width of the tomato leaves. The observation could be attributed to the additional nutrient made available to the plants and the water conserving property of the mulch. This enhancement in the growth parameters by the higher neem mulch rates might be explained to be as result of addition of organic matter turned into humus and resultantly into increased nutrient retention capacity of the soil by increasing effective cation exchange capacity. The fact that mulch covers the soil surface preventing evaporation, and also protects the soil and its organic content from direct contact with warm air thus increasing soil microbial activity and consequently encouraging decomposition, is probably the reason for high growth. Similar findings were also made by Kuldeep (2016).

Yield attributes which determine yield is the resultant of the vegetative development of the plant. Yield is as a result of the coordinate interplay of the yield attributes: number of fruit per plant, weight of fruit per plant etc. which were improved due to mulch application. The maximum record of number of fruit per stand and number of flower per stand observed in 5550kg/ha Neem Leaf Mulch rates could be related to the maximum branching and relatively strong growth performance of the plants. similarly, 8338kg/ha Neem Leaf Mulch rates recorded the maximum fruit weight, length and circumference as it produced the largest fruits. This could be said to be as a result of it's decomposition being slow due to the quantity,

releasing maximum additional nutrient for use by the plants as well and the tendency of it providing maximum soil cover therefore having better moisture conservation property.
In general, the cover of mulch creates a favorable micro climate for the activities of soil micro organisms which helps in maintaining and improving the soil physio-chemical and biological qualities, thereby improving the performance of growth and resultantly in yield attributes and yield. Similar findings were also made by Kuldeep (2016).

CONCLUSIONS

The different rates of neem leaves used as mulch for the experiment revealed that Neem leaves influences the growth and yield qualities in Tomato production. The neem as mulch material conserved moisture and maintained temperature of the soil. The higher Neem leaf mulch rate was effective in the control of diseases of tomato in Awka. The result of the experiment therefore shows that commercial production of tomato in Awka is possible with appropriate neem mulch rates.

RECOMMENDATION

8338kg/ha of neem leaf as mulch material is recommended for tomato farming in Awka and its environment. It is also recommended that further research be carried out on the use of 5550kg/ha and 8338kg/ha of Neem leaf for mulching in other areas in Southeastern Nigeria as they recorded the highest number of fruits, highest mean fruit weight and size.

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ENHANCING LOW SOIL STATUS WITH GROUNDED DRIED CASHEW LEAVES ON THE GROWTH OF COCOA SEEDLINGS.

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ABSTRACT
An experiment was conducted with a view of promoting grounded dry cashew leaves (GDCL) as organic fertilizer for raising cocoa seedlings. The experiment was laid out in a complete randomized design with three replications. The treatments consisted of 0g (Control), 5g and 10g of grounded dry cashew leave (GDCL). The duration of the experiment was 12 weeks. Among the treatments, 10g GDCL recorded superiority in almost all growth parameters measured. The results obtained show that better cocoa seedling growth could be achieved with the use of GDCL as growing media for nursery, as well as improving the soil. It was concluded that apart from being a waste, GDCL is recommended to be incorporated into the soil for nutrient enhancement and to solve its disposal problems as a waste. Future research should be considered to study other nutrient composition of GDCL not captured in this study and the rate of decomposition of GDCL.
Keywords: *Agro-waste, cocoa seedling, growth, nutrient, manure*

INTRODUCTION

Tree crops usually take several years to reach the peak of their production, particularly cocoa trees. Cocoa supports the livelihoods of individuals (Agbongiarhuoyi *et al*., 2013) as it plays a significant socio-economic role in Nigeria. In Cocoa production, (Ajewole and Iyanda, 2010) optimum motivation is a sensitive requirement for best practices. This has led to farmers and farmer groups producing their cocoa seedlings through community-based nursery schemes (Kehinde Ajao, 2011). On the other hand, soil amendment has been observed to be one of the solutions to soil fertility and over-cultivation problems (Aina *et al*., 2018), because it is believed that decaying plant materials adds nutrients to soil which is an act of soil amendment. Cashew (*A.occidentale)* tree leaves waste disposal is among some global problems affecting farmers. Even though they are genetically fixed in nature, it has flammable risks, and handling issues. Tan and Chan (2014) reported that leaves of *A.occidentale* inhibit the growth of *Brevibacillus brevis*, *Micrococcus luteus*, *Staphylococcus cohnii*, *Escherichia coli* and *Pseudomonas aeruginosa* and more from the bark extract (Manasa *et al*., 2013).
De Medeiros *et al*., (2021) stated that the improvement of physical, chemical, and biological attributes of the soil leads to creating an adequate environment for healthy plant development. More so, they are abundant; thus, it becomes an undeniable waste that may not be detrimental to the soil's physico-chemical properties. It was reported (Barna *et al*., 2015) that plants grown with biological sources of nutrients such as manures and composted organic waste are less susceptible to the attack of insects. Besides, Anderson *et al*., (2005) reported that organic fertilizer is cheaper and has more efficacy than inorganic fertilizer. Ayeni, (2011) reported that chemical fertilizer increased crop yield, but its cost implication affects farmers positively. Negatively it enhanced yield and contributed to food security (Park *et al*., 2008). Furthermore, Williams, (2009) stated that the choice of new technologies and discoveries to improve the farm yield positively may not be readily accepted by non-literate farmers. Hence an appropriate agronomic practice, adaptation, consisting of the use of grounded dry cashew leaves as manure to boost cocoa nursery plants should be a strategy that not only cob the challenges of cashew leaf disposers but can be used as inorganic fertilizer or soil amendment. Thus, the objective was to establish the fact that

grounded dried cashew leaves (GDCL) can enhanced cocoa growth, and at the same time served as amendment to improved soil fertility.

MATERIALS AND METHODS

The experiment was carried out in the greenhouse of Cocoa Research Institute of Nigeria (CRIN), Ibadan. The soil was collected from a depth of 0-15cm in a continuously cultivated farm plot that has little amount of composite plant materials, organic content, and low nutrient status after soil analysis. The soil collected was mixed with cashew leaf litters, which was air dried, grounded and filled into the soil in a ratio of 0g (control), 5g and 10g, in a polythene bag of 14.2 and 16.8 cm radius and length respectively, arranged in a randomized complete block (RCD) in three replicates. Pre/Post leaf and soil samples were analyzed in the lab to obtain their nutrient composition. The experiment was monitored for 12 weeks. Vegetative data was collected at 4 weeks after sowing (WAS), 6WAS, 8WAS, 10WAS, and 12WAS on growth morphological parameters (plant height, number of leaves, stem girth and leaf area). Data collected was subjected to statistical analyses (Genstat 17 Version). Analysis of variance was performed using a range test of 0.05% probability level.

RESULTS AND DISCUSSION.

The physico-chemical properties of the soil (Table 1) all fall below the critical levels; hence fertilization becomes appropriate. The soil pH (H_2O) was 4.25, not quite suitable for optimum cocoa production. N 0.08 compared to 0.09 and1.8gkg-1, K Potassium 0.49 also fall below the critical level of 1.2cmolkg-^{1} used to raise cocoa plant according to Egbe, N. E, *et al*., (1989) and wessel M (1971) respectively. Moreso after the experiment the soil was richer in nutrients when fertilized with the application of 5g of GDCL, an indication of easy absorption of the nutrient present from GDCL for growth. The incorporation of grounded dry cashew leaves (GDCL) as shown in Table 2 on the pre and post GDCL was not significantly different, but it was efficiently utilized by cocoa seedlings when mixed with the nursery soil. This was in cognizance of the report of Tanimu *et al*., (2007) and Murphy (2015) in their report that organic materials apart from being a major source of organic matter and plant nutrients resulted in improved soil physical and chemical attributes. The different types of treatments applied (Table 3) was not significantly different for cocoa seedling emergence. Subsequently, treatments with the application of GDCL emerged lesser when compared to the control (0g).

The cocoa seedling's morphological parameters at the nursery stage and plant vigor were influenced by GDCL as shown in Fig. 1 to Fig 4, although not significantly. 10g of GDCL produced the tallest plant height (Fig 1). Also, at 12WAS, 5g and 10g GDCL were similar (Fig 2) in leaf production (10.10) when compared to the control (8.8). 4WAS (Fig 3), the use of 10g GDCL improved the stem girth of the cocoa seedling, though not significantly with continuous elongation till 12WAS. This supported Pandit *et al*., (2018) report that dried cashew leaves may have the potential for enhancing soil nutrient availability. The already observed trend did not continue in Fig. 4 (leaf area), because the smallest leaf area was recorded from 10g of GDCL (37.48cm^2) plot, closely followed by 5g (40.53cm^2). However, the highest leaf area (40.79)) was recorded in seedlings sown without (NCL) the application of GDCL.

CONCLUSION

Cashew leaves litter can easily be sourced from farms due to their abundance as Agro-waste. The awareness of it as manure can solve waste disposal problems and can improve cocoa soil structure and texture. From this study, no exceptional impact of grounded dried cashew leaves on cocoa seedlings was observed using both application rates. However, application using higher rates is recommended for trial as the organic fertilizer have been observed to have basic nutrients that can support plant growth. The study provides a reasonable amount of information about the nutrient status of cashew dry leaves. Nevertheless, future studies on the rate of decomposition and its economic value to cocoa productivity should be shared with farmers through training toward best agronomy practices on cocoa farms.

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Table 1: Nutrient status of the pre and post soil mixed with Grounded dry cashew leaves.

Pre-soil-Sand 32.80, Clay 43.20, silt 24.00% (Clay loam)									
TRT	pH (1.1H2O)	OC%	N%	P ($mgkg^{-1}$)	K (cmol/kg)	Na (cmol/kg)	Ca (cmol/kg)	Mg (cmol/kg)	OM %
Pre-Soil	4.25	0.38	0.08	2.96	0.49	0.49	2.30	1.10	0.66

Post Soil									
0g (NCL)	4.87	0.34	0.13	5.13	0.17	0.3	4	1.9	0.59
GDCL 5g	4.89	0.4	0.18	7.31	0.23	0.33	3.3	1.4	0.69
GDCL 10g	4.99	0.27	0.04	4.82	0.68	0.72	4.4	2.1	0.46

**NCL- No cashew leaves, GDCL-Grounded dry cashew leaves*

Table 2: Nutrient status of the pre-grounded dried cashew leaf and post Grounded dried cashew leaves mixed with soil.

TRT	N (%)	P ($mgkg^{-1}$)	K ($mgkg^{-1}$)	Na (cmol/kg)	Ca (cmol/kg)	Mg (cmol/kg)	OM%	OC%
Pre GDCL	2.52	7.89	2.69	2.10	3.76	1.86	93.91	54.60
Post GDCL + Soil								
NCL	0.13	5.13	0.17	0.3	4	1.9	0.59	0.34
GDCL 5g	0.1	7.31	0.23	0.33	3.3	1.4	0.69	0.4
GDCL 10g	0.04	4.82	0.68	0.72	4.4	2.1	0.46	0.27

**NCL- No cashew leaves, GDCL-Grounded dried cashew leaves*

Table 3: Cocoa Seedling emergence (%) response to grounded dried cashew leaves.

TRT	2WAS	3WAS	4WAS
NCL	83.33a	83.33a	83.33a
GDCL 5g	66.67a	66.67a	66.67a
GDCL 10g	33.33a	66.67a	66.67a
S.E	19.2	19.2	19.2

**NCL- No cashew leaves, GDCL-Grounded dried cashew leaves*

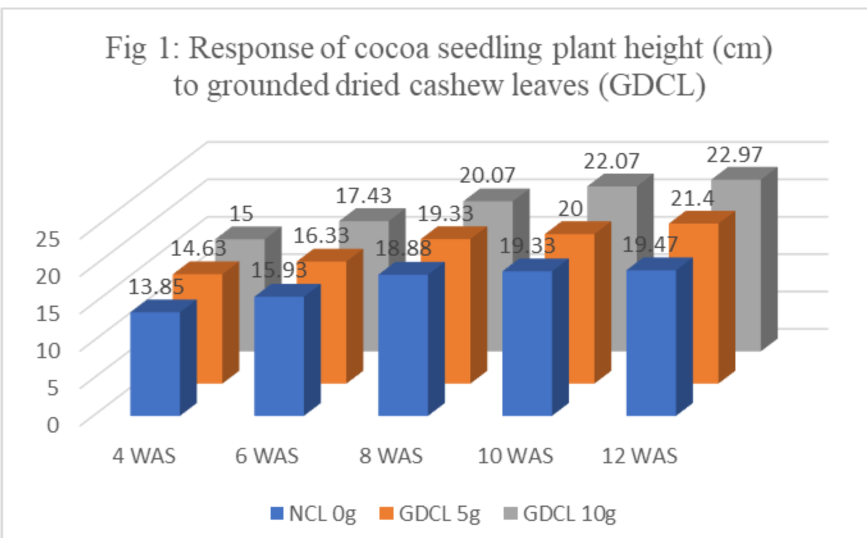


Fig 2: Response of cocoa seedling number of leaves to grounded dried cashew leaves (GDCL)

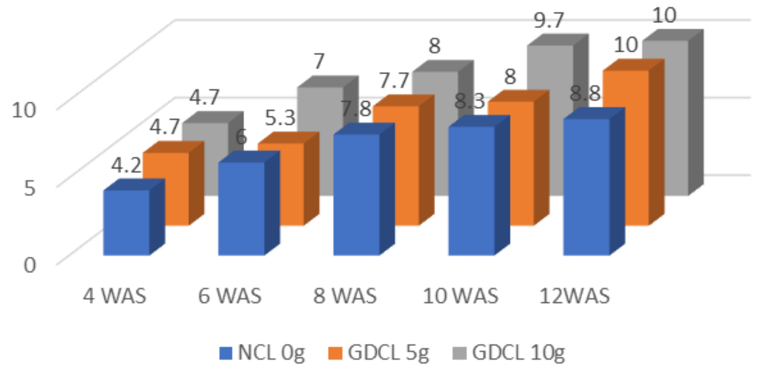


Fig 3: Response of cocoa seedling stem girth (mm) to grounded dried cashew leaves (GDCL)

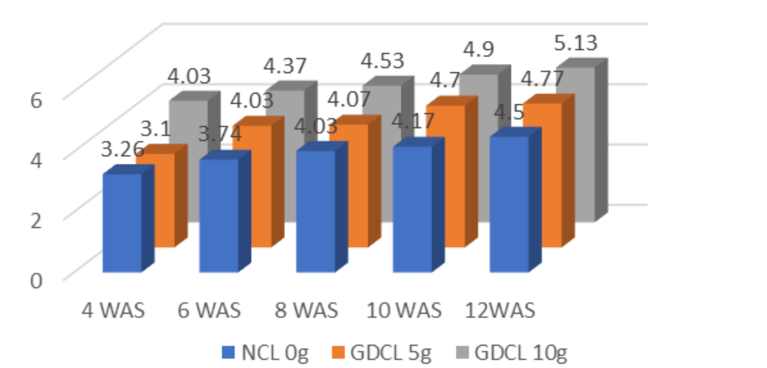
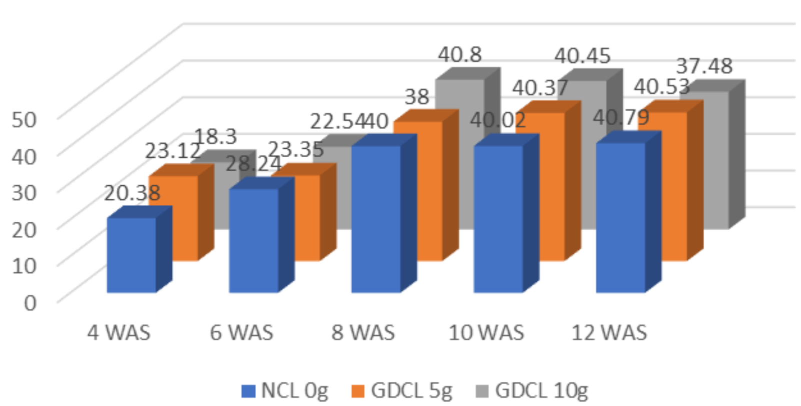


Fig 4: Response of cocoa seedling leaf area (cm^2) to grounded dried cashew leaves (GDCL)



EFFICACY OF AFRICAN MARIGOLD EXTRACT ON THE MANAGEMENT OF NEMATODE INFESTATION ON TOMATO (*Solanum lycopersicum* L.)

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ABSTRACT
The study assessed the efficacy of leaf and the root extracts of African Marigold for the management of nematode infestation on tomato (Solanum lycopersicum L.). The experiment was conducted at the Horticultural nursery of Crop Production Department, Federal University of Technology, Minna, Nigeria. Data collected on the following parameters: number of leaves, flowers, and fruits, leaf area, height, girth, and fruit weight were subjected to analysis of variance (ANOVA) using Statistical Analysis Software (SAS) and means were separated using Duncan Multiple Range Test (DMRT). Tomato plants treated with the root extract of African Marigold showed significantly higher number of leaves (74), flowers (8), and fruits (6), thicker stem (1.1cm), tallest plant (48.9cm), broadest leaf area (9.3cm^2) respectively, and they were statistically higher than other treatments. It was observed that 30 ml of African marigold root extracts performed better in suppressing the activities of the nematode thus translating to improved growth and yield of tomatoes. The study revealed that extracts of African marigold possess nematicidal properties that can be explored as alternative to synthetic nematicides in the control of nematode infection in tomatoes cultivation. It is recommended based on the findings from this research that 30 ml root extract of African marigold is required to improve the growth and fruit yield of tomato/pot against nematode infection. Further study is recommended for the evaluation of the exacts in the open, to be able come up with recommended dose.
Keyword: *African marigold extract, Nematicide, Solanum lycopersicum, Tomato*

INTRODUCTION

Tomato (*Solanum lycopersicum*) is a member of the Solanaceae family (Ercolano *et al*., 2012). All over the world, tomato is part of a healthy diet because it contains calcium and Vitamin K which helps maintain strong bones. It also contains vitamin B and Potassium which helps reduce cholesterol levels and lowers blood pressure (Bhowmik *et al*., 2012). Tomatoes are warm-season crop that require direct sunlight for optimum production, it do not thrive in cold weather or extreme heat. Fruit set will not occur at prolonged temperatures below 14 °C or above 30 °C. Tomatoes will produce good yields on a wide range of fertile, well drained soils with pH of 5.5 –7.5 (Yadav and Tungpu, 2012). The fruit is rich in lycopene which may have beneficial health effects. The tomato is a major vegetable crop that has achieved tremendous popularity over the last century. It is grown in practically every country of the world – in outdoor fields, greenhouses and net houses. The tomato plant is very versatile and the crop can be divided into two categories; fresh market tomatoes and processing tomatoes. In both cases, world production and consumption has grown quite rapidly over the past 25 years. Tomatoes, aside from being tasty, are very healthy as they are a good source of vitamins A and C. it also contains Lycopene; which is a very powerful antioxidant that can help prevent the development of many forms of cancer. Cooked tomatoes and tomato products are the best source of lycopene since the lycopene is released from the 3 tomato when cooked. A raw tomato has about 20% of the lycopene content found in cooked tomatoes. However, raw or cooked tomatoes are considered the best source for this antioxidant.

MATERIALS AND METHODS

Study Location

The experiment was conducted in the Horticultural Research and Nursery, Department of Crop Production, Federal University of Technology, Minna, Nigeria on latitude 9°40'N and 6°3'E.

Source of Seed

The Ibadan local seed cultivar was purchased from an Agro-Input store in Minna, Niger State, Nigeria. .

Preparation of Experimental Plots

The grasses and weeds of experimental nursery plot were removed and the land tilled to a depth of 15-30 cm. The soil was sterilized and was filled into polyethylene bag.

Seedlings planting and transplanting

The seedlings were planted using broadcasting method and were transplanted in the evening for better establishment of the seedlings after 21 days to 8 kg top soil into the polythene potting pots at one plant per stand. Planting was done.

Introduction of the Egg Mass of Nematode

The egg masses of the nematode were gotten from an infected (*Glycine max*) soybean plant and were picked and was introduced into the already sterilized sand filled potting bags at five (5) egg mass per pot.

Preparation of Crude Extract

The collected African marigold shoots and roots were shade dried under normal environmental condition and thereafter ground into uniform powder using a mortar and a pestle. Hundred grams from each of the dried powdered shoots and roots were weighed and mixed in 1000 ml distilled water separately. The solution was boiled, cooled and filtered using the Whatman No. 1 filter paper. Then filtrate was kept under room temperature and injected into the soil using a syringe fortnightly from the 7th day after transplanting.

Treatments and Experimental Design

The treatment levels were factorial combined, resulting to (4×5) and was applied at 10, 20, 30 ml and control. Completely randomized design (CRD) was adopted with five replications.

Data collection

Data were collected on number of leaf, leaf area, plant height, stem girth, number of flowers, number of fruits and fruit weight.

Data Analysis

The data collected on all the parameters were subjected to analysis of variance (ANOVA) using Statistical Analysis Software (SAS) and means were separated using Least Significant Difference (LSD) at 5 % level of probability.

RESULTS

The effect of the shoots and roots extract of African Marigold on the management of Nematode on the number of leaves of tomato in Table 1 was not significantly different at the first three weeks after transplanting. However, at 6, 7 and 8 WAT shoot extract recorded highest significant ($p \leq 0.05$) number of leaves compared to control but not significantly difference from 10 and 30ml. At 4, 5, 6, 7 and 8 WAT 30 ml of root extract recorded highest significant ($p \leq 0.05$) number of leaves compared to control but not significantly difference from 10 and 30 ml.

Table 2 shows the effect of the shoots and roots extract of African, marigold on the management of Nematode on the leaf area of tomato was not significantly different at 1 WAT. At 2 WAT, 10 ml of shoot extract recorded highest significant ($p \leq 0.05$) leaf area compared to control but not significantly difference from 20 and 30ml. Also at 3 WAT control has the narrower significant ($p \leq 0.05$) leaf area compared to other treatments. While, at 4 WAT 20 ml of shoot extract recorded highest significant ($p \leq 0.05$) leaf area compared to control. At 5 WAT pots treated with 10 ml of shoot extract recorded highest leaf area compared to control but not significantly difference from 10ml. At 6 WAT 20 ml of shoot extract treated pots recorded highest significant ($p \leq 0.05$) leaf area compared to control but not

significantly difference from 10 and 20 ml and at 7 and 8 WAT 30 ml of shoot extract recorded highest significant ($p \leq 0.05$) leaf area compared to control but not significantly difference from 10 and 20 ml.
Result presented in Table 3 revealed that at 1 and 2 WAT plant height of tomato planted in pots treated with shoots and roots extract of African Marigold was not significantly different. At 3 WAT, 30 ml of shoot extract recorded the tallest significant ($p \leq 0.05$) plant compared to control but not significantly difference from 10 and 20 ml. In a related development, 20 ml of root extract recorded highest significant ($p \leq 0.05$) plant height compared to control and 10 ml at 3 WAT Also, at 4WAT tomato treated with shoot extract in control had shortest significant ($p \leq 0.05$) plant height compared to other treatments. Root extract dosage of 20 ml recorded highest significant ($p \leq 0.05$) tallest plant compared to control but not significantly difference from 10 and 30 ml at 4, 5, 6 and 8 WAT.
The effect of the shoots and roots extract of African Marigold on the management of Nematode on the Number of tomato flower from plant treated with 20 and 30 ml of shoot extract produced significant ($p \leq 0.05$) highest number of flowers compared to control but not significantly difference from tomato treated with 10 ml at 5 WAT (Table 4). Table 5 revealed that 30 ml of shoot extract recorded highest significant ($p \leq 0.05$) number of fruits compared to control but not significantly difference from 10 and 20ml at 7 WAT. Likewise, at 8 WAT 10 ml and control has the lowest significant ($p \leq 0.05$) number of fruits compared to other treatments while 30 ml has the highest number of fruits and was significantly different from 10 and 20 ml. Shoot extract applied 30 ml recorded highest significant ($p \leq 0.05$) fruits weight compared to control but not significantly difference from 20ml treatment at 8WAT (Table 6). While at 8WAT 30 ml of root extract recorded highest significant ($p \leq 0.05$) fruits weight compared to control and also significantly different from 10 and 20ml.

DISCUSSION

This study showed that there was higher overall performance of plants treated with the botanical extracts than the untreated ones. The plants treated with 30 ml of the extracts gave overall performance compared to plants treated with 10 and 20 ml and the plants that was not treated had low yield. The study also showed that the plants treated with roots extracts gave overall higher performance when compared with the plants that was treated with shoots extracts. The mechanisms of plant extracts action may include denaturing and degrading of proteins, inhibition of enzymes and interfering with the electron flow in respiratory chain or with ADP phosphorylation (Susan and Noweer, 2005). These chemicals either affected the embryonic development or killed the eggs. Chitwood (2002) suggested that the nematicidal properties of plant species vary considerably with plant species and cultivar, the plant tissue used, plant growth stage, application method and the nematode species tested. The botanical extracts reduced the formation of galls caused by root-knot nematode, number of eggs/egg mass and final nematode population density in the soil. With the increase in concentration levels of the botanicals, there was corresponding significant increase in overall plant performance. This significant increase in overall plant performance could be due to the chemicals present in the extracts that possess ovicidal or larvicidal properties resulting in inhibition of the multiplication of the nematodes present in the soil.

CONCLUSION

From the results obtained from this study, it was observed that the tomato plants treated with extracts of African marigold performed better in terms of growth and yield performances. The botanical extracts, root extract in particular can therefore be recommended to serve as alternative to synthetic nematicides because they are eco-friendly, easy degradable, cost effective and easily available. However further research is needed to evaluate their efficacy under field condition of different agro ecologies

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Table 1: Effects of African marigold extract on the management of Nematode on the number of leaf of Tomato

	Number of leaves							
Treatment	1	2	3	4	5	6	7	8
	Weeks after transplanting							
Shoot extract								
10 ml	11.60	13.80	19.00	34.80	39.00	47.20	49.80	56.80
20 ml	13.60	17.20	23.40	35.00	53.00	58.00	67.20	72.00
30 ml	11.80	15.00	18.80	37.80	41.60	45.20	61.40	67.20
Control	13.20	16.20	15.60	24.80	23.60	20.60	28.00	21.60
Root extract								
10 ml	10.00	11.00	12.40	29.00	31.60	45.60	56.20	60.60
20 ml	11.60	14.60	22.40	41.00	46.60	53.20	61.00	62.40

30 ml	11.20	15.60	23.40	39.00	52.80	60.00	67.80	74.20
Control	10.20	10.60	11.40	17.80	22.40	20.60	29.00	31.40
LSD ($p \leq 0.05$)	0.40	0.78	1.56	2.26	3.30	3.86	4.43	5.13

LSD =Least Significant Difference ml = millilitre

Table 2: Effects of African marigold extract on the management of Nematode on the leaf area of Tomato.

Treatment	Leaf area (cm^2)							
	1	2	3	4	5	6	7	8
	Weeks after Transplanting							
Shoot extract								
10 ml	0.70	0.83	3.59	5.32	6.34	6.53	6.66	6.64
20 ml	0.70	0.77	4.62	5.93	5.18	5.93	6.62	6.65
30 ml	0.69	0.78	4.63	5.69	6.16	6.53	7.38	8.18
Control	0.69	0.76	1.50	2.93	3.13	2.25	2.74	2.04
Root extract								
10 ml	0.72	0.77	3.62	5.38	6.36	6.96	7.72	8.29
20 ml	0.68	0.77	4.86	6.08	7.42	7.84	8.19	8.30
30 ml	0.69	0.78	4.70	7.91	8.30	8.29	8.29	8.31
Control	0.70	0.76	1.48	2.93	3.26	2.06	2.93	3.48
LSD ($p \leq 0.05$)	0.01	0.07	3.63	5.27	0.38	0.46	0.46	0.50

LSD =Least Significant Difference ml = millilitre

Table 3: Effects of African marigold Extract on the management of Nematode on the plant height of Tomato

Treatment	Plant height (cm)							
	1	2	3	4	5	6	7	8
	Weeks after Transplanting							
Shoot extract								
10 ml	9.16	11.30	20.10	20.98	18.26	22.24	25.70	32.00
20 ml	9.12	13.50	14.80	25.70	30.16	35.52	37.90	35.44
30 ml	9.12	14.50	21.60	26.96	29.08	35.54	35.6 0	35.60
Control	9.14	14.40	14.10	17.76	22.80	15.16	18.44	12.40
Root extract								
10 ml	9.20	13.1	18.10	22.84	30.20	35.44	39.42	41.30
20 ml	9.20	15.1	20.90	26.08	33.70	38.56	45.22	48.90
30 ml	9.12	12.0	16.80	24.50	25.54	30.36	40.58	47.80
Control	9.20	12.5	13.80	19.30	25.20	13.54	20.20	20.58
LSD ($p \leq 0.05$)	0.03	0.45	0.87	1.85	1.85	2.30	2.48	2.79

LSD =Least Significant Difference ml = millilitre

Table 4: Effects of African marigold extract on the management of Nematode on the number of flower of Tomato

Treatment	Numbers of flowers 5	6	7	8
	Weeks after Transplanting			
Shoot extract				
10 ml	1.00	1.60	2.40	2.80
20 ml	1.20	2.60	4.60	5.00
30 ml	1.20	3.40	3.80	5.80
Control	0.00	0.00	0.00	0.00
Root extract				
10 ml	0.80	1.40	2.20	5.40
20 ml	2.80	4.60	5.00	5.40
30 ml	2.80	4.00	5.40	6.20
Control	0.00	0.00	0.60	0.80
LSD ($p \leq 0.05$)	0.24	0.43	0.45	0.64

LSD =Least Significant Difference ml = millilitre

Table 5: Effects of African marigold Extract on the management of Nematode on the number of fruits of Tomato

Treatment	Number of fruit 7	8
	Weeks after Transplanting	
Shoot extract		
10 ml	0	4
20 ml	4	8
30 ml	7	10
Control	0	4
Root extract		
10 ml	5	9
20 ml	6	10
30 ml	8	13
Control	0	3
LSD ($p \leq 0.05$)	0.05	0.08

LSD =Least Significant Difference ml = millilitre

Table 6: Effects of African marigold extract on the management of Nematode on fruits weight of Tomato

Treatment	Fruit weight (kg) 8	10	12
Weeks after Transplanting			
Shoot extract			
10 ml	0.52	0.77	1.21
20 ml	1.91	2.43	3.05
30 ml	2.43	3.22	3.81
Control	0.00	0.35	0.23
Root extract			
10 ml	1.08	1.65	2.35
20 ml	2.74	3.55	4.07
30 ml	4.09	4.89	5.11
Control	0.48	0.77	1.44
LSD ($p \leq 0.05$)	0.31	0.33	0.51

LSD =Least Significant Difference ml = millilitre

GROWTH AND YIELD OF TURMERIC (*Curcuma longa* Linn.) IN RESPONSE TO NITROGEN AND POTASSIUM FERTILIZER APPLICATION

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ABSTRACT
This study assessed the effect of N and K fertilizer application on the growth and yield of turmeric. It was a pot experiment using 5 levels of nitrogen (0, 45, 90, 135 and 180 kg N/ha), and 5 levels of potassium (0, 45, 90, 135 and 180 kg K/ha). The experiment was arranged in a 5 × 5 factorial fitted into a completely randomized design with three replications. Data were obtained on the plant height, number of leaves, number of tillers, biomass and rhizome yield. Applications of nitrogen and potassium significantly enhanced the growth and yield of turmeric. The highest biomass (7.61 g/plant) and rhizome (46.67 g/plant) was obtained with the application of 135 kg N/ha, and 180 kg K/ha There was an interactive effect between nitrogen and potassium application which enhances the growth and yield of turmeric.
Keywords: *Fertilizer application, N fertilizer, potassium fertilizer, turmeric, rhizome yield*

INTRODUCTION

Turmeric (*Curcuma longa* Linn.) is a spice crop native to tropical Southeast Asia. Its economic importance ranges from its use as culinary to its medicinal potentials. It is the major ingredient in curry powders, giving curlinary dish a characteristic peppery taste (Ravindran *et al*., 2007). It is also used in the pharmaceutical industries for the treatment of various kinds of diseases. (Sugiyama *et al*., 1996; Ishimine *et al*., 2003) due to its active ingredient curcuminiods.
Turmeric responds well to fertilizer application (Bose *et al*., 2008). Among the most important nutrient element required by turmeric are nitrogen (N) and potassium (K). Various researchers have reported different recommendations for turmeric production particularly in India where it is being cultivated on a large scale. Jagadeeswaran *et al*., (2005) noted that the nutrient exploiting property and applied nutrient efficiency of turmeric despite its economic importance has not been studied in details. In view of this, the experiment was aimed at determining the effect of N and K on the growth and yield of turmeric.

MATERIALS AND METHODS

A pot experiment was conducted at the National Horticultural Research Institute (NIHORT), Ibadan using 5 kg soil. Pre-cropping soil analysis was done using standard procedures. The experiment was a 5 × 5 factorial arranged in a completely randomized design. The experiment was replicated three times. The factors include 5 levels of N (0, 45, 90, 135 and 180 kg N/ha), and 5 levels of K (0, 45, 90, 135 and 180 kg K/ha). The N and K were applied at 2 equal split dose at 1 month and 3 months after planting. The source of the N was urea and that of K was muriate of potash. Data were collected on plant height, number of leaves, number of tillers, rhizome yield, and biomass yield.
All data were subjected to analysis of variance using SAS software 9.2 version and significant treatment means separated using LSD and DMRT.

RESULTS

The pre-cropping soil analysis indicates a pH of 6.9, the values of the major nutrient elements are as follows: total N 0.06 %, available P 3.65 mg/kg, exchangeable K 0.26 cmol/kg, Ca 12.44 cmol/kg and Mg 0.95 cmol/kg.

At 8 and 12 WAP the highest plant height was obtained with the application of 45 kg N/ha, but this was not significantly different from the applications of 90, 135 and 180 kg N/ha (Table 1). However, the control (0 kg N/ha) had a similar plant height with the use of 90 and 135 kg. The highest plant height at 16 WAP was obtained with the application of 180 kg N/ha which was not significantly different from the applications of 45 and 135 kg N/ha. The plant heights under the applications of 45, 90 and 135 kg N/ha at 16 WAP were not significantly different from each other. The highest plant height at 20 WAP also resulted from the application of 180 kg N/ha. This was not significantly different from the applications of 45 and 135 kg N/ha while a significantly lower plant height at 20 WAP was obtained with the control when compared with other treatments.

There was no significant difference in the plant height at 8 and 12 WAP with the application of potassium at different rates (Table 1). The use of 180 kg K/ha gave the highest plant height at 16 WAP but this was not significantly different with the applications of 45, 90 and 135 kg K/ha. The control gave the lowest plant height at 16 WAP but this also was not significantly different from the applications of 45, 90 and 135 kg K/ha. The highest plant height at 20 WAP was with the application of 180 kg K/ha, which was significantly higher compared with the control and the application of 45 kg K/ha but was similar with the applications of 90 and 135 kg K/ha. A significantly lower plant height at 20 WAP was obtained with the control but this was not significantly different from the applications of 45, 90 and 135 kg K/ha.

The highest number of leaves at eight WAP was under 180 kg N/ha but this was not significantly different from the applications of 45 and 135 kg N/ha (Table 1). The control gave the least number of leaves at eight WAP. At 12 WAP a higher number of leaves resulted from the application of 180 kg N/ha but this was not significantly different from the applications of 45 and 135 kg N//ha while a significantly lower number of leaves resulted from the control, but this was not significantly different from the applications of 45, 90 and 135 kg N/ha. At 16 and 20 WAP, a higher number of leaves was obtained with the application of 180 kg N/ha but was not significantly different from the application of 135 kg N/ha. The control gave a significantly lower number of leaves at 16 and 20 WAP.

At eight WAP, application of 135 kg K/ha gave a significantly higher number of leaves but this was not significantly different from the control and the applications of 45 and 180 kg K/ha. The highest number of leaves with potassium application at 12 WAP resulted from 135 kg K/ha but this was not significantly different from the control and the use of 180 kg K/ha. The application of 90 kg K/ha gave a significantly lower number of leaves. At 16 and 20 WAP the highest number of leaves resulted from the application of 135 kg K/ha. The lowest number of leaves resulted from the use of 90 kg K/ha but this was also not significantly different from the control and the applications of 45 and 180 kg K/ha.

The highest number of tillers obtained at eight weeks after planting was with the application of 180 kg N/ha but this was not significantly different from the applications of 45 and 135 kg N/ha (Table 2). The lowest number of tillers at eight weeks after planting resulted from the control. At 12 WAP a significantly higher number of tillers was obtained with the use of 180 kg N/ha when compared with other treatments while a significantly lower number of tillers resulted from the control. Application of 180 kg N/ha gave the highest number of tillers. A significantly lower number of tillers at 16 WAP resulted from the control compared with other treatments. At 20 WAP, a significantly higher number of tillers was observed with the application of 180 kg N/ha when compared with other treatments except 135 kg N/ha while a significantly lower number of tillers was obtained with the control.

With potassium application, the highest number of tillers at 8 and 12 WAP resulted from the application of 135 kg K/ha but this was not significantly different from the control and the applications of 45 and 180 kg K/ha. The lowest number of tillers at 8 and 12 WAP resulted from the application of 90 kg K/ha. The number of tillers with potassium application at 16 and 20 WAP were not significantly different.

The highest biomass yield resulted from the application of 180 kg N/ha but this was not significantly different from the application of 135 kg N/ha (Table 3). A significantly lower biomass yield resulted from the control but this was not significantly different from the application of 45 kg N/ha. In terms of K application, the biomass yields were not significantly different from each other with the applications of 45, 90, 135 and 180 kg K/ha, but application of 180 kg K was significantly better than the control.

The rhizome yields obtained with the applications of 45, 90, 135 and 180 kg N/ha were not significantly different from each other while a significantly lower rhizome yield compared with other application rates was obtained with the control (Table 3). A significantly higher rhizome yield was obtained when 180 kg K/ha fertilizer was applied compared with other application rates but this was not significantly different from the application of 135 kg K/ha while the application of 45 kg K/ha gave a significantly lower rhizome yield but was not significantly different from the control and the application of 90 kg K/ha. Significant interaction ($p<0.05$) existed with the combine application of N and K on the parameters examined

DISCUSSION

Application of 180 kg N/ha to the turmeric plant gave the best vegetative growth although it is not different with the application of 135 kg N/ha, this corroborates the findings of Haque *et al*. (2007), where they noted a better performance in the vegetative growth and rhizome yield of ginger with the application of N up to 180 kg/ha. Pawar and Gavande (1992) also observed the best vegetative and rhizome yield of ginger with 160 kg N/ha. The highest shoot biomass and rhizome yield was obtained when 135 kg N/ha was applied, although they were similar with the application of 180 kg N/ha. Tisdale *et al*. (1995), noted that N responses varies with soil type, plant varieties, duration of the growing season, type of fertilisers, time and method of application, moisture supply and nutrient interaction. The response of Turmeric to N fertiliser application resulted in an increase in dry matter production and yield. This however was in contrast to the findings of Gill *et al*. (1999), where they noted that N levels have no significant effect on the performance of turmeric.

It was observed that K significantly influenced the vegetative growth and yield of Turmeric. This was in agreement with the findings of Banafar and Tiwari (1995), who stated that plant height, number of leaves, number of tillers and rhizome yield increased due to an increase in the rate of K application. Razzaque and Mohamed (2001) however, reported that vegetative growth responses to K fertiliser were not significant. Behura (2001) noted that K alone cannot increase vegetative growth in Turmeric.

The significant interaction between N and K enhanced the vegetative and yield parameters of turmeric, this is in agreement with Akamine *et al*. (2007), where they observed that N in combination with K enhanced the growth of Turmeric than either N or K alone.

CONCLUSION

The study showed that interaction of N and K enhances the growth, biomass and rhizome yield of turmeric. The N enhances the growth and biomass yield of the plant while, the K enhances the rhizome yield.

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Table 1: Nitrogen and Potassium Application Effects on the Plant height and Number of Leaves of Turmeric at Different Weeks after Planting

	Plant height (cm) Weeks after planting				Number of leaves Weeks after planting			
Treatments	8	12	16	20	8	12	16	20
Nitrogen (kg/ha)								
0	23.25	26.17	30.62	32.98	5.40	6.43	9.07	12.80
45	28.30	30.39	34.18	37.87	6.63	7.40	11.33	16.77
90	25.73	27.88	33.49	36.56	6.03	7.10	11.30	16.27
135	26.49	28.743	34.29	38.74	6.67	7.40	12.10	18.37
180	27.92	30.18	37.11	40.67	7.20	8.23	13.50	19.13
$LSD_{0.05}$	3.73	3.39	3.14	3.02	0.89	1.00	1.64	2.33
Potassium (kg/ha)								
0	26.56	28.353	32.71	35.75	6.53	7.43	11.87	16.83
45	26.21	28.503	33.94	36.53	6.13	6.93	10.87	16.47
90	25.26	27.557	33.07	36.96	5.90	6.77	10.37	15.03
135	26.65	28.857	33.88	37.62	7.00	8.03	12.30	17.67
180	27.01	30.097	36.08	39.96	6.37	7.40	11.90	17.33
$LSD_{0.05}$	NS	NS	3.14	3.02	0.89	1.00	1.64	2.33
N × K	*	*	**	**	***	**	***	***

Table 2: Nitrogen and Potassium Application Effects on the Number of Tillers of Turmeric at Different Weeks after Planting

	Weeks after Planting			
Treatments	8	12	16	20
Nitrogen (kg/ha)				
0	0.03	0.03	0.43	1.50
45	0.10	0.13	1.13	2.00
90	0.07	0.13	1.07	2.17
135	0.13	0.13	1.13	2.50
180	0.23	0.33	1.33	2.67
LSD $_{0.05}$	0.16	0.16	0.48	0.47
Potassium (kg/ha)				
0	0.13	0.17	1.17	2.23
45	0.07	0.13	0.97	2.17
90	0.03	0.03	0.83	1.90
135	0.20	0.27	1.13	2.27
180	0.13	0.17	1.00	2.27
LSD $_{0.05}$	0.16	0.16	NS	NS
N × K	**	**	*	*

Table 3: Effect of Nitrogen and Potassium on the Biomass and Rhizome Yield of Turmeric

Nutrient Level	Biomass yield	Rhizome yield
(Kg/ha)	g/plant	
Nitrogen		
0	3.19	21.73
45	4.12	31.47
90	5.18	31.60
135	5.74	34.93
180	6.33	36.20
LSD	1.06	7.03
Potassium		
0	4.27	28.47
45	4.69	24.93
90	5.00	28.93
135	5.15	33.33
180	5.46	40.27
LSD	1.06	7.04
N × K	***	***

ECONOMIC ANALYSIS OF TURMERIC (*Curcuma longa.* L) PRODUCTION AMONG WOMEN FARMERS IN JABA LOCAL GOVERNMENT AREA OF KADUNA STATE

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ABSTRACT
This study focused on economic analysis of turmeric production among women farmers in Jaba Local Government Area of Kaduna State. Multistage sampling was used to select 20 women from each village making a total number of hundred (100) women that was used for the study. Primary data was used through the use of well-structured questionnaire. Descriptive statistics and gross margin analysis were used to analyse the data. The results shows that (76%) of the women turmeric farmers are between the age range of 21-40years of age, the majority of the farmers (74%) are married. Majority (42%) had secondary education and the rest had one form of formal education or the other. Majority (97%) had farm size ranged from 1-3. Majority of the farmers 74.4 % uses personal capital in turmeric production. Majority of the farmers (58%) indicated that their major problem is inadequate credit. The study recommends the presence of extension agents is need and agricultural loan facilities should be made accessible to turmeric women producers to ensure timely and adequate utilization of agricultural inputs, Government should provide grants and other facilities needed by the women and credit facilities from the study carried out has been a problem confronting them a relief and solution to this from government will encourage women farmers to continue in the production of turmeric.
Keywords: *turmeric, women, farming, kaduna state, economic analysis*

INTRODUCTION

Turmeric (*Curcuma Longa L*) is a herbaceous plant, believed to originate from South Asia and is grown for its rhizome that contains essential oil responsible for flavor and preservative quality. Turmeric is essentially a tropical crop and a perennial monocotyledonous herb belonging to the family *Zingiberaceae* (Sigrist *et al*, 2011; Jilani *et al*, 2012). Turmeric the golden specie is widely cultivated in different countries such as Nigeria, India, China, Sri-Lanka, Taiwan and Pakistan. It is a cross pollinated, triploid species which can be vegetatively propagated using its underground rhizomes (Sasikumar, 2005). Olojede and Nwokocha (2011) reported that in Nigeria, turmeric can be found growing from low attitude (5m above sea level) in the southern coastal plains from the rainforest to the mid latitude 4°37'N - 10°04'N. The yellow colour of turmeric is due to presence of crystalline substance known as curcumin. It is an important commercial spice crop grown in Nigeria and it considered the best in the World due to the presence of high curcumin content. Turmeric rhizome are rich in aromatic oil called tumerol, which finds its use in food and pharmaceutical industries. Turmeric is prescribed for the treatment of many medical problems ranging from constipation to skin diseases. It is used as a digestive aid and treatment for fever, inflammation, wounds infection, dysentery, arthritis, injuries, trauma, jaundice and other liver problems. Turmeric is also used as a dye in textile industries, in cosmetics, preparation of medical oil and ointment.

Turmeric affectionately called "KITCHEN QUEEN", the main spice of kitchen (Lal, 2012). In Nigeria, turmeric is cultivated mostly on subsistent bases in about 19 states and given different local names depending on the area. It is called *atale pupa in Yoruba 'gangamau in* hausa,; nwandumo in Ebonyi; *ohu boboch* in Enugu (Nkanu East); *gigir* in Tiv; *magina* in Kaduna; *turi* in Niger State; *onjonigho* in Cross River (Meo tribe). In Nigeria, women play roles in both family and household activities besides farming activities. They are the household managers but their work is considered as non- productive, unorganized, and undocumented. Hence, development assistance has failed to reach women in the rural areas both in absolute and relative terms compared to men for two reasons: Agricultural development programs were traditionally focused on men as producers and a lack of knowledge or false assumption about the role of women in agriculture. The level of women participation in decisions making process not only varies from region to region. Male dominance in decisions making in the household and economy has continued even in areas women are the key provider of labour because the influence of women has not been recognized due to lack of education, less awareness of their civil/ human rights, traditional norms and lack of credit facilities from the government. Nigeria is the fourth largest producer of turmeric with about 3 percent of the global annual production, and also according to the Federal Ministry of Agriculture and rural development women account for 75 percent of the farming activities.

With the present challenges facing the production of turmeric in Kaduna State, turmeric happens to be one of the most economic and efficiently utilized crop for generating income. Turmeric production is one of the major activities carried by women in Jaba Local Government Area of Kaduna State. Rural women play a key role towards turmeric production activities, despite these immense achievements, women are not given attention in production which can serve as means of generating income and livelihood activities, they are faced with gender bias encountered when compared with their male counterpart in the study area. Also, in the study area based on the importance of turmeric and the role women play in agricultural production. A study of this nature has not been carried out in the study area, in view of this, this study brought about the following objectives.

Objectives of the Study

The objectives were to describe the socio-economic characteristics of the women involve in turmeric production in Jaba Local Government Area, determine the costs and returns of turmeric production in the study area and identify the constraints militating against turmeric production in the study area.

METHODOLOGY

The Study Area The study was conducted in Jaba Local Government Area. It lies between latitude 90°N and longitude 8°E. The Local Government Area shares boundaries with Zango Kataf Local Government Area in the North, in the East by Jama'a Local Government Area, in the West by Kachia Local Government Area and in the South by Kagarko and Nasarawa State. The population of Kaduna State is 6,066,562 people according to 2006 census and the population of Jaba is 61,000 people according to Nation population Commission (NPC 2006) census. The Local Government Area is marked with distinct dry and wet seasons. The dry season is between November to March while wet season falls between April to October. The major occupation of the inhabitants of the Local Government Area is farming. Majority of the farmers practice small scale agriculture and other occupation which includes fishing, hunting, weaving, trading and many others etc. Crops grown in the area includes; turmeric, sorghum, millet, maize, rice, cocoyam, groundnut, acha, beans, ginger, cassava, soya beans, sweet potatoes, beni-seed and sugar-cane. During the dry season, farmers in Jaba Local Government Area are involved in the production of vegetables such as cabbage, spinach, tomatoes and pepper.

Sampling Technique

Multi-stage sampling was used for selection of respondents for the study. In the first stage five (5) district (Kwoi, Chori, Samban daji, Samban gida and Nok) were purposively selected out of the 21 districts because of the high production of turmeric. In the second stage one village each was further selected from each district making a total of five (5) villages. Simple random sampling was used to select 20 women farmers from each of these villages making a total number of hundred (100) women that was used for the study. But 94 questionnaires were retrieved which was the number of respondents used for the study.

Data Collection:

Primary data were collected by the use of structured questionnaire administered to the respondents.

Descriptive statistics

Descriptive statistics such as frequency distribution, percentages were employed.

Gross margin analysis

This was used to analyzed costs and returns of turmeric production in the study area Gross margin analysis was used because the respondents in the study area were subsistence farmers with negligible fixed capital cost, according to Olukosi and Isitor (1990). Stated that fixed capital for subsistence farming enterprise is always negligible.

This is expressed as follows:-

GM= TR-TVC Where: GM. = Gross Margin, TR= Total Revenue {output (kg) multiply by price (₦)} and TVC = Total variable cost

RESULTS AND DISCUSSION

Socio Economic Characteristics of the Respondents in the Study Area

Table 1 below shows 43.3% of the respondents were between 31-40 years. This shows that the women that farm turmeric in the study area are in their youthful ages. This result is in line with the finding of Taru *et al* (2008), this shows that, the eligibility of one's performance in certain activities or role including agricultural activities is determined by the age. This means that youth are more in turmeric production activities. Table 1 shows that majority of the respondents are married which makes a percentage of 70.1%. This implies that majority of the women in turmeric production in the study area are married. This result justified the high premium Nigerian society placed on marriage (Maisamari, 2008) and also (Asabe, 2005) deducted that the reason why married people had the highest respondents while the singles are only busy on how to migrate from rural to urban area and married are busy booking and securing for income to sponsor their children to schools medical bills, feeding and their shelter. The Table also shows attended tertiary institutions. This shows that the women in turmeric production in the study area are learned. Ogungbile *et al* (2003) and Njoku (2012) observe that one of the incentives of innovation adoption is high literacy rate and attainment of tertiary education. From this study it was observed that the respondents have varying sizes in relation to availability of farm land ranging from 1-8 hectares. Table 1 shows that 89.08% cultivates land between 1-3 hectares. Majority of the women turmeric farmers have small farm holding and are therefore small scale farmers. Furthermore, the table below shows the distribution of farmers by sources of capital 79.4% of the respondents use their personal savings as source of capital. Capital is an important factor of production and the respondents source their capital for their turmeric production from their personal savings.

Table 1: Frequency distribution of the women farmers based on their ages

Characteristics	Frequency N=100	Percentages
Age		
21-30	28	28.0
31-40	48	48.0
41-50	22	22.0
51- 60	2	2.0
Marital Status		
Married	74	74.0
Single	21	21.0
Divorced	2	2.0
Widowed	2	2.0
Separated	1	1.0
Education		
No formal education	7	7.0
Primary education	23	23.0
Secondary education	42	42.0
Tertiary education	27	27.0
Farm size		
1-3	97	97.0
4-6	2	2.0

7-9	1	1.0
Source of Capital		
Personal saving	83	83.0
Family	13	13.0
Cooperative society	4	4.0

Cost and Returns

The gross margin per hectare represents the difference between gross revenue and total variable cost per hectare. The gross return was ₦165,906.92. Table 2 shows that the variable cost of turmeric production among the women in the study area, seed ₦20,440, NPK ₦43,023.94, pesticides ₦820.85, labour ₦20,000 and total variable cost was ₦95,105 rent on land ₦11,125 and total cost of ₦106,230. The net farm income was ₦59,676.92. The operating ratio was 0.295. Further analysis showed that on every naira invested in turmeric production by women ₦0.63 was realized. Meaning that on every one naira invested there was a profit of 0.63 kobo. This shows that farming turmeric among the women farmers in Jaba Local Government Area was economically viable and profitable.

Table 2: Profitability Analysis

Items	Value (₦)
Gross return	165,906.92
Variable Cost	
Seed (₦)	20,440
Fertilizer(₦)	43,023.94
Pesticides (₦)	820.85
Labour	20,000
Total Variable Cost	95,105
Fixed Cost	
Rent on land	11,125.0
Total Cost (TFC+TVC)	106,230
Net Farm Income (GR-TC)	59,676.92
Operating ratio (TVC÷GR)	0.57
Return per capital invested NFI÷ TVC	0.63

Constraints encountered by the women farmers in turmeric production

The table below gives the constraints faced by the women farmers in the study area. The major constraints encountered by the women in turmeric production is inadequate credit with 53.5% the respondents have inadequate access to credit which causes production in their production because of lack of access to loans and funds to encourage as increase their production, 29.9% of the respondents faced season problem due to price fluctuations, 8.46% faced pest and disease problem and 3.76% of the respondents have the problem of poor transportation.

Table 3: Percentage distribution of respondents by constraints they encountered in Jaba Local Government Area

Constraints	Frequency	Percentage
Pest and disease	9	9.0
Poor transportation	4	4.0
Inadequate credit	58	58.0
Seasonal problem	29	29.0
Total	100	100

CONCLUSION

Based on the findings of this study, it could be concluded that turmeric is an important food crop in Nigeria, any attempt to increase its productivity would be a right step towards the resolution of food crisis; jobs can be directly created from enhanced turmeric production. Apart from ensuring food security and improving women participation in turmeric, increased turmeric production will provide more employment opportunities for the unemployed citizens in the study area.

RECOMMENDATIONS

The presence of extension agents is needed, because from the research carried out it showed that the Jaba women are blessed with the natural resources (turmeric) but have not exploited it much, also skills and knowledge which will be extremely important to their turmeric farming will be enhanced, Majority of the women farmers finance their production through personal savings which is mostly not adequate for appreciable production. Government should provide grants and other facilities needed by the women, this will give them sense of belonging and it will encourage their level of participation the more in turmeric farming and Credit facilities from the study carried out has been a problem confronting them a relief and solution to this from government will encourage women farmers to continue in the production of tumeric.

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PROFITABILITY OF CITRUS PLANTING MATERIAL PRODUCTION AMONG PRIVATE NURSERY OPERATORS IN BENUE STATE, NIGERIA

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ABSTRACT
The study was carried out to determine the profitability of citrus planting material production among private nursery operators in Benue state, Nigeria. Responses were obtained from 60 citrus nursery operators through a multi-stage sampling technique. Data such as socio-economic features of the nursery operators, quantities and prices of inputs and outputs were obtained. Data were analyzed using simple descriptive statistics and gross margin analysis. The result of the study revealed that majority of the respondent are male (95%),(50.0%) of the respondents were within the age bracket of 41-50,(76.7%) are married,(36.7%) of them had secondary school education with household size of 6-10 (58.3%), (81.7%) had no access to credit they finance their operation from personal savings and had between 6-10 years experience (58.3%), while (65.0%) rented land for their operation. Budgetary analysis result showed that gross margin, net returns and returns on investment accrued to the nursery operators were ₦886,000.00, ₦ 815,440.00 and 2.70 indicating that citrus planting material production was a profitable business in the study area. It is recommended that government should assist the operators with appropriate incentives to boost production that will increase income generation while also encouraging them to form cooperative so that they can gain from the use of pooled resources and finances in cooperatives.
Keywords: *Citrus, nursery, gross margin, return on investment.*

INTRODUCTION

Citrus Spp was introduce to Nigeria in the colonial era and has become a major fruit crop planted in the country. The commonly grown citrus species belong to the family Rutaceae (Iroabuchi *et al.,2022).* Basically, two major rootstocks are used in Nigeria. They are Cleopatra Mandarin in the south and Rough Lemon in the north. This is due to genetic resistance to soil borne diseases, rootstock/bud wood compatibility and weather hazards (Afolayan, 2016). In the early twentieth century, the multiplication of citrus was made by seeds, originating non-grafted plants, with many thorns and beginning of delayed production due to the long period of juvenility of plants obtained by this method. The production of grafted plants enabled the size reduction plants, few thorns and early production. In addition to these advantages, the grafting/budding enabled the production of clones, genetically identical plants, better adaptation to different environments and production systems and disease tolerance, through the proper selection of the rootstock, which attracted the interest of growers. For these reasons, vegetative propagation, by bud/ grafting of scion varieties of commercial interest in selected rootstocks, was established as the main method of commercial multiplication of citrus plants in the world (Horst *et al.,* 2016).

The establishment of an orchard is a long-time venture and mistakes committed at the initial stages for orchard establishment are very difficult to correct at later phases as they cause an unbearable loss to the growers. Therefore, production of substandard planting material plays a limiting role in the growth of fruit industry. Orchards established from inferior planting material are responsible for the poor income to farmers. Complications like low fruit production, severe fruit drop, poor fruit quality and reduced productive life span of plants are also associated with the superiority of the available planting material.

Consequently, production of healthy nursery plants must be ensured for prosperous future (Tanjeet et al.,2019).

Nurseries have the common goal of producing plant material for improving sites. They are established to produce seedlings, grown under favorable conditions at germination and early growth stage before transplanting to the field for planting purpose. Plant nurseries can be an informal, small- scaled arrangement or a large commercial enterprise that vary in size, facilities (supplies, tools, equipment, etc.), types of seedlings produced, and operations (Larinde and Ruth, 2014).

A number of available literatures had only dealt with studies of nursery establishment with primary focus on its environmental protection benefits, conservation and sustainability of landscaping and urban forestry around the residential areas (Ortese *et. al.,* 2012; Iroabuchi, *et. al.,* 2022). All these studies failed to provide necessary awareness and sensitization for people in seeing the prospects and hidden opportunities in the enterprise. Such revelation is necessary to relieve the pressure on the government to provide jobs to the teeming unemployed individuals through awareness creation on how people could become self-employed in the enterprise, reduction in poverty gap and reducing rural-urban drift.

Objectives of the Study

The general objective is to analyze the profitability of private citrus nursery operation in Benue State, Nigeria. The specific objectives are to:

1. describe the socio – economic features of private citrus nursery operators in the study area
2. estimate the cost and return of private citrus nursery production

MATERIALS AND METHODS

The study was carried out in Benue state, Nigeria. Benue State is delineated into three agricultural zones, namely; Northern zone (A), Eastern zone (B) and Central zone (C). The state comprises (23) local government areas with Makurdi as the state capital. It is located between longitude 7° 47' and 10° 0' East and latitude 6° 25' and 8° 8' North. It shares boundaries with five other states namely; Nasarawa state to the north, Taraba state to the east, Cross-River state to the south, Enugu state to the south-west and Kogi state to the west. The state also shares a common boundary with the Republic of Cameroon on the south-east. Benue state occupies a landmass of 34,059 square kilometers. Benue State has an estimated population of 5,741,815 million persons (NBS, 2016).The state enjoys a tropical climate which manifests into two distinct seasons. The rainy season is from April to October with total annual amount ranging between 1120 – 1500mm, while the dry season is from November to March. Temperatures are constantly high averaging between 28° – 32°C. Physiographically, the land is level and made up mainly of undulating plains at elevations ranging from 150m to 300m above sea level. The major crops grown here include, rice, yam, cassava, groundnut, millet, soybeans, maize, citrus, mango, sorghum, sweet potatoes, cocoyam, guava, oil palm, tomatoes, cowpea, cashew and okra. Small ruminants such as goat, sheep, and non-ruminants such as swine, rabbits and poultry are also reared in the state.

Sampling technique and data collection

Multistage sampling technique was employed in the selection of citrus nursery operators in the study area. The first stage involved the purposive selection of Gboko, Ushongo and Vandekeiya LGAs, because of their contribution to citrus production in the state. Second stage also used purposive selection of one major urban town in each of the selected LGAs due to the fact that plant nursery businesses were usually concentrated in urban areas. The final stage was the random selection of twenty citrus nursery operators in each LGA, resulting into a total of 60 respondents. The data for the study were collected with the aid of a well structured questionnaire.

Data analysis

Descriptive and inferential statistics such as frequency, percentage and gross margin analysis were used for data analysis. The Gross Margin model was specified from the point of view of estimation of total expenses (costs) as well as various returns or revenue within the production period. Gross margin (GM) analysis according to Olukosi and Erhabor (2005), gross margin (GM) analysis is the difference between gross income (revenue) and total variable cost (TVC) of production. This was used to determine the costs, returns as well as profitability of citrus nursery operation.

GM = TR-TVC,

where: GM = Gross margin, TR = Total revenue, TVC = Total variable cost.

The net return represents the total profit and was determined using:

Net return (profit) = TR-TC,

where: TR = Total revenue, TC = Total cost and

Rate of return to investment (ROI) = GM/TC. The variable cost comprises of cost of inputs such as planting materials, fertilizers, labour, pesticides, watering can among others, while fixed cost comprises of land rent and depreciation on fixed inputs.

RESULT AND DISCUSSION

The socio-economic characteristics of the citrus nursery operators presented in Table 1 showed that the nursery operators were mostly male as 95.0% of them were male. The mean age in the study area was 45.5years. About 76.7% of the nursery operators are married. About 36.7% of nursery operators had attained secondary education. About 58.3% of the nursery operators had between 6-10 persons in their household. About 81.7% of the nursery operators used their personal savings to fund their operation. About 58.3% of the nursery operators had between 6-10 years of experience with mean year of experience of 8 years. About 33.3% and 65.0% of the nursery operators acquired their nursery plots through inheritance and rent respectively.

As indicated in the results the citrus nursery operation is dominated by male who could supply the high physical labor requirement involved in nursery operation, also the enterprise is dominated by individuals in their productive age. This finding is similar to that of Fakayode *et. al.* (2008). Majority of the farmers are married which is an indication that they are responsible. High educational level indicated that attainment of formal education in different degrees of education would enhance the ability of the respondent to easily understand technical operation involve in nurseries production. Equally, large household size has positive indication that most of the farm hands (labor force) can be sourced within the household thus reducing cost of hiring labor for their operations as consistent with the findings of Larinde & Santus (2014). Majority of them use personal savings which is often meager to establish a large scale citrus nursery business because of the huge capital requirement involved. The years of experience is also a good signal that more experienced operators could predict the future outcome of production with some probability by considering performance of past years as argued by Enesi *et. al.* (2016). Most of the operators use rented land which affects the total cost of operation.

In Table 2, it was indicated that the total variable cost was ₦258,000 comprising the cost of rough lemon fruits purchased, cost of polybags, cost of fertilizer, cost of pesticides, cost of labor used, budding tape and cost of bud wood used for budding. The fixed cost was ₦70,560.00 comprising of transportation cost, depreciation cost on fixed assets and annual rent on land used for production. The total cost was ₦ 328,560.00. The total revenue from the sales of citrus seedlings was ₦ 1,144,000.00 and this implies that gross margin of the ventures was ₦886,000.00 and net return (profit) was ₦815,440.00 which is a good indication of profitability of the nursery operation and rate of return on investment was 2.70 showed that an average nursery operator earned ₦2.70 per ₦1invested in the business. These results implied that the production of citrus planting material among private nursery operators is a profitable business in the study area and should be encouraged.

CONCLUSION

Citrus nursery operation is dominated by middle - aged, educated, experienced with moderate household size. Majority of them rented the nursery plots they used and finance their enterprise with personal savings. The citrus nursery operation was profitable with high return on investment. Necessary provision and assistance should be given by the government to the nursery operators in the State. Such supports include provision of soft loans at reduced interest rate to help the nursery operators to acquire necessary equipment in their operations. Nursery operators should mobilize themselves into viable cooperatives so that they can gain from the use of pooled resources and finances in cooperatives. More so, there is need to educate the youths and others alike as regards the gains derivable from nursery production business especially considering its profitability to reduce unemployment of youth in the study area.

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Table1: Socioeconomic Characteristics of Citrus Planting Material Producers

Variables	Frequency	Percentage(%)
Sex		
Male	57	95.0
Female	3	5.0
Age(years)		
≤30	5	8.3
31-40	19	31.67
41-5	30	50.0
51 and above	6	10.0
Marital status		
Single	14	23.3
Married	46	76.7
Educational status		
No formal education	10	16.7
Primary education	12	20.0

Secondary education	22	36.7
Tertiary education	16	26.7
Household size		
≤5	15	25.0
6-10	37	61.7
11 and above	8	13.3
Source of capital		
Personal savings	49	81.7
Friends/relation	8	13.3
Cooperatives	3	5.0
Farming experience(years)		
≤5	18	30.0
6-10	35	58.3
11and above	7	11.7
Source of land		
Inheritances	20	33.3
Rent	33	55.0
Lease	7	11.7

Source: field data analysis, 2023

Table 2: Costs and Return of Small Scale Citrus Planting Material Producers

Items	Quantity	Unit price (₦)	Value in naira (₦)
Rough lemon fruit	500 fruits	50per fruit	25,000.00
Polybag	3,000	20	60,000.00
Fertilizer	1 bag	15,000.00	15,000.00
Pesticide	4 sachet	2,000.00	8,000.00
Labour	4 for 12months	2,500	120,000.00
Bud wood	500	50	25,000.00
Bud tape	1kg	5,000.00	5,000.00
Total variable cost			258,000.00
Transportation			50,000.00
Total depreciation on fixed asset			15,560.00
Annual rent on nursery plot			5,000.00
Total fixed cost			70,560.00
Total cost			328,560.00
Sweet Orange	2200	400	880,000.00
Tangerine	500	400	200,000.00
Lemon	60	400	24,000.00
Grape	50	400	20,000.00
Lime	50	400	20,000.00
Total revenue			1,144,000.00
Gross margin =TR-TVC			886,000.00
Net Return (profit) =TR-TC			815,440.00
Return per ₦1 invested=GM/TC			2.70

Source: field data analysis, 2023

VITAMINS AND MINERALS COMPOSITION OF SOME VEGETABLES CONSUMED IN NIGERIA

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ABSTRACT
Vitamin and mineral composition of some vegetables consumed in Nigeria; Telfaria occidentalis, Amaranthus hybridus, Solanum macrocarpon, Talinum fruticusum, Launaea taraxacifolia, Vernonia amygdalina, Cucurbita pepo, Senecio biafrae, Basela alba, Ocimum gratissimum were investigated. The β-carotene content of the samples ranged from 37.52 to 10.29 mg/100g FW, Tocopherol ranged from 4.15 to 0.74 mg/100g FW, and Vitamin C content ranged from 50.30 to 4.19 mg/100g FW. Mineral analysis showed that Solanum macrocarpon contains highest amount of calcium (762.33 mg/100g DW), Telfaria occidentalis contains highest magnesium and zinc (388.23, 34.90 mg/100g DW) respectively while Senecio biafrae contains highest amount of iron (2.80 mg/100g DW). Nigerian vegetables are a rich source of nutrient most especially Telfaria occidentalis (Ugwu) examined in this study which is more nutrient dense than the other vegetable samples.
Keywords: *Vegetables, Vitamins, Minerals.*

INTRODUCTION

Vegetables are defined as consumable parts of herbaceous plants; either wholly or in parts, raw or processed, or as portion of main dish or salad. They may be bitter, sweet, or tasteless [1]. They contain low levels of fat and high levels of vitamins, minerals and fibers [2]. Vegetables have also been described to be good sources of nutrients such as carotene and protein with appreciable amount of trace minerals [3]. George et al., [4] reported that available proteins in vegetables are higher than those in fruits but lower than those in grains. Recently, there has been increasing demand in the consumption of fresh vegetables mainly for their health benefits [5]. Dietary antioxidants such as vitamins E and C, carotenoids and polyphenolic compounds found in vegetables are reported to be effective nutrients in the prevention of some oxidative and degenerative diseases [6]. Aside serving as a source of micronutrient, vegetables are a rich source of carotenoids such as β-carotene, zeaxanthin, lutein, lycopene [7]. The potassium content of vegetables are also very important in the management of diuretic and hypertensive difficulties. In countries like Nigeria, where the daily meals are mostly carbohydrate foods, aside spicing up meals with vegetables they are an inexpensive and most readily available source of vital nutrients such as proteins, vitamins, minerals and essential amino acid [8]. The levels of these vitamins and minerals in leaves however vary from one plant to another and from one location to another. This study therefore aimed at examining the level of vitamin and mineral in some vegetables consumed in Nigeria.

MATERIALS AND METHOD

Vegetables were harvested from National Horticultural Research Institute Ibadan environment. Some of the green leafy vegetables were rinsed in water and the edible portions were separated from the inedible portion. Fresh leaves were then analysed for beta-carotene, tocopherol and vitamin C. The other fresh leaves were further oven dried at 60^0C for 24h and milled using a blender before packing in polyethylene bags for mineral analysis.

Determination of vitamins

The extraction and determination of vitamin A and E were according to the method described by Okonwu et al. [9], [10] while vitamin C was determined using titrimetric method [11].

Determination of minerals

The mineral contents (Ca, Mg, Zn, and Fe) of the leave samples were determined using Atomic

Absorption Spectrophotometer (AAS).

Statistical analysis

Data from this research (n=3) were subjected to one-way analysis of variance at 95% confidence interval.

RESULTS AND DISCUSSION

As presented in Table 1, *significant* difference was observed in Beta-carotene, Tocopherol and Vitamin C content among the leafy vegetables. *Telfaria occidentalis* and *Solanum macrocarpon* gave highest value for beta-carotene and tocopherol respectively; these qualifies them as a good source of antioxidant needed by the body to prevent free radicals activities. β-carotene is the most common form of carotene in plants and it is the best known provitamin A carotenoid [12]. β-carotene values obtained in this study are higher when compared with values presented by Viviane et al on fresh weight basis. This increase in value can be as a result of difference in species, location, degree of maturity at harvest, cultivation, and postharvest handling practices [13]. However, Viviane et al., [14] reported lower β-carotene values for *Talinum fruticusum* (12.52)*, Vernonia amygdalina* (13.16)*, Cucurbita pepo* (12.25)*, Amaranthus hybridus* (11.15) mg/100g DW after sundrying the leaves for about 24h. This confirms the report of Gomez [15] that drying conditions results in a decrease in concentration of carotenoids in some vegetables when compared with the unprocessed samples. Sundrying process causes photooxidation of both trans- and cis carotenoids thereby resulting into epoxidation and cleavage to apocarotenals before dividing into sets of low mass compounds thus losing their biological activities. This means certain percentage of β-carotene has been lost during drying due to photooxidation. Vitamin C value for *Telfaria occidentalis* (50.30 mg/100g) was significantly different from other leave samples and this was followed by *Cucurbita pepo* (48.62 mg/100g) while Launaea taraxacifolia (4.19 mg/100g) gave the lowest value. These vitamin C values were lower when compared with values obtained by Oboh et al., [16] for both fresh and sundried leave samples of *Telfairia occidentalis*, *Solanum macrocarpon, Occimum graticinum* and *Vernonia amygdalina*. These lower values may be attributed to difference in leave treatment before analysis.

Table 1: Beta-carotene, Tocopherol and Vitamin C content of the vegetables

Vegetables Local name	Scientific names	Beta-carotene mg/100g (Fw)	Tocopherol mg/100g (Fw)	Vitamin C mg/100g (Fw)
Ugwu	*Telfaria occidentalis*	37.52^{a}	0.74^{g}	50.30^{a}
Tete	*Amaranthus hybridus*	26.48^{c}	1.03^{ef}	24.82^{d}
Water leaves	*Talinum fruticusum*	13.71^{g}	1.10^{ef}	10.53^{f}
Yanrin/wild lettuce	*Launaea taraxacifolia*	15.18^{g}	1.84^{d}	4.19^{g}
Bitter leaves	*Vernonia amygdalina*	18.71^{e}	2.63^{b}	42.17^{c}
Elegede/Pumpkin	*Cucurbita pepo*	24.50^{d}	0.94^{f}	48.62^{b}
Worowo	*Senecio biafrae*	17.50^{f}	2.11^{c}	10.61^{f}
Indian spinach	*Basela alba*	10.29^{h}	1.97^{cd}	24.02^{d}
Igba leaves	*Solanum macrocarpon*	34.80^{b}	4.15^{a}	4.46^{g}
Scent leaves	*Ocimum gratissimum*	20.47^{e}	1.13^{e}	19.83^{e}

Table 2: Mineral contents of the vegetables under studied

Local names	Scientific names	Calcium mg/100g (dw)	Magnesium mg/100g (dw)	Zinc mg/100g (dw)	Iron mg/100g (dw)
Ugwu	*Telfaria occidentalis*	63.66^{f}	388.23^{a}	34.90^{a}	2.45^{b}
Tete	*Amaranthus hybridus*	75.32^{e}	255.81^{b}	3.68^{d}	2.12^{c}
Water leaves	*Talinum fruticusum*	48.00^{g}	205.20^{c}	3.40^{d}	1.09^{e}
Yanrin/wild lettuce	*Launaea taraxacifolia*	433.67^{c}	102.00^{e}	4.60^{c}	0.50^{g}
Bitter leaves	*Vernonia amygdalina*	460.33^{b}	112.00^{d}	0.66^{f}	0.97^{f}
Elegede/Pumpkin	*Cucurbita pepo*	18.88^{h}	12.00^{i}	0.92^{f}	1.31^{e}
Worowo	*Senecio biafrae*	61.00^{f}	13.23^{i}	2.20^{e}	2.80^{a}

Indian spinach	*Basela alba*	197.00^{d}	27.11$_{h}$	3.48^{d}	0.38^{h}
Igba leaves	*Solanum macrocarpon*	762.33^{a}	35.33^{g}	5.80^{b}	1.54^{d}
Scent leeavs	*Ocimum gratissimum*	45.00^{g}	81.03^{f}	0.87^{f}	0.03^{i}

Minerals are important in human nutrition. It is well known that enzymatic activities as well as electrolyte balance of the blood fluid are related to adequacy of Na, K, Mg and Zn. As presented in Table 2, all the values were significantly different for calcium with Solanum macrocarpon having the highest value 762.33mg/100g and Cucurbita pepo having the lowest value 18.88mg/100g. Calcium functions in bone and teeth formation, it also regulates nerve and muscle function [17]. This value was higher when compared with value obtained by Achikanu et al., [18] for Solanum macrocarpon 712.33mg/100ml. For magnesium, values ranged from 12.00 to 388.23mg/100g, being highest in *Telfaria occidentalis* and lowest in *Cucurbita pepo.* Iron content ranged from 0.03 to 2.80mg/100g with *Senecio biafrae* having the highest and *Ocimum gratissimum* having the lowest value.

CONCLUSION

Data from this study shows that vegetables such as *Telfaria occidentalis*, *Solanum macrocarpon*, *Vernonia amygdalina*, and *Senecio biafrae* contain appreciable amount of minerals and vitamins. Thus, it can be concluded that these vegetables can contribute significantly to the nutrient requirements of man and they should be used as a source of nutritional supplement.

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PROXIMATE AND PHYTOCHEMICAL COMPOSITIONS OF *Cola acuminata* AND *Cola nitida* FRUIT TESTAS

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ABSTRACT
Proximate and phytochemical compositions of testas of Cola acuminata and Cola nitida fruits were determined using standard laboratory procedures. The testas were shade-dried at room temperature, grounded to powder which was extracted with methanol. Saponins, steroids, coumarins, flavonoids, glycosides, terpenoids, tripterpenes and alkaloids were detected and quantified. Testas of C. nitida fruit had higher alkaloids content ($P < 0.05$) (0.91 ± 0.00) when compared with that of C. acuminata while other phytochemicals detected showed no significant difference ($P > 0.05$) when compared. The carbohydrate and crude protein contents of C. acuminata fruit testa (28.02 ± 0.29 and 14.72 ± 0.37 respectively) are significantly higher ($P < 0.05$) compared to that of C. nitida fruit testa (26.99 ± 0.27 and 12.13 ± 0.01 respectively). The presence of these bioactive components in relative and reasonable quantities is an indication that the testas are of medicinal and nutritional importance most especially as an anticancer and probable source of protein.
Keywords: *Phytochemicals, Proximate, Cola acuminata, Cola nitida, seed testa*

INTRODUCTION

Cola plants are native to West Africa and sub-region of Africa and it is used for several purposes among different ethnic groups such as entertainment of tribal chiefs and guests at ceremonial gatherings in Nigeria (Unya, 2021; Ogunsowo *et al.,* 2023). Traditionally used in treatment of diseases, fruits of cola plants are used to treat diseases such as asthma, whooping cough, low libido e.t.c. (Asogwa *et al.,* 2011; Ezuruike and Prieto, 2014). It is also scientifically proven to moderate activities of some key glycolytic enzymes *in-vitro* which suggests its antidiabetic claims (Oboh *et al.,* 2014). Kola is a tree crop, also referred to as a cash crop and is known to be localized to Africa, particularly Nigeria, Ghana and Ivory Coast with Nigeria as the world's largest producer (Olubamiwa *et al.,* 2011). Although, over 50 species of kola have been discovered, about seven are edible nuts out of which only two, namely: *Cola acuminata* and *Cola nitida* have been exploited commercially. According to Brickell *et al.* (2002), it was reported that the annual production from the African countries in which they are localized is estimated to be in excess of 250,000 tons. Likewise, *C. nitida* and *C. acuminata* have been of trade importance for at least a thousand year and mostly known as one of the constituents for the production of soft drinks.
Kola tree grows up to 40fts (12m) tall and there are some with excess of 75fts (25m) with small buttress root and very dense foliage, the flowers are white or cream and usually with red markings at the base and also has fleshy, irregular-shaped, pink or red and sometimes white seeds (Brickell *et al.,* 2002; Ogunsowo *et al.,* 2023). The pod of kola nut also referred to as the husk, accounts for more than half of the kola fruit and is often considered as farm waste (Olubamiwa *et al.,* 2011). The husk is mostly regarded as an agricultural waste because it has little or no economic importance or specific purpose (Adeyi, 2010) and same goes for the testa. Although, taken as a farm waste, kola nut husk and testa has been found to be rich in protein, fibre and to some extent lipids (Fabunmi *et al.,* 2019). The South Western Nigeria especially, states like Oyo, Ondo, Osun and Ekiti are the highest producers of these agricultural wastes (Asogwa, 2011). These wastes, which are also referred to as farm by-products from plants like kola, cocoa, coffee, cashew and cassava have been used in production of animal feeds (Fabunmi and Arotupin, 2015). Most of the life science researches on *Cola* plants are based on the seeds (Kola nut) because it is the part of the plant which has more economic importance. There is therefore a need to explore the economic importance

of other parts of the plant such as; the leaf, shoot, flowers and also some parts of the fruit e.g. the testa and the pod/husk which has been shown to be a very good constituent in broiler feed formulation (Olubamiwa *et al.,* 2011).

MATERIAL AND METHODS

The fruits of *C. acuminata* and *C. nitida* were obtained from a local market in Osogbo, Osun State of Nigeria. A standard high speed blender was also used to grind the dried Cola testas so as to increase the surface area for detection of bioactive ingredients.

Sample Preparation: The pods of the *Cola* fruits were opened, the seeds were removed, and then washed with distilled water to remove exudates and other unwanted particles. The seeds were soaked in water for few days after which the testas were removed and air dried at room temperature under the shade to avoid loss of bioactive components through irradiation. Dried Cola testas were then pulverized to fine powder using the high speed blender and finally extracted using methanol as solvent. The methanolic extract was dried and stored in the refrigerator for further analysis.

Determination of Moisture, Ash, Lipid, Protein and Crude Fiber Content.

These were determined by the methods according to AOAC (2005).

Qualitative and Quantitative Phytochemical Screening

The methanolic extract of the cola testas were screened for their secondary metabolites following the methods described by Odebiyi and Sofowora (1978) and Harbone (1973) respectively.

RESULTS AND DISCUSSION

Table 1: Qualitative Phytochemical Constituents of *Cola acuminata* and *Cola nitida* Fruit Testa

Parameter	*Cola acuminata*	*Cola nitida*
Saponins	+	+
Tannins	-	-
Phenolics	-	-
Steroids	+	+
Coumarins	+	+
Flavonoids	+	+
Glycosides	+	+
Terpenoids	+	+
Triterpenes	+	+
Anthocyanin	_	-
Amino Acid	-	-
Phlobatannins	-	-
Alkaloids	+	+
Fats	-	-

Key: + (present) - (absent)

Table 2: Quantitative Phytochemical Constituents of *Cola acuminata* and *Cola nitida* Fruit Testa

Parameter	*C. acuminata*	*C. nitida*
Flavonoids (mg/100g)	186.58 ± 0.29^a	185.85 ± 0.16^a
Glycosides (mg/100g)	10.82 ± 0.17^a	11.27 ± 0.01^a
Alkaloids (mg/100g)	0.74 ± 0.02^a	0.91 ± 0.00^b
Triterpenes (mg/100g)	15.36 ± 0.04^a	15.10 ± 0.05^a
Saponin (mg/100g)	1.18 ± 0.10^a	0.94 ± 0.01^a
Terpenoids (mg/100g)	9.50 ± 0.03^a	9.74 ± 0.08^a
Coumarins (mg/100g)	1.44 ± 0.05^a	1.40 ± 0.03^a
Steroids (mg/100g)	133.70 ± 0.74^a	131.13 ± 0.69^a

Values are expressed as mean of three replicates ± S.E.M and those with different superscript along column are significantly different ($P<0.05$) from each other.

Table 3: Proximate Analysis of *Cola acuminata* and *Cola nitida* Fruit Testa

Parameter	***C. acuminata***	***C. nitida***
Moisture Content (%)	12.64 ± 0.24^a	14.90 ± 0.21^b
Ash (%)	4.23 ± 0.38^a	3.70 ± 0.10^a
Carbohydrate (%)	28.02 ± 0.29^a	26.99 ± 0.27^b
Calorific Value (Kj/100g)	703.94 ± 0.91^a	701.92 ± 1.30^a
Lipid (%)	1.95 ± 0.04^a	1.21 ± 0.09^b
Crude Fibre (%)	40.26 ± 0.48^a	40.66 ± 0.02^a
Protein (%)	14.72 ± 0.37^a	12.13 ± 0.01^b

Values are expressed as mean of three replicates ± S.E.M and those with different superscript along column are significantly different ($P<0.05$) from each other.

Results from this study indicated the presence of secondary metabolites such as: flavonoids, glycosides, alkaloids, triterpenes, saponins, terpenoids, coumarins and steroids in the methanolic extracts of both *C. acuminata* and *C. nitida* seeds testas (Table 1). Alkaloids of *C. nitida* seed testa was significantly higher ($P < 0.05$) than that of *C. acuminata* seed testa with no significant difference ($P>0.05$) observed in other phytochemicals (flavonoids, glycosides, triterpenes, saponins, terpenoids, coumarins and steroids) investigated. Of all the phytochemicals investigated quantitatively (Table 2), flavonoids are found to be most abundant in testas of *C. acuminata* and *C. nitida* fruits (186 ± 0.29 mg/100g and 185.85 ± 0.16 mg/100g respectively). This is followed by steroids (133.70 ± 0.74mg/100g and 131.13 ± 0.69mg/100g for testas of *C. acuminata* and *C. nitida* respectively). Also found in significant quantities are triterpenes, glycosides and terpenoids with values of 15.36 ± 0.04mg/100g, 10.82 ± 0.17mg/100g and 9.50 ± 0.03mg/100g respectively for *C. acuminata*; 15.10 ± 0.05 mg/100g, 11.27 ± 0.01mg/100g and 9.74 ± 0.08 mg/100g respectively for *C. nitida.* The presence of these phytochemicals suggests that the testas of *C. acuminata* and *C. nitida* seeds can serve as a good source of bioactive components of greater medicinal value. For instance, saponins and coumarins have been said to be of immense importance as anticancer agents (Vianna *et al.,*2012).

Terpenoids and terpenes are significant for maintenance of membrane structure, repellant and attractants in plant (Kempinski *et al.,* 2015). The crude protein for *C. acuminata* and *C. nitida* testas (14.72 ± 0.37 and 12.13 ± 0.01 respectively) are higher compared to the one reported for kolanut testa by Fabunmi *et al.* (2019) the ones reported for *C. acuminata* and *C. nitida* seeds by Okeke *et al.* (2015) and Olorundare *et al.* (2023) while the ash content and lipid content of the testas are lower when compared to that of the seeds as reported by Okeke *et al.* (2015) (Table 3). Finally, this study recommends further purification and utilization of these phytochemicals for pharmaceutical purposes and exploration of the nutritional value of these testas.

CONCLUSION

The testa is a major part of the *Cola* fruit but commonly considered as unimportant agriculture waste by many farmers. With the results obtained above, testas of both *C. acuminata* and *C. nitida* seeds are rich in phytochemicals of medicinal importance and can be explored using their therapeutic potentials in the development of novel drug in pharmaceutical industries. The results from the proximate analysis of these testas also indicated that they are of nutritious value and can be useful nutritionally especially in the development of feeds for livestock.

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GROWTH PERFORMANCE AND QUALITATIVE TRAITS OF SELECTED OKRA (*Abelmoschus esculentus* L.) CULTIVARS

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ABSTRACT
This study was carried out to assess the growth performance and qualitative traits of seven selected NIHORT okra genotypes. The study was carried out at the vegetable research field of the National Horticultural Research Institute, Ibadan, using randomized Complete Block Design (RCBD) with three replicates. Plant height and number of leaves were taken at 2, 4 and 6 weeks after sowing (WAS). Morphological characterization of the cultivars was also carried out following IBPGR (1984) descriptor for okra. The results showed significant variation in terms of plant height (2 and 6 WAS) as NHOKRA1 recorded the highest plant height at 2 and 6 WAS with 5.64 cm and 40.25cm respectively. The number of leaves was significantly higher in NHOKRA1 at 2 WAS and NHAe47-4 at 4WAS. The qualitative traits as revealed by the morphological characterization evaluation showed that similarities were observed for the seven cultivars in terms of growth habit, fruit position, stem and fruit colour, branching habit among others. Distinct variations were observed for stem pubescence, leaf shape, number of nodes, fruit type among others. The distinct morphological variations observed among the cultivars can still be tapped by breeders for okra improvement. Although, cultivars like NHOKRA1 and NHAe47-4 have been registered and released and are currently being cultivated by farmers across the country, improvement of other cultivars with good potential is also important to expand okra genetic base. However, there is need to evaluate the yield potential to be able to make a good conclusive comparison among the cultivars.
***Keywords**: characterization, growth habit, okra cultivars, okra improvement.*

INTRODUCTION

Okra originated from the Abyssinian center, an area that includes Ethiopia, a portion of Eritrea, and the eastern higher part of the Anglo-Egyptian Sudan (Atchison, 2018). Presently, okra is grown nearly all over the world. Although, in Africa, the crop is cultivated in Kenya, Nigeria, Sudan, Gabon, Cote d'Ivoire, Mali, Mauritania, Senegal, Cape Verde, and Chad (Atchison, 2018)**.** Okra (*Abelmoschus esculentus*) belongs to the Malvaceae family and it is cultivated in all agro-ecological zones in Nigeria for its immature fruits and leaves which are consumed as vegetable. The dried seeds provide oil, protein, vegetable curd, and a coffee additive or substitute. Okra dry seeds contain 18–20% oil and 20–23% crude protein (Dantas *et al.*, 2021). Foliage can be used for biomass, and the dried stems serve as a source of paper pulp or fuel. To a limited extent, okra is used in canned, dehydrated or frozen forms. The world production volume of Okra as fresh fruit vegetable is estimated at 8.90M tons (Tridge, 2016). Although Nigeria accounts for 22.5% of the total world production of okra (FAOSTAT, 2019). Variations in flowering and fruiting depends on variety as early flowering and fruiting may commence within five weeks after planting.

There are numerous cultivars of okra grown throughout Nigeria and some are more prevalent in certain regions. The National Horticultural Research Institute (Ibadan) has developed many okra cultivars. Some have been registered while concerted research efforts are still ongoing to ensure development of new cultivars of improved traits in order to meet Nigerian farmers' and consumers' traits of preference such as earliness, tolerance to diseases, high yield, canopy structure among others. This study compares the growth performance of seven NIHORT okra lines and their qualitative traits.

MATERIALS AND METHODS

The study was conducted at the vegetable research field of the National Horticultural Research Institute (NIHORT), Jericho Reservation Area, Ibadan (lat. 7.398980 and long. 3.920400). Seven Okra genotypes developed by NIHORT (NHAe47-4/K, LD 88/K, NHOKRA 1, Bagauda Spineless, NHAe47-4, IK11, LD88) were evaluated at the early cropping season of 2023. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The plot size for each cultivar was 2m × 2m and a plant spacing of 50cm × 50cm was used. All recommended crop management practices to raise a healthy crop were carried out. Data were collected on plant height and number of leaves at 2, 4 and 6 weeks after sowing (WAS). Morphological characterization of the genotypes was carried out following IBPGR (1984) descriptor for okra. Data collected on quantitative traits were subjected to analysis of variance and significant means were separated using Duncan Multiple Range Test.

RESULTS AND DISCUSSION

The result in table 1 revealed that NHOKRA1 recorded the highest plant height (5.64 cm) at 2 WAS, but this was not significantly different from plant height of NHAe47-4 (4.94 cm) at 2 WAS. LD 88 had the lowest plant height at 2 WAS but it was not significantly different from IK11. The result also indicated that the number of leaves at 2WAS varied between 4.24 in NHOKRA1 (which was the highest) and 2.62 in LD 88 (which was the lowest). However, four genotypes (NHAe47-4/K, Bagauda Spineless, LD88/K and NHAe47-4 had statistically similar number of leaves. Similarly, LD 88 had the least number of leaves which was not significantly different from IK11 (Table1). At 4 WAS, no significant variation was recorded among the seven cultivars in terms of plant height. However, NHAe47-4 recorded the highest number of leaves at 4 WAS but this was not significantly different from IK11, LD88, Bagauda Spineless, NHOKRA1 and LD88/K. The lowest number of leaves was recorded in NHAe47-4/K with five leaves. At 6 WAS, NHOKRA1 had significantly highest plant height (40.25 cm) above all the other genotypes. NHAe47-4 had the lowest plant height but this was not significantly different from height of NHAe47-4/K (Table1). There was no significant difference in the number of leaves of the 7 genotypes at 6 WAS although IK11 had the highest number of leaves (10) while NHOKRA1 had the lowest number of leaves (8).

The results obtained in this study is supported by the findings of Ibrahim *et al*., (2020), where significant differences were observed between LD88 and NHAe47-4 regarding vegetative parameters like plant height. The significance observed could be as a result of differences in genetic make-up of the cultivars as reported by Elhag *et al*., (2014) who observed significant among okra genotypes in their previous study. The morphological characterization result also revealed variations and similarities among the cultivars as shown in table 2. All the cultivars have erect plant growth and position of fruit but with sparse branching habit at vegetative stage. Their stems, leaves and petiole colours are all green meaning that there is no other type of pigmentation. The shape of calyx was spiny, and the corolla colour was generally golden yellow. Major variations among the cultivars were observed for stem pubescence where they exhibited intermediate (2 cultivars), smooth (4 cultivars) and glabrous (1 cultivar). Distinct leaf shape, number of nodes and fruit type were also observed. Among the cultivars, two have smooth fruit while three are slightly spiny. The remaining two are spineless.

The results of this study agrees with that of Anyaoha *et al*., (2023) where the fruit surface (spinelessness) of NH47-4 was reported to be prickly. Ogwu *et al.,* (2018) also reported variations in the fruit type of selected okra genotypes as seen in this study. Furthermore, Anyaoha *et al*., (2023) and Osawaru *et al.,* (2013) reported similarities and morphological differences between accessions. The growth parameters evaluated also indicated that at least two or more cultivars have similar growth rate which may be due to the parental lines used to develop them. The distinct morphological variations observed among the cultivars can still be tapped by breeders for hybridization program. Although, cultivars like NHOKRA1 and NHAe47-4 have been registered and released for public use and are currently being cultivated by farmers across the country improvement of other cultivars with good potential is also important. However, there is need to evaluate their yield potential to be able to make a good conclusive comparison.

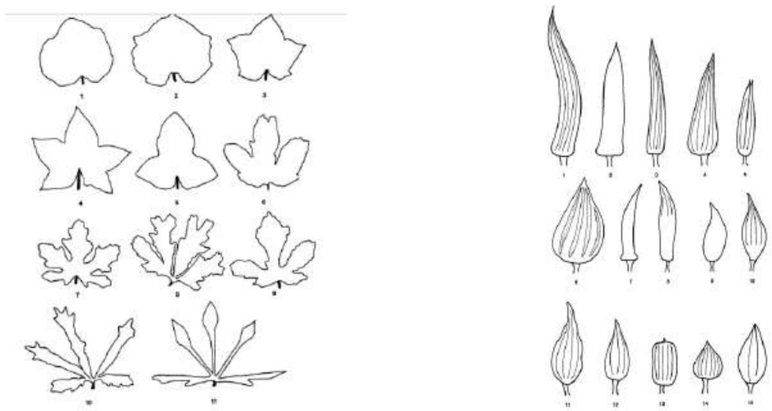
Table 1: Growth parameters of seven okra genotypes at 2, 4 6 weeks after sowing

Variety	**2 WAS**		**4 WAS**		**6 WAS**	
	Plant Height (cm)	**No of leaves**	**Plant Height (cm)**	**No of Leaves**	**Plant Height (cm)**	**No of Leaves**
NHOKRA1	5.64 a	4.24 a	16.83 a	5.66 b	40.25 a	7.75 a
NHAe47-4/K	4.45 bc	3.95 a	14.83 a	5.19 b	27.96 e	9.92 a
Bagauda Spineless	4.59 b	3.90 a	15.61 a	5.66 b	32.92 b	9.00 a
LD88/K	4.41 bc	3.76 a	14.82 a	5.38 b	30.29 bc	9.67 a
NHAe47-4	4.94 ab	3.72 a	19.28 a	7.33 a	24.71 e	8.58 a
IK11	3.71 cd	2.86 b	20.62 a	6.19 ab	29.50 d	10.08 a
LD88	3.05 d	2.62 b	16.20 a	5.71 b	34.04 b	8.42 a
S E	**0.25**	**0.20**	**2.42**	**0.59**	**1.90**	**0.87**

Means with the same letter are not significantly different in accordance with Duncan Multiple Range Test (DMRT) at 5% probability level.

Table 2: Variation observed in the qualitative traits of the seven okra genotypes observed.

Variety	NHOKRA1	NHAe47-4/K	Bagauda Spineless	LD 88/K	NHAe47-4	IK11	LD88
Plant Growth	Erect	Erect	Erect	Erect	Erect	Erect	Erect
Branching	Sparse	Sparse	Sparse	Sparse	Sparse	Sparse	Sparse
Stem Pubescence	Intermediate	Smooth	Intermediate	Smooth	Smooth	Glabrous	Smooth
Stem Colour	Green	Green	Green	Green	Green	Green	Green
Leaf Shape	3	7	6	10	7	6	10
Leaf Colour	Green	Green	Green	Green	Green	Green	Green
Leaf pubescence	Intermediate	Glabrous	Glabrous	Glabrous	Intermediate	Intermediate	Glabrous
Petiole Colour	Green	Green	Green	Green	Green	Green	Green
Number of nodes	1	5	7	6	5	4	6
Corolla colour	Golden Yellow	Golden Yellow	Golden Yellow	Golden Yellow	Golden Yellow	Golden Yellow	Golden Yellow
Red colour on the base of corolla	At the inside	At the inside	At the inside	At the inside	At the inside	At the inside	At the inside
Shape of calyx	Spiny	Spiny	Spiny	Spiny	Spiny	Spiny	Spiny
Position of fruits at the primary stem	Erect	Erect	Erect	Erect	Erect	Erect	Erect
Fruit pubescence	Hairy	Hairy	Hairy	Hairy	Hairy	Hairy	Hairy
Fruit type	10	6	6	4	10	12	4
Fruit Spinelessness	Spineless	Slightly spiny	Slightly spiny	Spineless	Slightly spiny	Smooth	Smooth



A B

Fig 1: Reference descriptors for fruit and leaf shape. A: Variation in leaf shape (IBPGR 1991). B: Variation in fruit shape (IBPGR 1984).

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INFLUENCE OF BIOCHAR ON Celosia argentea PERFORMANCE IN ATRAZINE AND NICOSULFURON-TREATED SOIL

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ABSTRACT
This study evaluated the performance of celosia in atrazine and nicosulfuron-treated soil amended with biochar. A 5 × 4 factorial experiment was laid in the screen house using a completely randomized design. Biochar at the volume rate of 0% (control), 5%, 10%, 15%, and 20% was incorporated into different potted soils which were subsequently treated separately with four levels of herbicides namely control (no herbicide), atrazine at 3.0 kg a.i ha-1, nicosulfuron at 40 g a.i ha-1, and a mixture of atrazine and nicosulfuron at 750 g a.i ha-1 and 60 g a.i ha-1. These treatments were replicated four times. Celosia was transplanted into the treated soils six weeks after application, coinciding with 2 weeks after sowing in the nursery. Data were collected from 3-6 weeks after transplanting (WAT) on plant height and number of leaves, while fresh and dry weights were determined at 8 WAT. The result showed that nicosulfuron residues significantly increased the number of leaves and the fresh and dry weights of celosia, whereas atrazine resulted in the lowest values from 3-6 WAT. Also, a 10% biochar inclusion rate significantly enhanced the growth and yield of celosia over biochar-free. However, celosia in soil treated with nicosulfuron and 10% biochar had the highest height, number of leaves and fresh weight. Hence adoption of this treatment in multiple cropping systems involving follow-up of maize with celosia is recommended.
Keywords:

INTRODUCTION
Maize (Zea mays) holds a pivotal position in the Nigerian farming system, with approximately 50% of the nation's farming households engaged in its cultivation (Sasu, 2023). Consequently, the adoption of selective herbicides such as atrazine and nicosulfuron for cost-effective weed management in maize fields is widespread across the country. These herbicides, aside from disrupting critical physiological processes of photosynthesis and acetolactate synthase in weeds, exhibit prolonged persistence within the soil, leading to an adverse phytotoxic "carryover" effect on subsequent crops (Jablonowski *et al*., 2011; Ahmadi *et al*., 2017). Furthermore, in rainfed multiple cropping systems, it is common practice to plant vegetables such as Celosia argentea following the maize crop to capitalize on the available soil moisture (Aladesanwa *et al*., 2001). However, Celosia argentea's vulnerability to atrazine and nicosulfuron residues in the soil can result in crop injury and reduced yields. Therefore, the extended persistence of these herbicides poses significant challenges in relay intercropping and rotational cropping systems, which are prevalent in Nigeria's agricultural systems.
Biochar, typically created through pyrolysis, is an exceptional soil amendment capable of enhancing soil quality by increasing pesticide adsorption potential (Kamila *et al*., 2021). Remarkably, biochar has been reported to have a high affinity for atrazine and nicosulfuron (Wang *et al*., 2020). Therefore, this study aims to investigate the implications of incorporating biochar into the soil as a potential crop injury mitigation strategy for cultivating celosia on herbicide-treated maize farms.

MATERIALS AND METHODS
The screen house study was conducted as a 5 × 4 factorial experiment using a completely randomized design and was situated at Adekunle Ajasin University, Akungba-Akoko, Nigeria. Four plots were marked in the screen house, each measuring 1 × 1 m. Five polythene pots, measuring 5 × 3 cm each, were filled with a mixture of 2 mm sieved topsoil and biochar, employing volume mixing ratios of 0% (control), 5%, 10%, 15%, and 20% biochar inclusion rates. This procedure was replicated four times

per plot, placing twenty pots within each plot. The physicochemical properties of the topsoil and biochar are presented in Table 1. The soil and biochar were slightly acidic and alkaline, respectively. Meanwhile, the organic carbon content of the soil was low. However, biochar had a relatively high quantity.
Subsequently, herbicide levels, including control (no herbicide), atrazine at 3.0 kg a.i ha-1, nicosulfuron at 40 g a.i ha-1, and a mixture of atrazine and nicosulfuron at 750 g a.i ha-1 and 60 g a.i ha-1, were separately applied to the plots using a knapsack sprayer. For the control treatment, water was solely applied. Six weeks after herbicide application, Celosia argentea (TLV 8) seedlings were transplanted into the potted soil at the two-leaf stage two weeks after sowing in the nursery. Data were collected on the height and number of leaves from 3-6 weeks after transplanting (WAT). The fresh and dry weights of the plants were determined at 8 WAT through destructive harvesting. The collected data were subjected to Analysis of Variance (ANOVA) using SPSS software, and significant means were separated using the Duncan multiple range test (DMRT) at a 5% probability level.

RESULTS AND DISCUSSION

Across weeks of evaluation, the performance of celosia was significantly influenced by the applied herbicides, biochar and their interactions. This highlights the potential role of soil residual activities of nicosulfuron and atrazine and the growth-promoting efficacy of biochar in Celosia production. Celosia in nicosulfuron-treated soil had the highest number of leaves, height, fresh and dry weight, though statistically similar to values from other herbicide treatments (Table 2). The exception was atrazine treatment from 4-6 WAT and herbicide-free at 5 WAT for the number of leaves (Tables 2). Comparable performance of celosia in nicosulfuron and herbicide-free treatment suggests that the soil residue of the former had no phytotoxic effect on the plants. Conversely, in line with Aladesanwa *et al*. (2001) and Hanson *et al*. (2020), the least growth (except for plant height at 3-4 WAT) and yield of celosia from atrazine treatment at the time of evaluation (Tables 2) might be connected to the boomerang effect of atrazine's prolonged persistence in the soil and associated phytotoxicity. The persistence of atrazine in the soil could be due to its resistance to abi dotic hydrolysis and direct aqueous photolysis (Liu, 2014).
Notably, the height, number of leaves and fresh weight of celosia in biochar-free treatments were lowest and differed significantly from values obtained from biochar treatments except 5% biochar at 4 WAT for number of leaves and 15% and 20% biochar for fresh weight (Table 3). The substitution of 10% of the soil volume with biochar significantly enhanced the number of leaves, height, and fresh and dry weight of celosia compared to the biochar-free treatment (Table 3). Meanwhile, this performance could be attributed to the substantial amount of organic matter in biochar, improving soil physical, chemical and microbial properties (Quilliams *et al*., 2013; Ghidotti *et al*., 2017). However, the numerical observations from the 10% biochar treatment were similar to the height observed in the 5% biochar treatment at 3 WAT and in 15% and 20% biochar treatments at 3 and 4 WAT, as well as the number of leaves in all biochar-inclusive treatments at 3 and 6 WAT, and the 15% biochar treatment at 4 WAT (Table 3). Additionally, the weights (both fresh and dry) of all biochar-treated soil were comparable to 10% biochar, except for the dry weight in the 5% inclusion (Table 3).
Furthermore, a critical appraisal of the herbicide-biochar interaction on the performance of celosia showed that 10% biochar in herbicide-treated soil promoted the growth of celosia over biochar-free soil with herbicide application as seen in the number of leaves and plant height of celosia at 3 to 6 WAT, except for the number of leaves in atrazine treatments without biochar at 5 and 6 WAT (Table 4). In contrast to soil treated with biochar, using atrazine and a mixture of atrazine and nicosulfuron in soil without biochar led to a decrease in the number of leaves at 4 and 5 WAT, respectively. Therefore, it appears that the application of biochar helps mitigate phytotoxicity. This finding agrees with the report of Clay *et al*. (2016) that the application of biochar to soil increases herbicide sorption and reduces phytotoxicity.
Notably, celosia in soil treated with nicosulfuron and 10% biochar consistently had the tallest plants with numerically highest leaves and fresh weight, but the best dry weights were recorded from herbicide-free + 10% biochar treatment (Tables 4). The adoption of nicosulfuron and 10% biochar by farmers can enhance their profitability and ensure the safe cultivation of celosia in maize farmlands that are subjected to intercropping and rotational cropping. Conversely, soils treated with atrazine-

nicosulfuron mixture in biochar-free soil produced the shortest plants with the least number of leaves across the weeks of evaluation except at 4 and 6 WAT when soils treated with atrazine + 0% biochar, and herbicide-free + 0% biochar produced celosia with least number of leaves, respectively (Table 4).

CONCLUSION

The residual effects of nicosulfuron in the soil six weeks after application did not negatively impact the growth and yield of celosia. In contrast, atrazine residue and residues from atrazine-nicosulfuron mixtures may temporarily hinder Celosia growth. Nicosulfuron proved to be more effective in enhancing Celosia performance compared to atrazine. Additionally, the growth-promoting potential of biochar for celosia became evident in biochar-amended soil. Enriching atrazine-treated and atrazine-nicosulfuron-treated soil with biochar creates a secure environment for cultivating celosia as a subsequent crop after maize.

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Table 1: Chemical properties of the potting soil and biochar

Potting mix	OC	OM	N	P	K	EH	EAL	Na	Ca	Mg	pH	CEC	SAND	CLAY	SILT
	(%)			[mg kg^{-1}]				[Cmol kg $^{-1}$]			[(1 : 2) H_2O]		(%)		
Topsoil	0.96	1.65	0.08	3.5	0.61	2.86	0.18	0.81	1.4	0.7	6.58	3.52	52.8	31.2	16
Biochar	94.8			5.24	2.77			2.61	3.21	1.86	9.32				

OC = Organic carbon, OM =, Organic matter, EH = Exchangeable hydrogen, EAL = Exchangeable aluminum, CEC = Cation exchange capacity

Table 2: Effect of herbicide residue on growth and yield of celosia

Treatments	Number of leaves				Plant height (cm)				Fresh weight (g/plant)			Dry weight (g/plant)		
	3WAT	4WAT	5WAT	6WAT	3WAT	4WAT	5WAT	6WAT	Shoot	Root	Total	Shoot	Root	Total
Atrazine (A)	7.90a	11.75b	23.55b	36.25b	5.94a	7.78a	11.57a	19.37a	11.80b	3.10b	14.90b	1.14b	0.67b	1.81b
Atrazine+Nicosulfuron (M)	8.15a	14.35ab	30.95ab	48.50ab	5.76a	6.62a	13.51a	24.20a	19.00ab	3.80ab	22.80ab	2.28a	1.07ab	3.39ab
Nicosulfuron (N)	9.20a	17.95a	41.80a	67.40a	5.63a	9.20a	15.00a	24.94a	27.45a	6.50a	33.95a	2.39a	1.10ab	3.45ab
Control (C)	7.90a	13.10ab	24.80b	47.05ab	5.20a	8.32a	13.42a	23.76a	21.75ab	4.70ab	26.45ab	2.51a	1.49a	3.10a

Means in a column followed by the same letter are not significantly different according to DMRT (P = 0.05).

Table 3: Effect of biochar on growth and yield of celosia

Treatments	Number of leaves plant				Plant height (cm)				Fresh weight (g/plant)			Dry weight (g/plant)		
	3WAT	4WAT	5WAT	6WAT	3WAT	4WAT	5WAT	6WAT	Shoot	Root	Total	Shoot	Root	Total
0% Biochar (B0)	4.94b	7.19c	12.31c	23.63b	3.08b	4.28c	6.51c	12.01c	7.00b	1.31b	8.31b	1.72b	0.64b	2.37b
5% Biochar (B5)	8.88a	11.50bc	27.75b	50.69a	6.43a	8.76b	13.98b	24.94b	22.81a	4.50ab	27.31a	1.68b	0.67b	2.25b
10% Biochar (B10)	9.81a	21.44a	48.75a	70.69a	6.96a	11.26a	18.76a	31.71a	31.75a	7.88a	39.63a	3.05a	1.77a	4.82a
15% Biochar (B15)	8.69a	16.19ab	31.75b	52.56a	5.55a	8.88ab	13.82b	23.96b	20.63ab	4.50ab	25.13ab	2.16ab	1.21ab	3.37ab
20% Biochar (B20)	9.13a	15.13b	30.81b	51.44a	6.14a	9.34ab	13.81b	22.78b	17.81ab	4.44b	22.25ab	1.79b	1.12ab	2.91ab

Means in a column followed by the same letter are not significantly different according to DMRT (P = 0.05).

Table 4: Interaction effect of herbicide and biochar on the growth and yield of celosia

Treatment	Number of leaves				Plant height (cm)				Fresh weight (g/plant)			Dry weight (g/plant)		
	3WAT	4WAT	5WAT	6WAT	3WAT	4WAT	5WAT	6WAT	Shoot	Root	Total	Shoot	Root	Total
A + B0	4.25de	5.25e	13.00cd	24.75cd	3.60c-e	4.83c-e	7.35de	12.15c	8.75cd	2.00c	10.75c	0.53c	0.13b	0.66c
A + B5	8.50a-d	8.00de	17.00cd	27.75cd	5.95a-d	4.94c-e	7.65c-e	11.35c	8.25cd	1.50c	9.75c	0.60c	0.25b	0.85bc
A + B10	9.50a-c	17.25b-d	33.25b-d	50.00b-d	7.38a	11.25ab	17.98ab	32.60ab	19.75a-d	6.25a-c	26.00a-c	2.51a-c	1.74ab	4.25a-c
A + B15	8.75a-d	15.00b-d	24.00cd	31.75cd	2.63a-c	8.75a-d	12.00b-e	19.00bc	10.00cd	2.25bc	12.25c	0.83bc	0.58b	1.41bc
A + B20	8.50a-d	13.25b-d	30.50cd	47.00b-d	6.15a-d	9.13a-d	12.90b-e	21.65a-c	12.25b-d	3.50bc	15.75bc	1.23bc	0.62b	1.85bc
M + B0	3.75e	7.00de	9.75e	20.50cd	2.25e	3.38e	5.33e	10.38c	5.50cd	0.75c	6.25c	1.48bc	0.31b	1.79bc
M + B5	8.50a-d	11.50b-d	24.00cd	44.75b-d	6.15a-d	9.50a-d	14.38a-d	25.7a-c	15.50b-d	2.00c	17.50bc	1.83bc	0.90b	2.73bc
M + B10	10.00ab	22.00ab	64.50ab	90.00ab	7.28a	11.65ab	19.85b	33.43ab	42.25ab	10.25ab	53.50ab	2.98a-c	1.04b	4.02a-c
M + B15	9.55a-c	15.75b-d	25.25cd	38.00b-d	6.30a-c	9.33a-d	13.65b-e	25.73a-c	12.25b-d	2.50bc	14.75bc	2.01bc	1.26b	3.27bc
M + B20	8.75a-d	15.50b-d	31.25cd	48.25b-d	6.83a-c	9.25a-d	14.38a-d	25.75a-c	18.50a-d	3.5bc	22.00a-c	3.12a-c	2.01ab	5.13ab
N + B0	6.50b-e	8.75de	15.75cd	33.75cd	3.55c-e	4.80c-e	7.10de	13.55c	10.50cd	1.75c	12.25c	3.34ab	1.48ab	4.82a-c
N + B5	9.25a-c	13.25b-d	45.25a-c	73.50a-c	7.03ab	10.13a-c	17.78ab	31.30ab	33.75a-d	7.00a-c	40.75a-c	1.81bc	0.67b	2.48bc
N + B10	11.75a	31.25a	71.25a	104.50a	8.05a	13.70a	22.78a	35.73a	48.00a	11.75a	59.75a	1.81bc	1.21b	3.01bc
N + B15	7.50a-e	17.50b-d	42.25a-d	67.50a-d	3.85b-e	7.93b-e	12.78d-e	22.15a-c	24.50a-d	6.50a-c	31.00a-c	3.46ab	1.31b	4.77a-c
N + B20	11.00ab	19.00bc	45.50b-d	58.50a-d	5.65a-d	9.93a-c	14.58a-d	22.25a-c	20.50a-d	5.50a-c	26.00a-c	1.51bc	0.68b	2.19bc
C + B0	**5.25c-e**	**7.75cd**	**10.75cd**	**14.50d**	**2.90de**	**4.13de**	**`6.30de**	**11.95c**	**3.25d**	**0.7c**	**4.00c**	**1.55bc**	**0.64b**	**2.19bc**
C + B5	9.25a-c	13.25b-d	24.75cd	56.75a-d	6.60a-c	10.48ab	16.15a-c	31.40ab	33.75a-d	7.50a-c	41.25a-c	2.47a-c	0.87b	3.34bc
C + B10	8.00a-e	15.25b-d	26.00cd	38.25b-d	5.13a-e	8.43a-e	14.43a-d	25.10a-c	16.00b-d	3.25bc	19.25bc	4.89a	3.09a	7.98a
C + B15	8.75a-d	16.50b-d	35.50b-d	73.75a-c	5.43a-d	9.53a-d	16.85ab	22.88ab	35.75a-c	6.75a-c	42.50a-c	2.32a-c	1.69ab	4.02a-c
C + B20	8.25a-d	12.75b-d	27.00cd	52.00a-d	5.95a-d	9.50a-d	13.38b-e	21.45a-c	20.00a-d	5.25a-c	25.25a-c	1.31bc	1.15b	2.46bc

Means in a column followed by the same letter are not significantly different according to DMRT (P = 0.05). A=Atrazine, M=Atrazine + Nicosulfuron, C=Herbicide-free soil, B5% = 5% biochar, B10% = 10% biochar, B15% = 15% biochar, B20% = 20% biochar, C+B0 = Untreated soil

QUANTIFYING KENAF VEGETABLE YIELD ACROSS DIVERSE PLANT STANDS IN FIBRE KENAF FIELD

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ABSTRACT
Kenaf (Hibiscus cannabinus) is often sown with multiple seeds per stand to compensate for low germination rates, leading to variability in plant density per stand. Consequently, thinning and supplementary sowing are required to mitigate competition and achieve the recommended plant population per stand. This study aims to estimate the effects of different plant densities on kenaf's growth and vegetable yield when thinned to two plants per stand. Kenaf (Ifeken 400) seeds were sown in the field following a Randomized Complete Block Design for the arrangement of experimental plots. Subsequently, kenaf plants from plant stand densities ranging from 1 to 5 plant(s) were observed. Findings indicate that stand density significantly influenced ($p<0.05$) kenaf growth and yield parameters. Single-plant stands exhibited superior height, leaf count, and stem girth. Moreover, individual kenaf plants in single-plant stands exhibited higher fresh and dry weights compared to individual kenaf plants in multiple-plant stands. The highest total fresh weight per stand was recorded in stands with 5 kenaf plants. Additionally, a fresh kenaf vegetable yield ranging from 16 to 20g per stand was obtained by thinning the stand densities to 2 plants per stand. These findings contribute to a better understanding of how to optimize kenaf cultivation for fibre and vegetable purposes while simultaneously promoting sustainable agricultural practices.
Keywords: *Competition, Plants per Stand, Thinning, Supplying, Vegetable Kenaf*

INTRODUCTION

Kenaf (Hibiscus cannabinus), a plant of significant agricultural interest, offers versatile applications as a consumable vegetable and a valuable fibre source. (Kujoana *et al*., 2023). This dual utility underscores its vital role in addressing various societal needs, ranging from nutrition to industry. However, the high oil content in kenaf seeds leads to a rapid decrease in viability (Akinbode *et al*., 2022). In response, farmers employ the practice of sowing multiple seeds per stand to counteract reduced germination rates. This leads to densely populated stands where plants engage in complex interactions, including competition for essential resources like soil nutrients, water, sunlight, and airflow (Zhai *et al*., 2018). The growth and yield of kenaf are intricately influenced by various factors, with the number of plants per plot playing a pivotal role (Yusoff *et al*., 2019). This factor is crucial as it directly affects interactions within the stands, significantly impacting the crop's overall health and development.

In Nigeria, kenaf cultivation for fibre production typically involves a spacing of 20cm x 50cm, with two plants per stand following thinning (Olanipekun *et al*., 2019). Thinning, which is the selective removal of surplus plants within a stand, plays a fundamental role in kenaf production. Notably, Webber III *et al*. (2002) emphasized that the optimal kenaf plant population for maximizing fibre yield is 187,500 to 375,000 per hectare. Therefore, the significance of thinning lies in its ability to achieve ideal plant spacing and optimize plant stand density for various end purposes. Additionally, thinning reduces competition and fosters the development of thicker stems and higher-quality fibre (Reta-Sánchez *et al*., 2010).

Researchers and farmers have explored thinning practices to maximize kenaf cultivation's benefits for fibre and vegetable purposes. However, the repurposing of thinned kenaf plants as a consumable vegetable has been underexplored in kenaf cultivation for fibre production. The adaptive utilization of thinned kenaf plants for consumption offers the opportunity to turn waste into wealth. Nevertheless, the literature lacks comprehensive insights into the potential vegetable yield based on the number of kenaf plants per stand in fibre kenaf fields. Hence, this study addresses this knowledge gap by investigating the effect of varying plant counts per stand on kenaf's agronomic performance and vegetable yield from thinned kenaf plants.

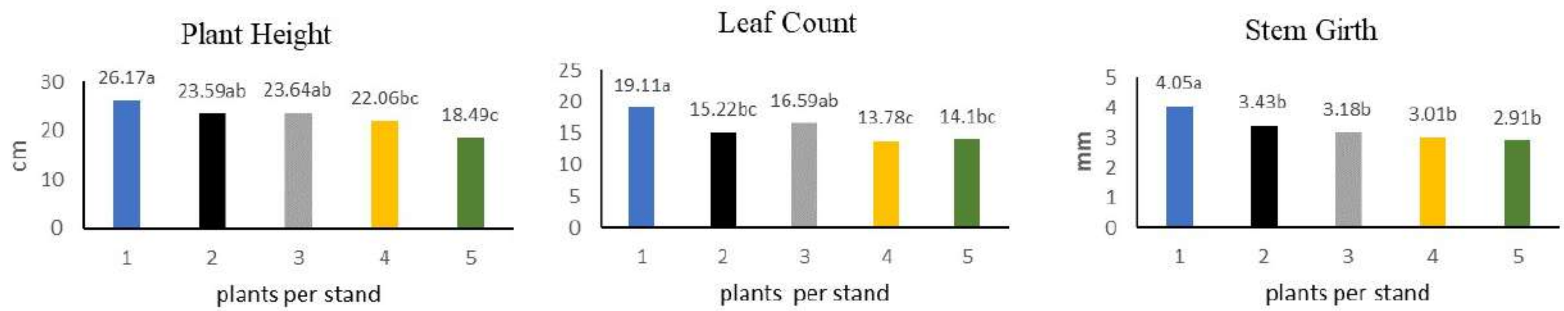
MATERIALS AND METHODS

A field trial was established at the Institute of Agricultural Research and Training (IAR&T) Ibadan in 2023. This was layout in Randomized Complete Block Design. After thorough ploughing and harrowing, 2m x 10m plots were set up within three blocks. Kenaf seeds (Ifeken 400 variety), sourced from the Seed Store Unit of IART, were sown in 20cm x 50cm spacing, with five seeds sown per hole. At the five-week mark following sowing, plant stands varying from 1 to 5 plant(s) per stand were sampled in triplicate from each block. Data on height, number of leaves, stem girth, as well as fresh and dry weights were collected from the samples. In stands containing more than two kenaf plants, the fresh weight of kenaf plants intended for vegetable use was determined by subtracting the combined weight of two plants designated for fibre kenaf production from the total weight per stand. The data were subjected to Analysis of Variance (ANOVA) using SPSS® software, and significant means were separated using the Duncan Multiple Range Test at a 5% significance level.

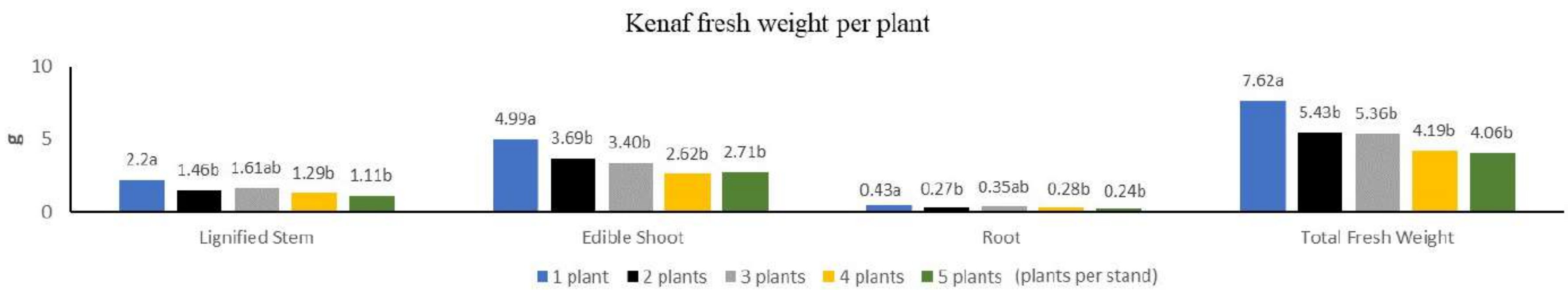
RESULTS AND DISCUSSION

The findings from this study indicate a significant impact ($p<0.05$) of stand density on kenaf growth at 5 weeks after sowing (Fig. 1). Specifically, kenaf plants in single-plant stands exhibited the best performance in terms of height, leaf count, and stem girth. These kenaf plants showed significantly better growth compared to plants in other densities, except for the height of the kenaf plants in 2 and 3 plant stands and the number of kenaf leaves from stands with 3 plants (Fig. 1a). This result aligns with the report of Yusoff *et al*. (2019), which suggests that as plant stand density rises, there is heightened competition for crucial soil nutrients, water, sunlight, and proper airflow, consequently leading to a decrease in kenaf growth. Similarly, for both fresh and dried measurements, the lignified stem, edible shoot, root, and whole plant of kenaf plants from single-plant stands exhibited significantly greater weight compared to corresponding plant components from individual plants in different stand densities. The exceptions to this trend included the fresh weight of lignified stems and root plants in stands with 3 plants, the dry weight of lignified stems per plant in stand densities of 2-5 plants, and the edible shoot weight per plant in the 2-plant stand density (Fig. 1b and 1c). These observations further emphasize the impact of intraspecific competition on kenaf performance.

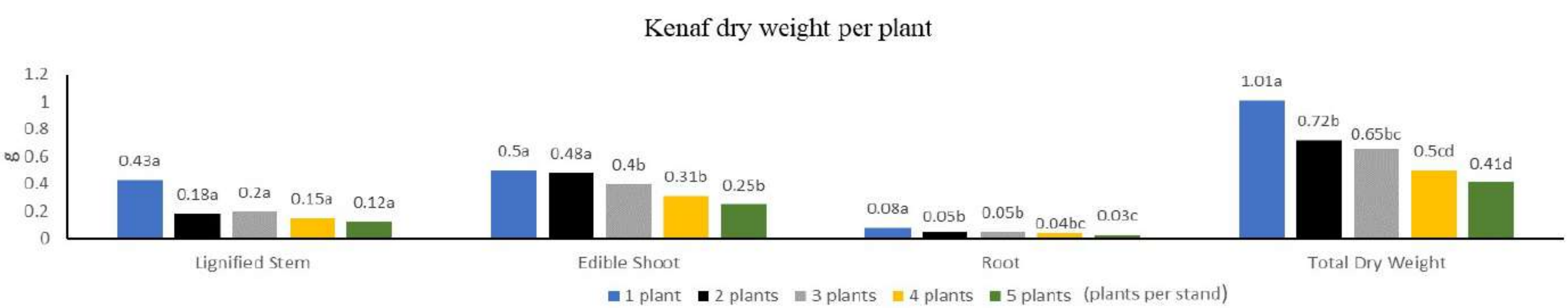
Conversely, the cumulative weights of the whole kenaf plant and its component parts from stands with 5 plants were the highest, significantly different from observations for other stand densities, except for the fresh weight of lignified stem in stands with 3 and 4 plants, the fresh weight of roots in stand densities of 1-4 plants, the dry weight of lignified stem in stand densities of 1-4 plants, and the dry weight of the edible shoot, root, and whole plant in stand densities of 3 and 4 plants (Figs. 1d & 1e). Remarkably, the fresh and dry weights of all kenaf plants and plant components, except for the fresh weight of roots per stand, were significantly influenced ($p<0.05$) by stand density (Figs. 1d & 1e). Furthermore, the fresh edible shoot weight of kenaf plants per stand significantly increased with the addition of two kenaf plants within the stand (Fig. 1d). The results emphasize the advantage of cultivating multi-plant stands to achieve optimized vegetable yield, even in cases where seed germination is not a challenge. Notably, these findings are consistent with the report by Acreche *et al*. (2005), which highlights the influence of plant density on kenaf yield per unit area of production.


Plant Height
cm
26.17a
23.59ab
23.64ab
22.06bc
18.49c
plants per stand
Leaf Count
19.11a
15.22bc
16.59ab
13.78c
14.1bc
plants per stand
Stem Girth
mm
4.05a
3.43b
3.18b
3.01b
2.91b
plants per stand

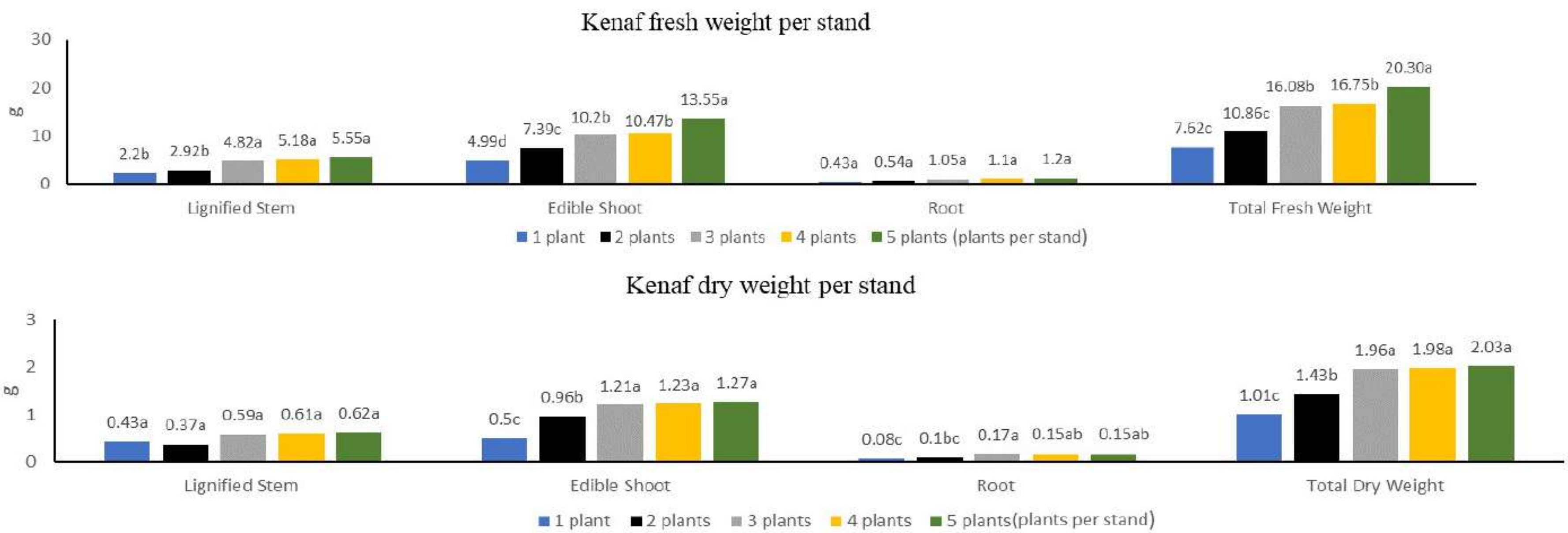
a


Kenaf fresh weight per plant
g
2.2a
1.46b
1.61ab
1.29b
1.11b
4.99a
3.69b
3.40b
2.62b
2.71b
0.43a
0.27b
0.35ab
0.28b
0.24b
7.62a
5.43b
5.36b
4.19b
4.06b
Lignified Stem
Edible Shoot
Root
Total Fresh Weight
1 plant
2 plants
3 plants
4 plants
5 plants
(plants per stand)

b


Kenaf dry weight per plant
g
0.43a
0.18a
0.2a
0.15a
0.12a
0.5a
0.48a
0.4b
0.31b
0.25b
0.08a
0.05b
0.05b
0.04bc
0.03c
1.01a
0.72b
0.65bc
0.5cd
0.41d
Lignified Stem
Edible Shoot
Root
Total Dry Weight
1 plant
2 plants
3 plants
4 plants
5 plants
(plants per stand)

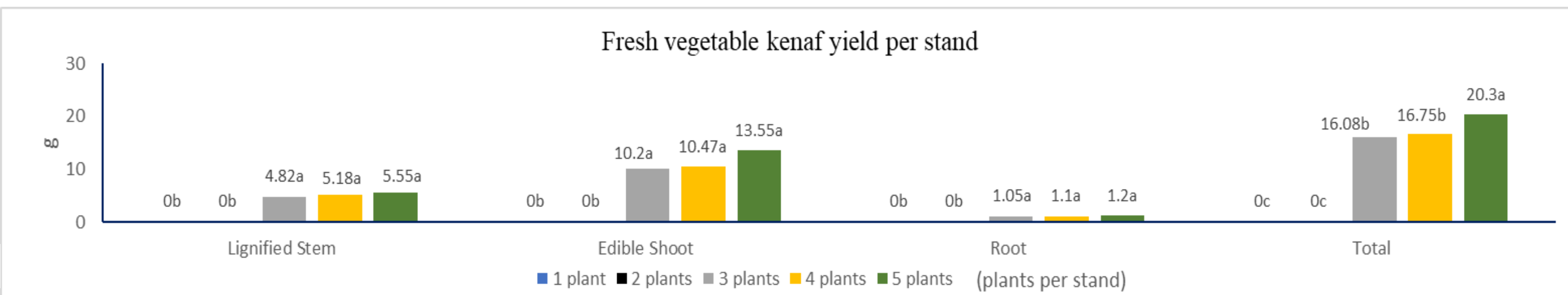
c



d

e

Figure 1: Effect of Plant Stand Density on Kenaf Growth



f

Figure 2: Effect of Plant Density on Kenaf Vegetable Yield

Considering the naturally varying densities of kenaf plant stands from the same seeding rate in this study, the potential for non-uniform and underpopulated kenaf stands for fibre production is evident. Therefore, it may be necessary to ensure uniform kenaf plant distribution for fibre production by supplying kenaf stands with single plants and thinning multi-plant kenaf stands comprising 3 to 5 plants. Following stand thinning to 2 plants per stand, stands where only 1 or 2 plants emerged yielded no vegetable (Fig. 2). This deprives the farmers of the short-term immediate benefit of food or income that can be generated from vegetable kenaf sales prior to fiber production. In contrast, weight of lignified stem, edible shoot, root and whole plant of kenaf vegetable that was obtainable after thinning increased with kenaf stand density (Fig. 2). Stands with 5 plants had significantly higher total fresh weights than stands with 3 and 4 plant densities. However, the latter two plant densities compared favorably with the 5-plant density for the fresh weight of lignified stems, edible shoot, and root (Fig. 2). As the numerical vegetable yield from thinned plants increased proportionally with the number of plants per stand, with the highest fresh kenaf vegetable biomass achieved in stands containing 5 kenaf plants, it can be inferred that the potential yield of kenaf vegetables from thinned plants depends on the initial plant population per stand and increases with higher seed germination rates per stand. Notably, fresh kenaf vegetable yields from thinned stands ranged between 16 and 20g per stand. Excluding border plants, a planting spacing of 20 cm x 50 cm results in 100,000 stands per hectare. This study's findings suggest that, with a kenaf seed viability of 100 percent, fibre kenaf fields have the potential to yield up to 2 tonnes of fresh vegetable kenaf per hectare in addition to the fibre yield. This can generate an additional revenue of about ₦200,000 per hectare at the rate of ₦100/kg.

CONCLUSION

While acknowledging the significant challenge posed by seed viability in kenaf production, this study lays the groundwork for estimating the potential yield of vegetable kenaf through thinning practices in fields initially designated for fibre kenaf cultivation. This introduces an alternative source of income and food for farming families and the broader Nigerian population while highlighting the significance of improving seed viability in kenaf production.

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RESPONSE OF SESAME *(SESAMUM INDICUM)* YIELD TO DIFFERENT RATES OF NPK 15: 15:15 FERTILIZER APPLICATION

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ABSTRACT
*Experiment was conducted at the Teaching and Research Farm of Oyo State College of Agriculture and Technology, Igbo-ora. To assess the effect of different rates of NPK 15:15:15 fertilizer on the growth and seed yield of sesame (Sesamum indicu). Treatments were allocated to pots in Complete Randomized Design (CRD) and replicated five times. Treatments were; Control (0kgNPK/ha), 30, 60, 90 and 120 kg NPK/ha. At harvesting data collected were; Total dry matter (stem, root and seed) weight. Data collected were subjected to Analysis of variance **(ANOVA)** and significant means separated by Duncan Multiple Range Test **(DMRT)** at 0.5%. There was significant difference among the treatments examined and the use of 120kg/ha N gave the highest response followed by 60kg/ha N. Similarly, 120kg/ha N > 60kg/ha N was shown by all characters considered but with no significant difference. Thus, 60kg/ha N is recommended for optimum yield to minimize cost of production.*
Keywords: *NPK 15:15:15, Sesame, Growth, Performance and Different Rates*

INTRODUCTION

Sesame (*Sesamum indicum* L.), otherwise known as *sesamum* or benniseed, is a member of the family *Pedaliaceae*. It is one of the most ancient oilseed crops known to mankind. Sesame plays an important role in human nutrition. Most of the sesame seeds are used for oil extraction and the rest are used for edible purposes (El Khier *et al.,* 2008). The major world producers include India, Sudan, China and Burma (that contributes about 60% of the total world production) (El Khier *et al.,* 2008). It is cultivated for its edible seeds, used for bread, biscuits, Crackers, and so forth and as seasoning in food and complement to many dishes all over the world due to the quality of its oil, protein, antioxidant, anti-proliferative properties as well as its high adaptability in harsh climatic and extreme environment (Namiki, 2007). In Nigeria, the seeds are consumed fresh, dried, fried or when blended with sugar. It is also used as a paste in some local soups (Fariku, *et. al.,* 2007).

However, the demand for sesame seeds has increased in the last two decades due to high oil quality, protein and antioxidant contents, and wide adaptability in extreme climatic and edaphic environments. Recently, Olatunji, *et. al.* (2022) in their work concluded that sesame enriched biscuits provide a viable means to obtain good quality nutrition and minimal risk of heart or organ disabilities. In spite of its multi-dimensional uses, the commercial and mechanized cultivation of sesame in Nigeria is not encouraging and its yield is very low. On the average 500kg of sesame seeds are harvested per hectare in Nigeria (Alegbejo, *et al*., 2003) which is much lower than the average yield of other countries such as Egypt (1120 kg ha^{-1}), Mexico (960 kg ha^{-1}), and China (900 kg ha^{-1}) (Anonymous, 1996). Poor growth of locally cultivated sesame can be traced to low soil fertility. Among the measures adopted to increase the production of sesame is the introduction of new varieties with high yield potentials as well as application of suitable cultural practices such as fertilization and weed control.

Paucity of information on the appropriate fertilizer recommendation for sesame is one of the major production problems in Nigeria. Fertilizer is usually not applied to sesame by traditional farmers in

Nigeria (Van Rheenen, 1973). Previous trials have, however, shown varietal and location differences in response to N and P fertilization in Northern Nigeria (Voh, 1998). The purpose of this present study therefore, was to evaluate the effects of different rates of NPK 15:15:15 fertilizer on the yield of sesame *(Sesamum indicum).*

MATERIALS AND METHOD

The experiment was carried out during early 2021 dry season at the Teaching and Research Farm of Oyo State College of Agriculture and Technology, Igboora, located on latitude 7°30N and 3⁰45E. It was conducted under a Complete Randomized Design (CRD), replicated five (5) times. The test crop used is (*Sesamum indicum)* varieties named NCRIBEN- 05E (Kenena 4), obtained from NCRI, Badeggi. Seeds were plant drill in the poly-bag and later thin to one seedling per stand at three (3) weeks after planting. NPK 15.15.15 was applied two weeks after planting. The rates of application were; T1 (00\kg/ha) as control. T2, (30kg/ha), T3 = (60kg/ha), T4 = (90kg/ha) and T5 = 120kg/ha) respectively.

Soil sample and sampling analysis

Soil samples were taken randomly in the field by using soil auger at the depth of 0-15cm; the soil was air dry for three weeks. The dried soil was sieved using 2mm mesh size sieve and mixed to obtain a composite sample soil. Sample of the composite soil was therefore taken to the laboratory for soil analysis. Weeding was done manually by hand-weeding throughout the period of the research. Data collected were yield and yield components which include; Number of pods, stem dry weight, total dry matter, root dry weight and seed dry weight. All data collected were subjected to Analysis of variance (ANOVA) and the significant means were separated using Duncan Multiple Range Test (DMRT) at 5% probability level.

RESULT AND DISCUSSIONS

The result obtained in Table 1, indicated that the soil of the experimental site was slightly acidic with pH value 0f 6.20 and low in Organic carbon 17.6. Total N available P, K, Ca and Mg were low. The TN, Available P as well as Org. C contents of this soil were an indication of poor fertility status of a tropical soil. The result recorded in Table 2 also indicated that the soil has 76.2% sand, 9,7 % silt and 1.41% Clay and textural class was loamy sand. Table 3 showed that the use of N fertilizer at different rates had significant difference ($P \leq 0.05$) on the yield of *Sesamum indicum.* Treatment (T1) control had the lowest *Sesamum indicum* yield whilst treatment (T5) fertilized with 120kgN/ha gave the highest *Sesamum indicum* seed dry weight yield respectively. The order of response for the seeds dry weight was T5> T3 > T2 & T4 > T1. From all the yield and yield components evaluated T5 always gave the best response followed by T3 in all the characters examined but with no significant difference.

However, there was no significant ($P > 0.05$) difference between 60kgN/ha and 120kgN/ha rates of application. This indicated that 120kgN/ha had greatest influence on the yield than other rates applied but with no significant difference when compared with yield due to application of 60 kg N ha^{-1}. From the total number of pods considered, the order of response by the treatments was T3 > T5> T4> T2>T1 respectively. Thus, it means for maximum economic returns, the use of 60 kg N/ha should be considered. Hence, it can be concluded that the effects of N fertilizer applied at different rates had significant difference ($P < 0.05$) on the yield and yield components of *Sesamum indicum* plants.

The result obtained in Fig. 1, showed that treatment T1 had the lowest number of pods/plant with mean value of 32.5 whilst treatment T5 produced the highest mean number (79.2) pods/plant followed by T3 (76.8) with no significant treatment mean difference throughout the period of investigation up to 12 weeks after planting (WAP). Hence, the use of 60 kg N/ha should be considered for optimum production of *Sesamum indicum.* The observed results corroborated the findings of Gebregergis and Amare (2019) that affirmed that in the potential areas, application of 46-100 kg N/ha gives optimum yield and the application of less than 46 kg N/ha is economical in the marginal areas.

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Table 1: Chemical properties of the soil used

PARAMETER	VALUE
pH (H2O)	6.20
Org. C (g kg-1)	17.6
Total N (g kg-1)	1.20
Available P (g kg-1)	12.50
K (cmol kg-1)	0.47
Ca (cmol kg-1)	2.41
Mg (cmol kg-1)	0.53

Table 2: Physical properties of the soil used.

Physical Properties	Values
Sand	76.2%
Silt	9.7%
Clay	14.1%
Textural Class	Loamy sand

Table 3: Yield components of *Sesamum indicum*

TREATMENT	Total Dry Matter(kg)	Stem Dry Weight(kg)	Root Dry Weight(kg)	Seed Dry Weight(kg)
Co	8.2	7.1	1.1	0.9c
30kgN/ha	4.4	3.2	1.2	1.1c
60kgN/ha	9.8	8.2	1.5	1.6ab
90kgN/ha	5.4	4.2	0.9	1.1c
120kgN/ha	13.5	11.2	2.3	2.2a
LSD (0.05):	6.6 ns	6 ns	1 ns	0.5

Mean follow by the same column are significant different at 5% level of probability by DMRT

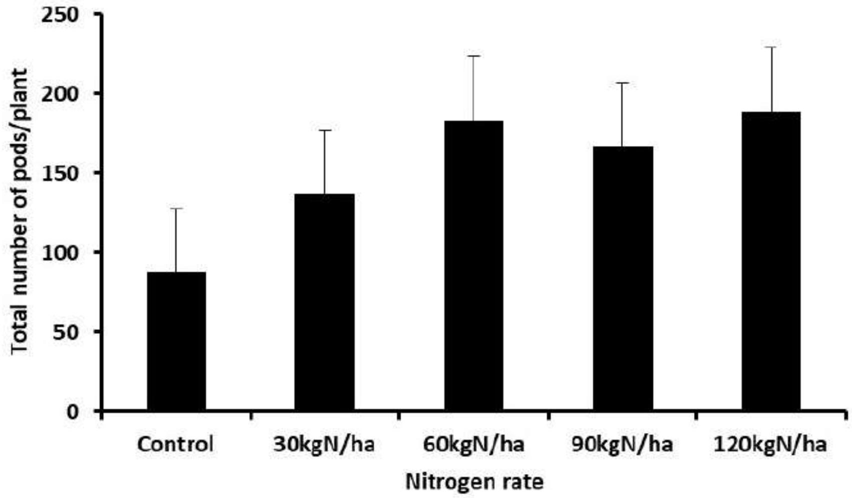

Fig 1: Effects of Nitrogen rate on total number of pods/plant

INFLUENCE OF POULTRY LITTER BIOCHAR AND POULRTY MANURE ON THE PERFORMANCE AND ANTIOXIDANT OF OKRA (*Abelmoschus spp*, (L) Moench) IN IKORODU, NIGERIA

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ABSTRACT

The study evaluates the influence of poultry litter biochar and poultry manure on the performances of okra in South-Western Nigeria. The experiment consists of 5 treatments: 7.5 t/ha biochar, 7.5 t/ha poultry manure, 2.5 t/ha biochar + 5 t/ha poultry manure, 5 t/ha biochar + 2.5 t/ha poultry manure and control (no application) laid out in Randomized Complete Block Design (RCBD) and replicated three times. Data on growth and yield attributes were collected from six randomly selected okra plants/treatments and were subjected to Analysis of Variance (ANOVA) with significant treatment means compared using Duncan Multiple Range Test (DMRT) Results of this study revealed that, 7.5 t/ha poultry litter biochar and 2.5 t/ha poultry litter biochar + 5 t/ha poultry manure best improved the soil compared to all other soil amendment with the combination of 2.5 t/ha poultry litter biochar +5 t/ha poultry manure observed to have an edge compared to the other treatments in the improvement of growth and yield performances . Therefore, it is recommended that to improve the soil as well as the performance of okra, combination of 2.5 t/ha poultry litter biochar + 5 t/ha poultry manure should be adopted, however due to the low radical scavenging power of the fruits from that treatment, it is recommended that further study should be carried out with other rates of application combination especially with the free radical scavenging power of the fruits as the main parameter.

Keywords: *Poultry manure, Poultry litter Biochar, performance, okra.*

INTRODUCTION

Okra (*Abelmoschus spp*, (L) Moench), is a very important vegetable crop in the tropical and sub-tropical regions (Bisht and Bhat, 2016). The crop is a dicotyledonous plant, of the family *Malvaceae* (Schippers, 2000) which comprise a number of species including other foods, fibre, and medicinal crops such as cotton and kenaf (Anderson and Pharis, 2013). It is one of the oldest cultivated crops and presently grown in many countries and is widely distributed in Asia, Africa, Southern Europe and America (Oyelade *et al*., 2013). It is reported to have originated in tropical Africa (Akanbi *et al*., 2015). The continuous need for enhanced and improved crop performance creates the need for the increasing demands on soil fertility all around the world (Mosier *et al*., 2021; Wild, 2013). This shows that, the soil is the most important input for optimum crop performance. To maintain good soil fertility requires skills and technical knowledge of soil quality and health which generally refers to the soil's fitness for good crop growth without depleting or environmentally hazardous (Acton and Gregorich, 2015). A number of researchers have shown that inorganic fertilizers have deleterious effects on the soil environment, which has made it a necessity for organic sources like poultry litter biochar and poultry manure for soil amendment more popular in recent times.

The use of biochar for soil improvement for crop yields in agricultural fields is lately recognized (Srinivasara *et al.,* 2013). Biochar is carbon rich product obtained from different feedstock such as wood chip and wood pellets, tree bark, crop residues, and organic wastes (Srinivasara *et al.,* 2013) at low temperatures (<700∘C) (Lehmann and Joseph, 2012). It stores carbon for long time to improve soil fertility and optimized soil pH (IBI, 2012). Application of biochar not only increases crop productivity and soil cation exchange capacity (CEC) but also is possible to increase soil macro- and microelement (Glaser, 2014). Different studies reported that biochar increases soil pH, plant growth, and yield (Sohi *et al.,* 2019) but few studies reported the influence of biochar on early stages of plant growth such as on seed germination and seedling growth in different regions of the world (Lehmann and Joseph, 2012).

Poultry dropping is a good fertilizer containing nitrogen, phosphorus, potassium and micro-nutrients with high photosynthetic activities and thus promotes root and vegetable growth (John *et al.*, 2014). . Magkos *et al.* (2013), reported that poultry manure is a good source of macro and trace elements not contained in other organic manure. It is a reservoir of nutrients, released during humidification that is eventually made available to the growing plants. Organic manure such as poultry manure can be used to ameliorate the amount of toxic compound produced by the chemical fertilizers. Poultry manure increase the organic matter (OM) content of soil and in turn releases the plant nutrients in available form for the use of the plants. Deskissa *et al.* (2018) emphasized that manure enable a soil to hold more water, improve the drainage, organic acids that help to dissolve soil nutrients and then made available for the crops.

Enhancing crop production is of global issue, this will require new innovations to improve crop productivity through soil amendments practices (Liang *et al*. 2014). To achieve optimum crop growth, the soil should contain high amount of nutrients because plants absorb nutrients from the soil for optimum performance. Therefore, the need to research into these organic sources hence the need to experiment on their effects on the soil and performance of crops. Therefore, the main objective of this study was to evaluate the influence of poultry litter biochar and poultry manure on the growth and yield of okra in South-Western Nigeria.

MATERIALS AND METHODS

Experimental site and Land Preparation

The study was carried out on 171m^2 (19m x 9m) area of land at the Teaching and Research farm of Lagos State Polytechnic, Ikorodu. The experimental site was ploughed and stumps were removed. A total number of 15 beds with a dimension of 3m x 2m was constructed with 1m discard from outside and 0.5 m discard between each experimental bed.

Experimental Design and Layout

The experiment was laid out in Randomized Complete Block Design (RCBD) with 5 treatments: 7.5 t/ha biochar, 7.5 t/ha poultry manure, 2.5 t/ha biochar + 5 t/ha poultry manure, 5 t/ha biochar + 2.5 t/ha poultry manure and control (no application) replicated three times.

Treatment application and Crop Maintenance

Okra V35 variety seeds were planted at two (2) seeds per hole using dibbling method at a spacing of 50 cm x 50 cm (Ogundiran 2013) which was later thinned to one vigorous plant per stand two weeks after planting to give a plant population of 24 plants per plot and a total of 360 plants for the whole experiment. The biochar and poultry manure were prepared and applied to each experimental plots two weeks before planting to allow for mineralization. Manual weeding was done every two weeks to eliminate weed infestation. While Pirimiphos-methyl + cypermethrin insecticide as well as Mancozeb fungicide were applied to prevent insect and fungi infestation as at when necessary.

Pre-planting and post-harvest Soil Sample collection and analysis

Soil samples were collected at random from 10 different locations on the experimental site prior to cropping and after harvest from each treatment plots. The soil samples were analyzed for soil physiochemical properties following routine laboratory procedures.

Data Collection

Six (6) plants were selected randomly from each experimental plot for data collection. Data were collected on, number of leaves, plant height (cm), stem girth (cm) at 2, 4 and 6 weeks after planting (WAP). Number of days to 50% flowering, number of fruits per plant and fruit weight (kg) were collected to determined yield performance. Data collected were subjected to Analysis of Variance (ANOVA). Means of treatments were compared using Duncan Multiple Range Test (DMRT) at 5% level of probability using SAS 9.1 statistical software (SAS, 2012).

RESULTS

Pre-Experimental soil physio-chemical properties

The pre-cropping soil physio-chemical analysis revealed that the site to be slightly alkaline soil (pH 8.69), low in Organic Carbon (2.62%), organic matter (0.18%), Total N (0.16%) and Available P (5.28 ppm) as well as low in exchangeable bases Na (0.15 cmol/kg), K (0.17 cmol/kg), Ca (2.45 cmol/kg) and Mg (1.96 cmol/kg). The soil was observed to have a CEC of 4.76 and the particle size percentage of sand, silt and clay (62.78%, 20.10% and 17.12% respectively) with soil textural class of sandy loam.

Effects of poultry litter biochar and poultry manure on soil chemical properties

The soil chemical properties was significant differences ($p \leq 0.01$) influenced by poultry litter biochar and poultry manure application (Table 1). Sole application of poultry litter biochar (7.43) significantly improved the soil pH compared to other treatment. While sole application of poultry manure and 2.5 t/ha PLB + 5 t/ha PM did not differ significantly and the least pH (6.60) was observed in the control.

The highest total organic matter (2.7%) was observed in 7.5 t/ha poultry litter biochar amended plots closely followed by 7.5 t/ha poultry manure (2.64%) and the lowest value (2.13%) was observed in the control. Total N value in amended soil ranges between 0.21 – 0.24%, with the highest total observed in 7.5 t/ha poultry litter biochar (0.24%) and the minimum (0.19%) was observed in the control (Table 1).

Available P significantly increased from 5.28ppm pre-cropping to a range of 17.92 – 21.75ppm in the plots incorporated with poultry litter biochar and poultry manure with the maximum available P recorded with application of 7.5 t/ha PLB (Table 1).

From the result in Table 1, exchangeable bases (K, Ca, Mg and Na) value was significantly improved with the different levels of the PLB and PM incorporated into the experimental plot. Plot supplied with 7.5 t/ha PLB recorded the highest exchangeable bases value, while the least was observed in the control plot.

Table 1: Effects of poultry litter biochar and poultry manure on soil chemical properties

Treatments	pH	TOM (%)	N (%)	P (mg/kg)	K (mg/kg)	Ca (mg/kg)	Na (mg/kg)	Mg (mg/kg)
7.5 t/ha PLB	7.43a	2.76a	0.24a	21.75a	24.77a	10.53a	7.73a	18.28a
7.5 t/ha PM	7.24b	2.64b	0.21c	20.52c	20.37d	10.33a	5.16d	15.86c
2.5 t/ha PLB + 5 t/ha PM	7.25ab	2.45c	0.23b	21.27b	22.77b	9.57b	6.73b	17.29b
5 t/ha PLB + 2.5 t/ha PM	7.15b	2.18d	0.21c	17.92d	21.53c	8.33c	5.60c	15.27d
Control (no application)	6.60c	2.13e	0.19d	14.37e	18.73e	7.43d	3.60e	11.75e
Significance	**	**	**	**	**	**	**	**

Means with similar letter(s) in the same column are not significantly different at 5% D.M.R.T.
PLB = poultry litter biochar, PM = Poultry manure

Effect of poultry litter biochar and poultry manure on okra growth performance

Result in table 2 shows that poultry litter biochar and poultry manure significantly ($p \leq 0.05$) influenced okra growth performance. At 2 and 4 WAP, 2.5 t/ha poultry litter biochar + 5 t/ha poultry manure had the highest number of leaves (3.38, 5.61) while the least number of leaves (2.83, 4.44) was observed in the control. No significant difference ($p \geq 0.05$) was observed at 6WAP

Tallest plant (5.78 cm) was recorded for okra planted in plots amended with 7.5 t/ha poultry litter biochar at 2 WAP and the shortest plant (4.26 cm) was observed in 7.5 t/ha poultry manure. At 4 and 6 WAP, the tallest plants (9.26 cm and 15.6 cm) were observed in 2.5 t/ha poultry litter biochar + 5 t/ha poultry manure with the shortest plants (7.33 cm and 12.15 cm) were observed in control (Table 2).

Table 4: Effect of poultry litter biochar and poultry manure on okra growth

Treatments	Week After Planting (WAP)								
	number of leaves			plant height (cm)			stem girth (cm)		
	2	4	6	2	4	6	2	6	4
7.5 t/ha PLB	3.05ab	5.78a	8.98b	5.78a	8.98b	14.18b	1.84	1.89ab	3.89
7.5 t/ha PM	2.94bc	4.26c	7.78bc	4.26c	7.78bc	13.81bc	1.71	1.97ab	4.05
2.5 t/ha PLB + 5 t/ha PM	3.38a	5.25ab	9.25a	5.25ab	9.25a	15.63a	1.87	2.25ab	4.86
5 t/ha PLB + 2.5 t/ha PM	3.27ab	4.94bc	9.00ab	4.94bc	9.00ab	15.60a	1.82	2.49a	4.94
Control (no application)	2.83c	4.92bc	7.33c	4.92bc	7.33c	12.15c	1.67	1.80b	3.85
Significance	*	*	*	*	*	*	Ns	*	ns

Means with similar letter(s) in the same column are not significantly different at 5% D.M.R.T.
PLB = poultry litter biochar, PM = Poultry manure

Effect of poultry litter biochar and poultry manure on the stem girth (cm) of okra

Stem girth was not significantly affected by poultry litter biochar and poultry manure application. However, stem girth 4 WAP significantly ($p \leq 0.05$) influenced (Table 2). At 4 WAP the thickest stem (2.49 cm) was recorded from 5 t/ha poultry litter biochar + 2.5 t/ha poultry manure and the thinnest stem (1.80cm) was recorded in the control (Table 2).

No significant difference($p \geq 0.05$) was observed in the stem girth of okra at 2 and 6 WAP.

Effect of poultry litter biochar and poultry manure on days to 50% flowering of okra and okra fruit yield attributes

Result presented in Figure 2 shows that the treatments significantly influenced the number of days to 50% flowering of okra with the okra in plots treated with 2.5 t/ha poultry litter biochar + 5 t/ha poultry manure and 5 t/ha poultry litter biochar + 2.5 t/ha poultry manure flowered first (49.68 days) followed by 7.5 t/ha poultry litter biochar (50 days) while it takes 52 days for okra in control flowered. Significant differences ($p \leq 0.05$) were observed in the number of harvested okra pods as influenced by poultry litter biochar and poultry manure soil amendment (Figure 3). The highest number of pods (29.33) was observed in 2.5 t/ha poultry litter biochar + 5 t/ha poultry manure while the least was observed in the control (13.00). Statistical analysis of the data indicated that pod width and length were not significantly ($p \geq 0.05$) affected by poultry litter biochar and poultry manure application (Figure 2). Okra pod weight was observed to be significantly ($p \leq 0.05$) affected by poultry litter biochar and poultry manure application (Figure 4) with 2.5 t/ha poultry litter biochar + 5 t/ha poultry manure having the heaviest pod (354.00 g) and the poorest performance (135.67) in terms of pod weight was observed in control.

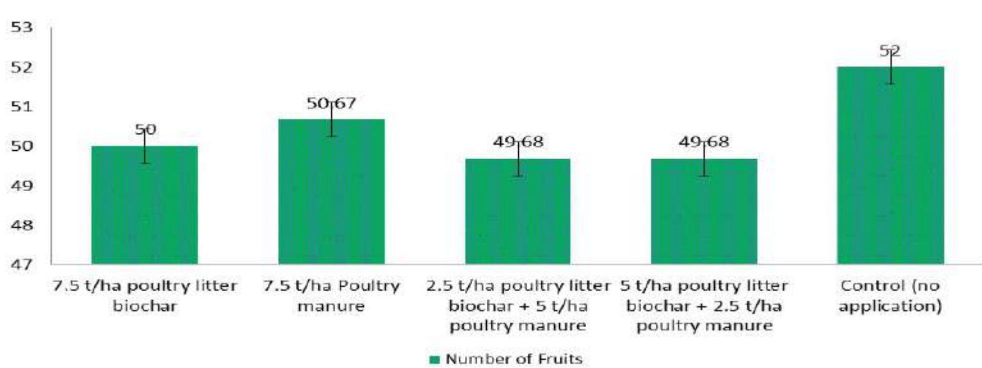

Figure 1: Effect of poultry litter biochar and poultry manure on days to 50% flowering of okra

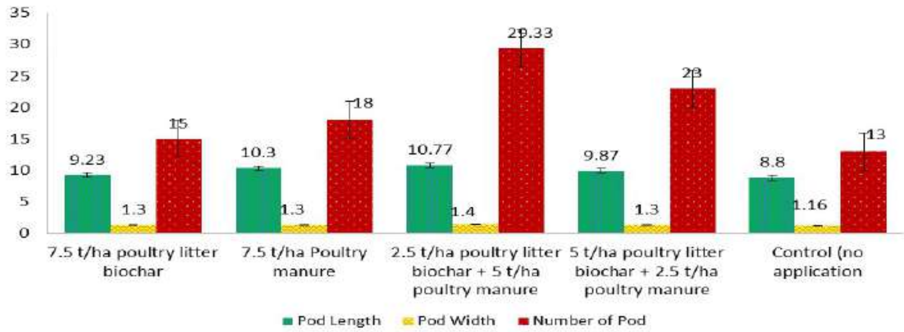

Figure 2: Effect of poultry litter biochar and poultry manure on pod length (cm), pod width (cm), and number of pods of okra

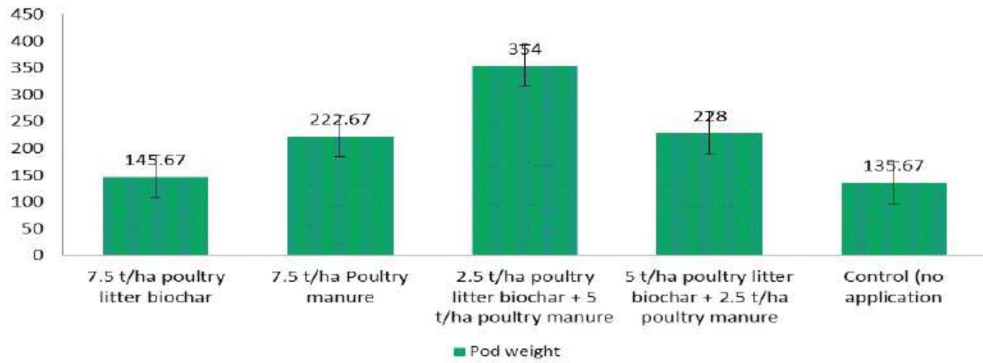

Figure 3: Effect of poultry litter biochar and poultry manure on pod weight (g) of okra

Effects of poultry litter biochar and poultry manure on the free radical scavenging power of okra fruits

Significant difference ($p \leq 0.01$) was observed in the Free radical scavenging ower of okra fruits (Table 2) was observed to be lowest in 2.5 t/ha poultry litter biochar + 5 t/ha poultry manure amended plots and was significant difference ($p \leq 0.01$) compared with other treatments that recorded higher value. However, non-significant difference was observed in 7.5 t/ha poultry manure, 7.5 t/ha poultry litter biochar, control and 5 t/ha poultry litter biochar +2.5 t/ha poultry manure respectively.

Table 2: Effects of poultry litter biochar and poultry manure on the free radical scavenging power of okra fruits

Treatments	**Free radical scavenging power of fruits (%)**
7.5 t/ha poultry litter biochar	46.89a
7.5 t/ha Poultry manure	55.76a
2.5 t/ha poultry litter biochar + 5 t/ha poultry manure	27.59b
5 t/ha poultry litter biochar + 2.5 t/ha poultry manure	45.42a
Control (no application	46.29a
Significance	**

DISCUSSION

According to the results obtained from this study, 7.5 t/ha poultry litter biochar and 2.5 t/ha poultry litter biochar + 5 t/ha poultry manure best improved the soil as compared to all other soil amendments. This might be due to the biochar ability to reduce soil pH thereby unlocking more nutrients thus making them available in the soil for plant uptake, this is in line with the studies of Van Zwieten *et al.,* 2010; Stephen *et al.,* 2011; Halim *et al*. (2016) who in their respective experiments found out that biochar application increases the soil pH, N, P, K, Mg, Ca, and organic matter content of the soil. In the growth and yield attributes of okra considered in this experiment, plots treated with the combination of both poultry litter biochar and poultry manure (2.5:5 as well as 5:25) were observed to perform best followed by plots treated with 7.5 t/ha poultry manure then 7.5 t/ha poultry litter biochar while the control gave the poorest performances. The performance of the combination of 2.5 t/ha poultry litter biochar + 5 t/ha poultry manure was observed to have an edge compared to the other treatments this is hypothesized to be due to the biochar making the nutrients present in the poultry manure be readily available for the plant to absorb easily. This aligned Sanni *et al.,* (2022) who reported that biochar application increases the yield of cowpea.).

In the free radical component of okra fruits, 7.5 t/ha poultry litter biochar, 7.5 t/ha poultry manure, 5 t/ha poultry litter biochar x 2.5 t/ha poultry manure as well as the control all had high free radical scavenging powers while the least which is rather very low as compared to all others was observed in 2.5 t/ha poultry litter biochar+ 5 t/ha poultry manure which is against the finding of Raffaella (2015) who found out that biochar application increases the free radical scavenging power of tomato fruits. This result might be due to the rate of application or a synergetic effect of poultry litter biochar and poultry manure.

CONCLUSION

From the result of this study, it is revealed that application of 2.5 t/ha poultry litter biochar + 5 t/ha poultry manure improved the experimental soil fertility and okra performances. Thus, it is recommended for adoption by okra farmers in the study area. However, as a result of the low radical scavenging power of the fruits, it is suggested that further study should be carried out with other rates of application combination especially with the free radical scavenging power of the fruits as the main parameter.

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BIOACTIVITY OF *Hippocratea velutina* AFZEL LEAF AND STEM POWDERS AS STORAGE PROTECTANTS AGAINST *Balanogastris kolae* (DESBROCHER DES LOGES) ON *Cola nitida*

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ABSTRACT

The bioactivity of Hippocratea velutina leaf and stem powders was tested against Balanogastris kolae adult emergence on stored Cola nitida. The quantitative phytochemical screening of H. velutina leaf powder gave the following mean absorbance values: Total tannin (1.6885 mgTAE/mL); Total phenolic (1.8387 mgGAE/mL); Total alkaloids (4.1600 mg/mL) and Total flavonoids (2.0510 mgRE/mL) while that of the stem powder was as follows: Total tannin (0.9135 mgTAE/mL); Total phenolic (1.8395 mgGAE/mL); Total alkaloids (5.0000 mg/mL) and Total flavonoids (1.3797 mgRE/mL). Powders were applied at 5 g, 10 g, 15 g and 20 g concentrations. Data were recorded at 2, 4, 6, 8, 10 and 12 weeks after treatment application. Kolanuts protected with 15 g leaf powder and stored for 12 weeks had the lowest number of emerged adults (2.00), which was significantly different ($p < 0.05$) from other treatments. The least number of adults (0.67) was recorded from 5 g stem powder-coated nuts, while the highest number of adults (26.67) was recorded from 15 g coated nuts. However, there was no significant difference ($p > 0.05$) in the number of adults found on untreated (control) kolanuts and all other treatments. The few numbers of adult weevil emergence obtained from nuts coated with 15 g and 20 g H. velutina leaf powder showed it successfully restricted adult weevil emergence which may be due to its higher flavonoid content. H. velutina stem powder did not significantly reduce adult emergence from treated nuts compared with the untreated.

***Keywords**: Adult emergence, Balano gastris kolae, Bioactivity, Cola nitida, Hippocratea velutina leaf.*

INTRODUCTION

In the last few decades, chemical pesticides have been used to control agricultural insect pests. As a result of massive and repeated applications, these synthetic pesticides have brought a lot of detrimental effects on the environment and caused contamination of non-target organisms. Hence, they are termed ecologically unsafe as they persist for a more extended period in the environment and exhibits residual effect as they enter into the food chain, where they cause serious havoc on non-target organisms, most especially humans (Alavanja *et al*., 2004; Upadhyay 2016; Ifebueme *et al.* 2020). One of such insect pest usually controlled by these chemical pesticides is *Balanogastris kolae*, a significant pest of kolanuts. It is the most common and economically important weevil of kolanut. *B. kolae* is a destructive field-to-store pest of kolanuts in West Africa, as they are capable of causing close to 100% damage if not checked on time (Asogwa *et al*., 2015; Azeez, 2015; Popoola *et al*., 2020). Several kinds of research have been carried out on using different plant parts to control *B. kolae*. Azeez (2015) reported that ethanolic plant extracts of *Lycopersicon esculentum* Mill*, Hyptis suaveolens* (L) Poit*, Cymbopogon citratus (*Stapf)*, Loranthus braunii* (Spaague Var)*, Alstonia boonei* (De Wild) and *Sarcocephalus latifolius* (Sm) resulted into 100% mortality of the weevils. A similar trend was observed by Ugwu *et al*. (2019) when 100% concentrations of *Azadirachta indica* (A Juss), *Piper guineense* (Schum and Thonn) and *Afframomum melegueta* (K Schum) caused 100% mortality of the adult *B. kolae*. Despite the array of plant extracts reported to be effective in decimating this weevil's population, there is a need to explore other plant species having insecticidal properties to reduce pressure on the existing ones.

The insecticidal property of *Hippocratea*, a genus of flowering plants belonging to the family Celastraceae, has been documented. They are distributed across all the tropics and comprise more than a hundred genera and 1300 species. Most of them are climbers, using their branchlets to twist around their supports (Okwute *et al*., 2018; Onyekere *et al.,* 2019). The common species of *Hippocratea* are*; H. africana, H. indica, H. excelsa, and H. velutina*. The use of this plant family in controlling insect pests of stored products has been studied, though not extensively. Methanolic leaf extract *of H. africana* exhibited suitable insecticidal property against *Sitophilus zeamais* (Oboho *et al*., 2022) and beta-cell cytotoxicity effects (Okokon *et al.,* 2013). Ndem *et al*. (2013) reported that the crude root extract of *H. africana* has anti-plasmodial properties. More so, Folawewo *et al*. (2017) investigated the antibacterial activities of the hexane and methanolic root bark extract of *H. africana* and discovered that the crude methanol extract exhibited the largest zone of inhibition against *Morganella morganii.* According to Reyes-Chilpa *et al.* (2003), the root cortex of *Hippocratea excelsa* possesses antifeedant and toxic properties against *Sitophilus zeamais.*
Information on the biological activities of *Hippocretea velutina* Afzel, a member of this family, is not currently available; hence, the need to assess its insecticidal activity on *B. kolae.* Therefore, this research aims to investigate the efficacy of the stem and leaf powder of *Hippocratea velutina* in the control of kolanuts weevils, *Balanogastris kolae* adult emergence.

MATERIALS AND METHODS

Study Area and preparation of the plant materials

This work was carried out at the Insect Chemical Ecology Laboratory, Department of Crop Protection and Environmental Biology, University of Ibadan, Ibadan, Oyo State, Nigeria. The plant material, *Hippocrates velutina,* was obtained from the Forest Research Institute of Nigeria in February 2022. It was sorted into leaves and stems, air-dried for two weeks, and the dried plant materials were ground to a coarse powder using an electric corn mill grinder M6FFC-160. The leaf and stem powders were then stored separately in airtight containers and kept in a dry place until needed.

Quantitative phytochemical analysis

Total flavonoid content: Procedure to determine the total flavonoid content of the plant extracts was as described by Deepika & Savita (2017). To 0.5 mL of extract (5mg/mL), 2 mL of distilled water and 0.15 mL of Sodium Nitrite (5% $NaNO_2$w/v) was added, and the mixture was allowed to stand for 5 mins. To the mixture, 0.15 mL of Aluminium chloride (10% $AlCl_3$) was added and left to stand for 6 min. 1 mL of sodium hydroxide (4% w/v, NaOH) was added. The mixture was made up to the 5 mL mark, and incubated at room temperature for 15minutes. The absorbance was measured at 510 nm. The procedure was repeated to obtain the blank and calibration curve for standard flavonoid Rutin (5-100 µg/mL) (Kavitha *et al.,* 2016).

Total phenolic content: Procedure from Deepika & Savita, (2017) was used to determine the total phenolic content of the plant extract. To 2 mL of Folin- ciocalteu (1:10) was added to 0.5 mL of the plant extract (5 mg/mL) in a test-tube, and incubated for 5minutes at room temperature (in the dark). Sodium carbonate (7.5% w/v, 4 mL) was added to the mixture. The resultant mixture was incubated in the dark for 30 mins at room temperature with intermittent shaking. The absorption was measured at 765 nm. Calibration curve for Gallic acid (1-20 µg/mL) and blank was also determined using the same procedure.

Total tannins: Total tannin content was determined with procedure from Kavitha *et al.* (2016). Folin ciocalteu (0.25 mL) was added to 3.75 mL of distilled water. The extract (0.05 mL of 5 mg/mL) and 0.5 mL of Na_2CO_3 was added to the solution. The mixture was made up to 5 mL mark with distilled water. The mixture was well shaken and incubated at room temperature in the dark for 30 mins. Absorbance was measured at 700 nm. Calibration curve was obtained for Tannic acid (20 -100 µg/mL). **Total alkaloids content:** Alkaloid content of the extracts were determined by titrimetric method. Obtained supernatant of the samples (10 mL of each) were taken into 10 mL of 0.1 N HCl in a flask and shaken thoroughly for 2-3 min. The lower layer contains alkaloids neutralized with 0.1 N HCl. The HCl portion (10 mL) was collected in a beaker and 2-3 drops of methyl red were added giving a slightly reddish colour. This was then titrated against 0.1N NaOH till colour changes from red to pale yellow. This was done in triplicate. The total amount of alkaloids was calculated by considering the following equivalent: 1 mL 0.1 N HCl = 0.0612 g of alkaloid (Taiwo *et al.* 2020).

Source of kolanuts

Freshly skinned kolanuts (*Cola nitida*) was purchased from a local market in Osogbo, Osun State, Nigeria. The kolanuts were cured for three days (72 hours) before the application of treatments.

Experimental set up

The method described by Akunne *et al*. (2018) was followed with some modifications. Exactly 140 g of clean uninfested kolanuts was measured into 1.5 L transparent plastic cylindrical containers with perforated lids to allow aeration. The leaf and stem powders in the proportions of 5 g, 10 g, 15 g and 20 g were added separately into the containers holding the 140 g kolanuts and then shaken vigorously to mix thoroughly. Another 140 g kolanuts, not treated with plant material, was also measured in a container and served as a control. Each of the treatments was replicated thrice. All treatments were arranged in a completely randomized design (CRD). The set-ups were kept in the laboratory at 28±2 °C and 80±2 % relative humidity.

Data Collection and Statistical Analysis

The number of emerged adults from the different treatments was counted and recorded fortnightly from 2 weeks after storage until 12 weeks (3 months). Data generated were subjected to one-way analysis of variance (ANOVA) using Genstat Release 12.1 at a 0.05 significant level. The ANOVA results were used to determine the most effective concentration of the powders that could mitigate adult weevil emergence from kolanuts.

RESULTS

The quantitative phytochemical analysis of the leaf and stem powder of *Hippocretea velutina* revealed the presence of flavonoids, tannins, alkaloids and phenols (Table 1). Total tannin (1.6885 mgTAE/mL); Total phenolic (1.8387 mgGAE/mL); Total alkaloids (4.1600 mg/mL) and Total flavonoids (2.0510 mgRE/mL) while that of the stem powder was as follows: Total tannin (0.9135 mgTAE/mL); Total phenolic (1.8395 mgGAE/mL); Total alkaloids (5.0000 mg/mL) and Total flavonoids (1.3797 mgRE/mL).

Table 1: Quantitative phytochemicals analysis of *Hippocretea velutina* (HV) leaf and stem powders

Phytochemicals	*Hippocreatea velutina*		T-test value	Significance
	Leaf	Stem		
Total Flavonoids	2.0510	1.3797	0.001252	$P < 0.05$*
Total Phenols	1.8387	1.8395	0.978686	$P > 0.05^{NS}$
Total Alkaloids	4.1600	5.0000	0.087012	$P > 0.05^{NS}$
Total Tannins	1.6885	0.9135	0.084513	$P > 0.05^{NS}$

Adult weevil emergence from Kolanuts treated with *Hippocratea velutina* Leaf Powder

The number of adults that emerged from kolanuts protected with *Hippocratea velutina* Leaf Powder (LP) from 2 Weeks After Storage to 12 Weeks After Storage (WAS) is depicted in Figure 1. The number of weevils that emerged from the treated and control kolanuts increased with time. At 10 and 12 WAS, more weevils were recorded from 5 g (13.67, 24.0) and 10 g (14.67, 22.67) and control (13.33, 13.7), respectively. A few weevils emerged from kolanuts stored with 15 g (2.0, 2.0) and 20 g (3.0, 10.0) LP at 10 WAS, and 12 WAS, respectively. Adult weevil emergent from kolanuts treated with *H. velutina* LP and stored for three months are displayed in Table 2. Kolanuts protected with 15 g LP had the lowest number of emerged adults (2.00), significantly different ($p < 0.05$) from other treatments. Also, kolanuts coated with 20 g LP and stored for three months (12 weeks) had a low number of weevils, 10.0, and it was significantly ($p < 0.05$) lower than the control (untreated) (13.67). The number of emerged adults on kolanuts decreased in the order of 10 g (22.67) > 5 g (20.67) > Control (13.67) > 20 g (10.00) > 15 g (2.00) (Table 2).

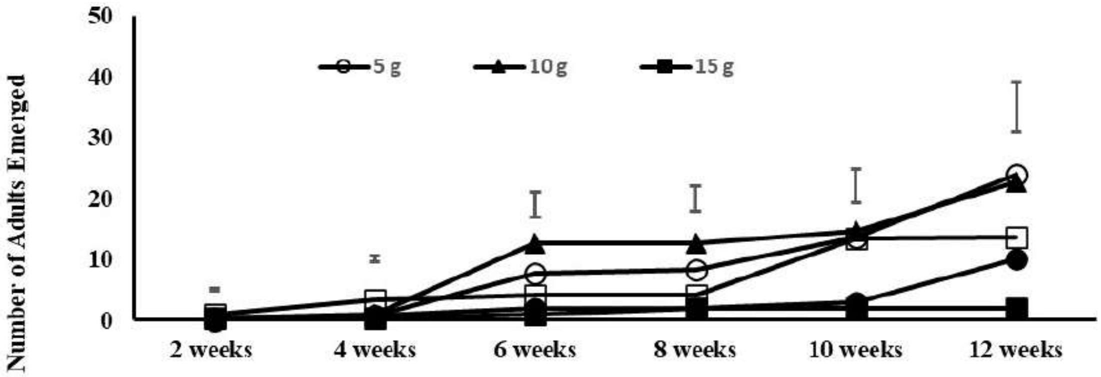

Figure 1: Adult emergence from Kolanuts protected with *Hippocratea velutina* leaf powder

Table 2: Number of Adults emergent from kolanuts protected with *Hippocratea velutina* leaf powder after 3 months of storage.

Concentrations	Number of emerged Adults
5 g (4%)	4.0 ± 1.6 ab
10 g (7%)	3.78 ± 1.7 a
15 g (11%)	0.33 ± 0.14 d
20 g (14%)	1.67 ± 1.1 c
Control	2.27 ± 1.1 b

Means ± SE with the same letters are not significantly different at $p < 0.05$ using SNK test.

Adult weevil emergence from Kolanuts treated with *Hippocratea velutina* Stem Powder

Figure 2 shows the number of adults that emerged from kolanuts coated with *H. velutina* Stem Powder (SP) and stored for 12 weeks (3 months). Adult weevils were recorded fortnightly from 2 weeks after storage to 12 weeks after storage (Figure 2). The least number of adults emerged from kolanuts coated with 5 g, while the highest number of adults was found on kolanuts coated with 15 g SP. At six weeks of storage, the number of emerged weevils increased tremendously compared to the number of weevils at 2 and 4 weeks of storage from kolanuts coated with 15 g and 20 g SP. Adult emergent from kolanuts coated with different concentrations of *H. velutina* SP are shown in Table 3. There was no significant difference at $p > 0.05$ in the number of adults found on control (untreated) kolanuts and all other treatments. However, the least number of adults (0.67) was recorded from 5 g (4% w/w) coated nuts, while the highest number of adults (26.67) was recorded from 15 g (11% w/w) coated nuts (Table 3).

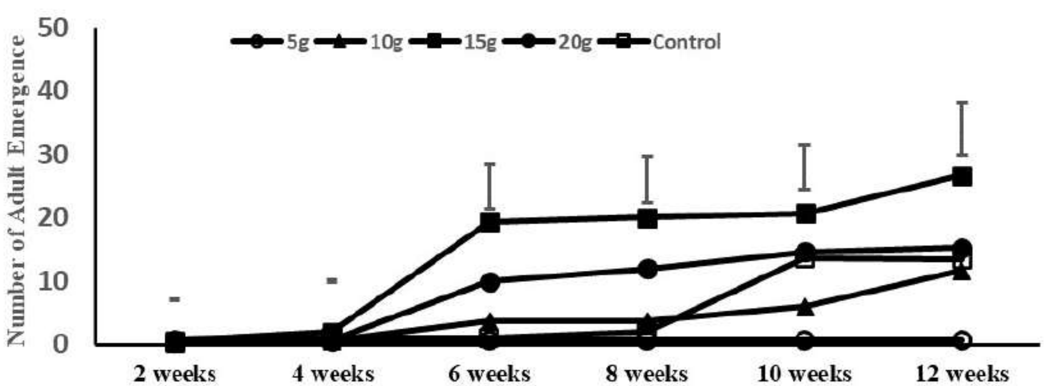

Figure 2: Adult emergence from Kolanut protected with *Hippocratea velutina* stem powder

Table 3: Number of Adults emergent from Kolanuts protected with *Hippocratea velutina* Stem powder after 3 months of storage.

Concentrations (w/w)	Number of emerged Adults
5 g (4%)	0.11 ± 0.1 b
10 g (7%)	1.94 ± 0.7 ab
15 g (11%)	4.44 ± 2.1 a
20 g (14%)	2.56 ± 1.1 ab
Control	2.28 ± 1.9 ab

Means ± SE with the same letters are not significantly different at $p < 0.05$ using SNK test.

DISCUSSION

The present study established the insecticidal ability of the *Hippocratea velutina* plant samples which can be attributed to their phytochemicals constituents. Phytochemicals such as flavonoids, tannins, alkaloids and phenols found in this plant sample have been reported to possess pesticidal activities against a host of insects (Zain *et al*., 2022; Maazoun *et al*., 2019; Ghosh *et al*., 2010). Flavonoid has been documented to have strong insecticidal activities (Maazoun *et al*., 2019; Ghaly *et al*., 2014). From this study, there is a significant difference in the quantity of the flavonoids present in the leaf powder of the botanical sample as it is higher (2.0510 with p> 0.05) than that of the stem (1.3797). This may account for the reduced number of adult emergence in *H. velutina* leaf compared to that of the stem powder observed in this study. The effect of the various concentrations of the leaf and stem powders of *H. velutina* could mitigate the rate of kola weevil emergence from cured stored kolanuts. The number of adult weevils emerging from nuts coated with 15 g (11% w/w) and 20 g (14% w/w) *Hippocratea velutina* Leaf powder was few, which suggests that these powders successfully restricted adult emergence. The phytochemical constituents in the leaf powder would be responsible for the low adult emergence. The protection of kolanuts achieved by *H. velutina* leaf powder is in agreement with Oboho *et al.* (2022), which reported the severe disruption of *Sitophilus zeamais* (Mots.) mid-gut sections by *Hippocratea africana* plant extract. Also, Reyes-Chilpa *et al.,* (2017) further corroborate this present study as it was noted that *H.excelsa* root cortex was equally toxic to *Sitophilus zeamais*.
Similarly, Onyekere *et al.,* (2019) found that crude methanolic extracts of *H. welwitschii* leaves showed activity against a broad spectrum of microorganisms, including gram-positive – *Staphylococcus aureus, Pseudomonas aeruginosa*, *Bacillus subtilis* and gram-negative – *Escherichia coli* and *Salmonella typhi.* It also exhibited antifungal activities against *Candida albicans* and *Aspergillus niger.* The plant species *Hippocratea africana, H. excelsa* and *H. welwitschii* all belong to the same genus as *H. velutina.* Hence the bioactivities of the members in the genus Hippocratea against organisms could be similar. Meanwhile, Anikwe *et al*, (2004) reported that the fruit powder of *tetrapleura tetraptera* (Shum and Thonn) was toxic to the adult *B. kolae* resulting in high mortality of the insect pests. Also, Akunne *et al,* (2018) investigated the effect of the root powder of *Derris elliptica* (Wall.) Benth in controlling *B. kolae* infestation and discovered that across all the concentrations, a very high mortality was observed. The root powder application at the 10g and gave the most increased mortality of *Balanogastris kolae.*
More so, the insecticidal ability of the leaf powder of *H. velutina* reported in this study can equally be attributed to the mode of action of powder samples as the particles of the powder may cause blockage of the adult weevil spiracles resulting in to anoxia, a condition in which there is no sufficient oxygen for normal respiration which consequently leads to suffocation of the insects (Chougourou *et al*., 2015, Fernando *et al*., 2012). Furthermore, plant powder could also act as an antifeedant as well as a repellent because the odour emanating from it can repel the adult weevil from colonizing the nuts after the application of treatments thus, hindering the insects from penetration and feeding on the kolanuts (Chougourou *et al*., 2015). Powdered plant products may also penetrate the insect body via the *respiratory system causing poisoning of the adult weevil and resultant death (Kedia et al*., 2015). Also, Sousa *et al.* (2005) reported that the plant powders caused dehydration to insects by gradualy removing the cuticle layer and their subsequent death. *Hippocratea velutina* stem powder did not significantly reduce adult emergence from treated nuts compared with the untreated (control)

kolanuts. Secondary metabolites in the stem powder were not potent in forestalling adult emergence compared to the leaf powder from the same plant, *H. velutina.*

CONCLUSION

The study evaluated the efficacy of *Hippocratea velutina* at 4, 7, 11, and 14% w/w (5, 10, 15, and 20 g, respectively) leaf and stem powders in protecting kolanuts in storage from Kola weevil infestation and damage. Clean, uninfested kolanuts (140 g) were coated with varying concentrations of leaf and stem powders of *H. velutina*. Leaf powder at 15 and 20 g / 140 g Kolanut (11 – 14% w/w) was superior to stem powder of *H. velutina* in reducing the number of emergent adult kola weevils after three months. Plant extracts and powders of plant origin are biodegradable and leave no residue on crops; hence 11 – 14% *H. velutina* leaf powder could be increased and reapplied repeatedly to ensure its ability to protect kolanuts against weevils' infestation and damage. Reduction in the number of emerged adults from kolanut coated with 15 g and 20 g Leaf powder over 12 weeks (3 months) will subsequently reduce damage to nuts by the activities of the kolanut weevils. Identifying the chemical compounds in *Hippocratea velutina* leaf powder responsible for reducing adult emergence in stored kolanuts is necessary. These findings on the insecticidal potential of *H. velutina* are the first report because there is no accessible documentation of any research work conducted on this plant at the time of writing this report. Hence the need to investigate further the phytochemical properties of *Hippocratea velutina*..

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INFORMATION AND COMMUNICATION TECHNOLOGIES: A HORTICULTURIST COMPANION FOR ENHANCED PRODUCTIVITY IN NIGERIA

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ABSTRACT
This study examined the contributions of Information and Communication Technologies to horticultural enterprises in Nigeria. The study uses secondary data to examine the importance of horticulture to Quality of life, information need, available ICTs, sources of information, benefits derived, and the constraints to ICT utilization. The study found that quality diets and sustainable livelihood come from horticulture; while production and marketing information were the most needed. The available ICT for them were Radio, Television, and Android with information sources being Radio and mobile money payment. The ICT benefits derived were the provision of timely information on market links. However, the constraints encountered in the use of ICT were insufficient funds and poor electricity supply. The study concludes that ICTs are useful for information dissemination and gathering though with a lot of constraints. Hence, horticulturist should form a cooperative society to pool their resources together to overcome the challenges

INTRODUCTION

Horticulture is the branch of Agriculture that deals with the cultivation of garden crops (fruits, vegetables, and ornamental plants) for food, aesthetics, and medicine (Lab Innovation, 2023). Its importance for food security is unveiled in its ability to provide food that enriches the human diet with balanced meals, healthy living, and a good-looking environment; hence its contributions to sustainable development cannot be overemphasized. The sector in agriculture has been useful for employment generation of various kinds, as it has been a source of livelihood for as many that engaged in horticultural practices across the value chain. The sector has been a steady source of income for those who cultivate varieties of high-valued fruits, vegetables, and ornamental plants (BYJU'S Exam Prep, 2023).

However, the sustainability of this sector of agriculture depends on the availability of resources such as land, water, human, financial, and reliable information as insufficient information on horticulture has been a great reason for its low productivity in Africa (Lab Innovation, 2023). Information is power, assets, and valuable resources that are indispensable for the maximum productivity of horticulture. Furthermore, it is a means to attain the global sustainability of agribusiness among the horticulturist who needs information on horticultural practices of fruits, vegetables, and ornamental plants across its value chain. The information needed for uptimum production by a horticulturist includes market information, agricultural extension information, information on post-harvest practices, sources of credit, pests and diseases management, food safety practices, access to inputs, and weather reports among others. According to Bhusal, Sagar and Khatri, (2021) effective and efficient information for agribusiness could easily be harnessed by ICTs such as Radio, Television, App for horticulture, GPS, print media, internet, and mobile phones among others; as ICTs have been a bridge that links the researchers, extension officers, and horticulturist together.

ICT information comes with bountiful benefits for the horticultural sector of agriculture for enhanced efficiency and productivity of fruits, vegetables, and ornamental plants as it renders timely access to information for higher productivity (Ramanna, 2020 and Khaliq, Naeem, Abbas, Khalid, 2016). However, there are various challenges and limitations to the use of ICTs by the horticulturist in developing nations which include fluctuation services and inadequate access to ICTs (Naik, Rao, Rambabu and Rekha, 2022 and Obinna, Udeanya and Chinwendu, 2023). To this end, this study reviewed the contributions of horticulture to Quality of life, information needs of the horticulturist, sources of information, types of ICTs available for horticulturist, benefits to ICT utilization, and constraints to use of ICTs by the horticulturist.

METHODOLOGY

Secondary data was used for the study using past studies as found in websites, research reports, annual reports, and already conducted survey analyses.

a. Contributions of horticulture to Quality of Life

Picture 1: Horticultural food product
Source: Feed the Future Innovation Lab for Horticulture. https://horticulture.ucdavis.edu/horticulture-overview

The great role of horticulture in sustainable development that enhances a good quality of life is as follows;

Enhances Human diets: Fruits, vegetables, and ornamental plants are the product of Horticulture. These products specifically contribute nutrients like vitamin, minerals, antioxidants, fiber, and roughage to sustain and enhance the intake of balanced diets, and prevents most of the disorders that inadequate nutrients in fruits, vegetables, and ornamentals can cause in man.

Provision of sustainable livelihoods: Horticulture has proven to be a good job provider for people across its value chain. Employment offered by this sector of agriculture includes; input suppliers, (seed, manure, pesticides, fertilizer, and herbicides); extension officers, labourers (Farm hands), transporters, processors, industries that use the horticultural produce as raw material, and marketers among others. Fruits, vegetables, and ornamental plants increase farmers' profits as affirmed by Obinna, Udeanya, and Chinwendu, (2023)

B. Information needs of the horticulturist

Horticulturist needs to be abreast of the following information for the smooth running of the enterprise. These include;

a. Market information: This will enable the horticulturist to know the available market, current price, and marketing strategies needed for the successful production of horticultural crops (Obinna, Udeanya, and Chinwendu 2023.)

b. Production information: This involved having ample information about the varieties of fruits, vegetables, and ornamental plants as per the suitable land source, soil well-being and soil nutrients.

c. Agricultural extension information: The agricultural extension is a link between the researcher and the horticulturist in the dissemination of agricultural information and the adoption of technology by farmers using various methods (Narasimha, 2021).

C. **Types of ICTs available for horticulturist practices**

The available ICT will determine the type and mode of horticultural information that farmers could receive. Also, this will determine the format through which the information could be accessed. The sources available and accessible by the horticulturist includes; Radio (Horticultural Radio programme and, Radio jingle, marketing information); Television, Short service message (SMS); Android phones, videos, and video conferencing with the scientist and researchers (Obinna, Udeanya, and Chinwendu 2023).

D. Sources of ICT-based information

ICT-based information on horticultural practices could get to the end user through the following services as follows; a. Mobile Money Providers. b. Radio. Television. c. Telecommunication companies (Telcos) d. Smart/Precision agriculture solution service providers (Sensor and wireless sensor network, Geographical Information System, Remote Sensing) e. Internet Service Providers f. Mobile Money Providers (Obinna, Udeanya, and Chinwendu, 2023).

E. Benefits of ICT utilization

There are a lot of benefits that a horticulturist can enjoy from the use of available and accessible ICTs in their enterprise. Through the use of ICT, the horticulturist has access to timely and accurate information. ICTs link horticulturists to local, urban, regional, and global markets either for selling their produce or for getting farm input via reliable market information; as well as promoting horticultural innovations and precision farming (Bhusanar and Singh, 2019). Utilisation of ICT improves the management of land and natural resources at their disposal ICTs support the sustainability of the rural economy via its efficiency and productivity and Provide information about pest and disease control (Ramanna, 2020). The use of ICTs offers better and cheaper access to finance and the provision of weather information. ICT has been a renowned tool that enhances livelihood, productivity, and poverty reduction (Khaliq, Naeem, Abbas, Khalid, 2016).

F. Constraints to ICT utilization by the horticulturist.

According to Obinna, Udeanya, and Chinwendu, (2023) and Naik, Rao, Rambabu, and Rekha, (2022), the constraints to the use of ICT information by farmers include insufficient funds, high cost of possessing ICTs, insufficient supply of electricity, ignorance of available useful ICT tool, poor network, insufficient access to ICTs, high cost of ICT maintenance and poor ICT skills of farmers. These constraints when at a high level could inhibit the effective use of ICT among the horticulturist and hence prevent maximum productivity (Yekinni, Adeniyi, Ladigbolu and Adebisi, 2020 and Lab Innovation, 2023)

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EVALUATION OF WEED SUPPRESSIVE ABILITY OF FLUTED-PUMPKIN *TELFAIRIA OCCIDENTALIS* HOOK F. ACCESSIONS

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ABSTRACT
Crop cultivars with enhanced weed suppressive abilities could play a key role in Integrated Weed Management (IWM) strategy. A field experiment was conducted at the National Horticultural Research Institute, Ibadan to evaluate the Weed Suppressive Abilities (WSA) of fluted-pumpkin Telfairia occidentalis Hook F. accessions. Thirty-eight accessions from all the major fluted-pumpkin production areas in Nigeria were evaluated. The experiment was laid out in Randomised Complete Block Design with three replications. Data were collected on weed species composition, weed density, weed biomass, weed ground cover and fluted-pumpkin canopy cover. Results indicated that 57% of the weed species were broadleaves, 33.3% were grasses while 9.1% were sedges. Results also indicated significant differences in weed density, weed biomass, weed ground cover, and fluted-pumpkin canopy cover ($p < 0.05$). Accession 38 had the lowest weed density, weed biomass and weed ground cover. The result suggested that the accessions with high canopy cover could suppress weeds, reduce weed competition with fluted-pumpkin, and hence reduce the frequency of weeding.
Key words: *Accession, Fluted-pumpkin, weed density, weed biomass, canopy-cover.*

INTRODUCTION

Fluted pumpkin (*Telfairia occidentalis*), commonly known as iroko or ugu in Yoruba and Igbo languages respectively in Nigeria is an important vegetable crop belonging to the plant family Cucrbitaceae.(Prota, 2006). It is a nutritious vegetable of tropical West Africa widely cultivated for its leafy shoots and immature edible seeds (Akoroda, 1990). The leaves are rich in iron and used to cure anaemia while also being high in protein content (Okoli and Mgbeoku, 1983). Weed competition is a major limiting factor to its production as weed competition with the crop adversely affects the crop. Although fluted pumpkin is a poor competitor with weeds, the variation in its genetic composition could play an important role in integrated weed management. Weed competitiveness comprises of the major elements namely Weed Tolerance (WT) and Weed Suppressive Ability (WSA). Weed Tolerance is the ability of a crop to maintain high yields in the presence of weeds while weed suppressive ability is the ability to suppress weed growth (Rodenburg *et. al.* 2009). The major objective of this paper therefore is to evaluate the weed suppressive ability of fluted-pumpkin accessions.

MATERIALS AND METHODS

The field trial was conducted around vegetable nursery building of the National Horticultural Research Institute headquarters, Ibadan in the 2022 cropping season between March and November. The experimental site was slashed, ploughed and harrowed with tractor-mounted implements. The plot size was 2m by 2m (4m^2) with 38 fluted-pumpkin accessions. The seedlings were transplanted at a spacing of 1m x 0.5m, making a population of 20,000 plants ha^{-1}. The experiment was laid out in Randomised Complete Block Design (RCBD) with three replications. At 4 weeks After Transplanting (WAT), inorganic fertilizer (NPK 20:10:10) mixed with organic fertilizer (poultry manure) was applied at 100 and 300 kg ha^{-1} respectively to supply the necessary nutrients to the plants as the site has been in use for planting fluted-pumpkin over many years. Staking was also done at 4WAT using teraga or table method and the crop was trailed appropriately using rope. Weed removal was done at intervals of 4, 8, 12 weeks after transplanting when crop canopy had been fully formed, and prior to pod harvesting. Data were collected on weed species composition, weed density, weed biomass, weed ground cover and fluted-pumpkin canopy cover. Weed species composition, density, and biomas were obtained from two 50cm x 50cm quadrats randomly thrown in the diagonal transects of each plot. Weeds within each quadrat were counted and cut at the base with sharp knife, sorted by species, and bulked together to form a sample. The samples collected were oven-dried at a temperature of 80^0C for 48 hours to obtain weed biomass. Weed ground cover and fluted-pumpkin canopy cover were obtained using the Line Intercept Method (LIM) used in vegetation assessment (Coulloudon *et. a*l. (1999). Statistical analysis of the data collected was performed using GenStat release 4.23 Discovery Edition Statistical software package. Means were separated using Least Significant Difference (LSD) at 5 percent probability level.

RESULTS

Nineteen weed species were frequently (more than 10%) observed in the plots. The most dominant ones were *Cleome viscosa, Mitracarpus villosus, Euphorbia heterophyla, Commelina benghalensis, Peuraria phaseoloides, Panicum maximum, Paspalum scrobiculatum and Tridax procumbens.* Of the weedspecies observed, 57.1 per cent were broadleaves, compared to grasses and sedges which were 33.3 and 9.5% respectively. This observation corroborates the findings of Olorunmaiye *et al*. 2010 that broadleaves are dominant in vegetable fields.
Weed density differed significantly among the accessions at 4, 8, and 12 WAT (table 1).

Table 1: Weed suppressive ability of fluted-pumpkin *Telfairia occidentalis* Hook F. accessions

Accessi on no.	Weed density (m^{-2})			Weed biomass ($g\ m^{-2}$)			Pumpkin canopy cover (%)	Weed cover (%)
	4 WAT	8 WAT	12 WAT	4 WAT	8 WAT	12 WAT		
AC1	126.7	272.0	213.3	70.0	109.1	209.3	79.0	21.0
AC2	78.7	353.0	282.7	50.3	184.3	370.3	81.0	19.0
AC3	65.3	242.7	201.3	62.3	108.7	264.5	79.7	20.3
AC4	81.3	197.3	92.0	55.9	87.6	466.9	81.3	18.7
AC5	129.3	278.7	46.7	39.6	141.9	189.5	83.0	17.0
AC6	72.0	333.3	420.0	55.6	189.2	574.4	0.0	100.0
AC7	68.0	378.7	328.0	64.0	220.4	740.8	0.0	100.0
AC8	40.0	434.7	416.0	61.1	293.7	812.8	0.0	100.0
AC9	89.3	278.7	150.7	46.7	110.1	282.8	41.0	59.0
AC10	120.0	408.0	362.7	46.5	198.5	253.6	83.3	16.7
AC11	73.3	150.7	202.7	66.3	64.0	321.5	80.0	20.0
AC12	81.3	402.7	420.0	43.2	216.4	858.5	20.3	79.7
AC13	65.3	342.7	409.3	57.9	237.9	653.9	68.3	31.7
AC14	44.0	332.0	36.0	35.6	120.4	170.0	89.3	10.7
AC15	142.7	436.0	317.3	67.9	103.5	258.8	64.0	36.0
AC16	69.3	206.7	453.3	80.1	101.6	411.6	30.7	60.3
AC17	88.0	129.3	138.7	57.2	52.9	194.3	53.3	46.7
AC18	66.7	221.3	89.3	51.2	82.0	251.2	64.0	36.0
AC19	60.0	260.0	189.3	51.3	136.9	296.9	74.3	25.7
AC20	44.0	394.7	250.7	33.7	318.8	390.7	54.7	45.3
AC21	41.3	440.0	596.0	33.1	180.7	788.3	46.7	53.3
AC22	66.7	444.0	630.7	63.9	255.1	720.4	0.0	100.0
AC23	38.7	107.3	73.3	71.6	182.0	164.3	34.7	65.3
AC24	93.3	296.0	677.3	48.5	200.5	996.5	43.7	56.3
AC25	64.0	385.3	753.3	55.3	367.2	712.9	0.0	100.0
AC26	69.3	406.7	402.7	42.3	183.3	763.9	0.0	100.0
AC27	110.7	200.0	278.7	29.5	129.6	302.8	79.3	20.7
AC28	105.3	185.3	228.0	36.8	57.7	92.4	0.0	100.0
AC29	125.3	401.3	696.0	70.5	276.0	1,085.3	0.0	100.0
AC30	86.7	350.7	328.0	58.9	133.7	321.5	76.3	23.7
AC31	65.3	137.3	76.0	68.0	189.7	188.5	84.3	15.7
AC32	92.0	352.0	624.0	53.6	193.7	821.9	0.0	100.0
AC33	73.3	234.7	753.3	46.4	140.3	753.3	0.0	100.0
AC34	78.7	164.0	36.0	52.3	54.7	13.6	83.7	16.3
AC35	93.3	421.3	385.3	56.0	144.4	726.4	0.0	100.0

AC36	76.0	400.0	832.0	50.0	184.7	808.3	0.0	100.0
AC37	94.7	352.0	382.7	25.1	226.3	876.3	45.3	54.7
AC38	90.7	88.0	20.0	45.3	27.9	15.1	93.7	6.3
LSD (0.05)	30.96	23.58	47.57	33.27	24.88	92.82	9.9	9.9
P (0.05)	**	**	**	NS	**	**	**	**

WAT-Weeks after transplanting. LSD- Least Significant Difference, **Significant P at 0.05, NS Not significant

At 2 WAT, accession 15 had the highest weed density which is significantly similar to that obtained in accession 1, 5, 10, 27, and 28. The lowest weed density was obtained in accession 38. At 8 WAT, the highest weed density was obtained in accession 22 while the lowest was obtained in accession 38. At 12 WAT, the highest weed density was obtained in accession 32 and it differed significantly from all other accessions (LSD = 47) while the lowest weed density was obtained in accession 38. Weed biomass also differed significantly among the accessions at 8 and 12 WAT but did not differ at 4 WAT. At 8 WAT, the highest weed biomass (367.2 gm^{-2}) was obtained in accession 25 which is significantly higher than those obtained in all other accessions. Accessions 8, 22, and 29 had similar weed biomass (293, 255, and 276 gm^{-2}respectively). At 12 WAT, accession 29 had the highest weed biomass while accession 38 had the lowest. By implication, accession 38 is the most superior accession in weed suppression while accession 25 is the weakest accession in weed suppression. The differences in the variation in weed suppressive abilities of the accessions could be attributed to the differences in the weed and fluted-pumpkin's canopy cover (Table 1).

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APPENDIX

SOURCES OF THE ACCESSIONS

Accession	Source(s)
1.	Afo-oru 1, Mbaise, Imo State.
2.	;Afo-oru 2
3.	Mbato 1
4.	Ejule 1 (Kogi State)
5.	Ogun 1
6.	Iwo 1 (Osun State)
7.	Mbato 2
8.	Orokan, Benue State
9.	Oyo 1
10.	Ugbokolo 1 Benue State
11.	Obolloafor, Enugu State.
12.	Mbato 3
13.	Ede 1, Osun State

14. Agbeluowo, Abia State.
15. Osogbo 1, Osun State.
16. Ugbokolo 2.
17. Amaozara, Enugu, State
18. Osogbo 2
19. Eti-osa, Edo State
20. Ede 2
21. Ohado-Opi, Enugu State
22. Akure 1, Ondo State.
23. Mbato 4
24. Owo 1
25. Akure 2
26. Oyo 2
27. Oyo 3
28. Akungba, Ondo State
29. Akure 3
30. Oyo 4
31. Ogurute, Enugu State
32. Owo 2
33. Ahiaba-Okuala, Abia State
34. Efugo, Oturpa, Benue State.
35. Ejule 2, Kogi State.
36. Adum, Benue State.
37. Ogun 2
38. Mpuka, Abia State

MORPHOLOGICAL EVALUATION OF SELECTED PEPPER (Capsicum spp.) ACCESSIONS UNDER PROTECTED ENVIRONMENT IN IBADAN.

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ABSTRACT
The morphological evaluation of ten accessions of pepper was conducted in a Complete Randomized Design (CRD) with four replicates in the screen house at the National Horticultural Research Institute (NIHORT), Ibadan, Oyo state. Pepper seeds were sown and raised in the nursery for 4-5 weeks before transplanting. 15 qualitative and 9 quantitative traits were assessed. The quantitative data were subjected to analysis of variance and mean separation was done with the aid of Duncan's multiple range test at 5% probability level. The result indicated significant variations for plant height, canopy width, unit fruit weight, 100 seed weight among others. plant height ranged between 78cm in NHSMB-F1/R4 and 33.5cm in NHRod-D/R2. The widest canopy was recorded in NHRod- Frt/R1 (62.5cm) while NHTTS-5/R3 had the smallest canopy width (33cm). Highest 100 seed weight was observed in NHBawa-Frt/R1 (0.49g) which is significantly different from other accessions. The qualitative data showed that leaf and Stem pubescence were observed to be sparse for all the accessions. All the accessions except NHSMB-F1/R1 have intermediate branching habit. NHSMB-F2/R1, NHSMB-F1/R4 and NHRod-D/R2 have purple nodal anthocyanin while the remaining accessions have green. Variations among the cultivars were also observed for fruit shape where they exhibited triangular (3 accessions), elongate (4 accessions), blocky (1 accession), almost round (1 accession) and campanulate (1 accession). The information from this study can be used to formulate methods and strategies for conservation and in turn genetic improvement of the pepper crop. Further studies on wider range of pepper accessions in order to establish their morphological distinctness, genetic diversity and relatedness may provide higher opportunities for selection and hybridization for the development of improved cultivars.
Keywords: *accessions, morphological evaluation, pepper, qualitative trait*

INTRODUCTION

Pepper (Capsicum spp.) is an economically important horticultural crop that has been widely used in cuisines worldwide as both a vegetable (bell peppers) and as spices (chili peppers) for condiments purposes (Zimmer *et al*. 2012). Although many peppers from the Capsicum genus of the Solanaceae family are known, only five are cited in literature as fresh or culinary spices: *C. annuum, C. baccatum, C. chinense, C. frutescens* and *C. pubescens* (Kantar *et al*., 2016; Meckelmann *et al*., 2013; Rigon *et al*., 2012) and only two are most commonly used: *C. annuum* and *C. frutescens* (Fernández-Bedmar and Alonso-Moraga, 2016; Gurnani *et al*., 2016). The genus Capsicum, has a great nutritional and economic value, and is widely grown in the whole world (Hill *et al*., 2013). The species of the Capsicum genus have great variability in its main morphological characters, such as form, size, color and position of flowers and fruits. Pepper plants are autogamous, diploid with 2n=2x=24 or 2n=26 chromosomes and have pungency as a marking characteristic, which is attributed to the alkaloid substances, more specifically the capsaicinoids (Moscone *et al*., 2007).

Various constraints have been identified for the low productivity of pepper in Nigeria and among these is inadequate high yielding and diseases tolerant cultivars as well as poor seed quality. Therefore, breeding improved varieties which satisfies the preferences of farmers and consumers has become a necessity. But, this will be impossible without identifying suitable parental pepper genotypes. Terefe *et al*, (2022) has reported that crop improvement heavily relies on a comprehensive understanding of the genetic variability and their genetic relationships which could be used in breeding programs (Furthermore, studying and understanding the qualitative and quantitative traits of pepper enables researchers to identify, classify, and assess the performance of different genotypes in order to facilitate selection of superior accessions for specific purposes and provides insights into genetic diversity present among pepper accessions. In addition, this will also contribute to the expansion and conservation of pepper germplasm for future research and breeding efforts. The objective of this study was to assess morphological characteristics of ten accessions of pepper collection and document them for further research activities.

MATERIALS AND METHODS

The evaluation of pepper morphological characters was conducted following a complete randomized design with four replications. Ten pepper accessions obtained from the Seed Technology Unit, National Horticultural Research Institute (NIHORT), Ibadan, Oyo state, were evaluated in the screen house at NIHORT, Ibadan. Seeds from this collection were sown in trays, monitored for 4-5 weeks and later transplanted into pot filled with sterilized top soil. Required crop management practices for pepper (irrigation, weeding fertilizer application etc) were carried out at the required periods. Data were collected using the IPGRI, AVRDC and CATIE (1995) Capsicum spp descriptor on 24 characters (15 qualitative and 9 quantitative) covering vegetative, flowering and yield traits. The quantitative data for vegetative and yield were subjected to analysis of variance (ANOVA). Mean separation was done with the aid of Duncan's multiple range test at 5% probability level.

Plate 1: Reference descriptor for Variation in calyx margin (IPGRI, 1995)

RESULTS

The result in table 1 showed significant variations among the ten accessions for plant height which ranged between 78cm in NHSMB-F1/R4 and 33.5cm in NHRod-D/R2. Furthermore, the widest canopy was recorded for NHRod- Frt/R1 (62.5cm) while NHTTS-5/R3 had the smallest canopy width (33cm). With respect to mature leaf length, highest mature leaf length was recorded in NHRod-C/R1 (12.38cm) which was significantly different from all other accessions. The lowest value for mature leaf length (4.50cm) was recorded in NHBawa-Frt/R1. The same trend was observed for mature leaf width as NHRod-C/R1 had the highest while NHBawa-Frt/R1 had the lowest (1.8cm). A cursory look at table 2 showed that highest unit fruit weight was observed in NHRod-C/R1 (4.69g) but it was not significantly different from that of NHTTS-5/R3 (4.59g), NHRod-D/R2 (4.56g) and NHRod-Frt/R1 (4.40g). The Table further showed that fruit width ranged from 2.53cm to 0.67cm among the 10 pepper accessions and NHRod-Frt/R1 recorded the highest value. In addition, NHSMB-F2/R1 had the highest fruit length (6.93 cm) which was statistically different from all other accessions. Results of the seed data (Table 2) showed that the highest 100 seed weight was observed in NHBawa-Frt/R1 (0.49g) which is significantly different from other accessions. It is followed by NHTTS-5/R3 (0.44g) and NHSMB-F2/R1 (0.44g) which are not significantly different from NHSMB-F1/R4 (0.42g). The table also showed variation in the number of seeds per fruit with NHTTS-5/R3 having the highest number of seeds (47.50).

Results on morphological characterization in Table 3 showed that there were variations and similarities among the pepper accessions. Leaf and Stem pubescence were observed to be sparse for all the accessions. Similarly, stem colour, lamina margin and stem shape were generally green, entire and cylindrical respectively. All the accessions except NHSMB-F1/R1 have intermediate branching habit. NHSMB-F2/R1, NHSMB-F1/R4 and NHRod-D/R2 have purple nodal anthocyanin while the remaining accessions have green. NHRod-C/R1 and NHTTS-5/R3 have their stigma exsertion on the same level while other accessions are exserted. variations among the cultivars were also observed for fruit shape where they exhibited triangular (3 accessions), elongate (4 accessions), blocky (1 cultivar), almost round (1 cultivar) and campanulate (1 cultivar).

Table 1: Growth parameters of 10 pepper accessions evaluated for morphological traits

Accessions	Plant height (cm)	Canopy width (cm)	Mature leaf length (cm)	Mature Leaf width (cm)
NHRod- Frt/R1	66.00b	62.50a	5.63 de	2.92 cd
NHBawa-Frt/R1	67.50b	50.00b	4.50 e	1.80 e
NHSMB-F1/R1	44.50d	46.50cd	5.33 de	2.57 cde
NHSMB-F1/R4	78.00a	57.50a	5.73 de	2.48 cde
NHSMB-F2/R1	68.00b	53.50b	9.13 b	3.30 c
NHSMB-F3/R1	43.00d	48.50b	5.62 de	2.67 cd
NHSMB-F3/R4	70.00b	47.00bc	8.05 bc	4.15 b
NHRod-C/R1	52.00c	42.00d	12.38 a	5.47 a
NHRod-D/R2	33.50e	45.50cd	4.57 e	2.48 cde
NHTTS-5/R3	56.00c	33.00e	6.72 cd	2.41 e
S.E	3.20	3.50	**0.65**	**0.26**

Means with the same letter are not significantly different in accordance with Duncan Multiple Range Test (DMRT) at 5% probability level.

DISCUSSION

High variations have been observed in the morphological traits assessed among the ten selected accessions of pepper which could due to genetic components. Variations in cayenne pepper genotypes have also been reported by Abdul-Rafiu *et al*, (2018) in which number of fruits and seed yield and other traits were assessed. In 2012, Maga *et al*., utilized multivariate analysis to study agro-morphological traits in aboriginal Nsukka yellow pepper (Capsicum annumm) genotypes and observed wide diversity for all the characters studied. The pepper accessions evaluated in this study based on morphological variations and similarities can be classified into three different species; Capsicum annuum, C. chinense and C. frutescens. These three species are generally grown in Nigeria with varying degree of uses. Proper documentation of the data generated from this study will be useful for further research as the potential use of each of the accession can easily be identified. This information can be used to formulate methods and strategies for conservation and in turn genetic improvement of pepper crop. Further studies on wider range of pepper and addition of more accessions in order to establish their morphological distinctness, genetic diversity and relatedness may provide higher opportunities for selection and hybridization for the development of improved cultivars.

Table 2: Fruit and seed parameters of 10 accessions of pepper evaluated for morphological traits

Accessions	Unit fruit weight (g)	Fruit width (cm)	Fruit length(cm)	100 seed weight(g)	Number of seed per fruit
NHRod-Frt/R1	4.40 ab	2.53 a	3.37 bc	0.36 e	22.00 bc
NHBawa-Frt/R1	3.41 bcd	1.30 c	4.37 b	0.49 a	40.50 a
NHSMB-F1/R1	2.17 e	0.67 d	1.93 d	0.40 d	6.00 c
NHSMB-F1/R4	2.22 de	0.67 d	1.13 e	0.42 bc	19.50 c
NHSMB-F2/R1	3.49 abc	1.53 bc	6.93 a	0.44 b	38.00 ab
NHSMB-F3/R1	2.23 de	0.63 d	2.07 d	0.33 f	7.00 c
NHSMB-F3/R4	2.40 cde	0.70 d	4.67 b	0.33 f	14.50 c
NHRod-C/R1	4.69 a	2.00 b	1.77 de	0.41 c	12.00 c
NHRod-D/R2	4.56 a	2.30 a	2.27 d	0.36 e	15.00 c
NHTTS-5/R3	4.59 a	2.53 a	1.77 de	0.44 b	47.50 a
SE	**0.36**	**0.17**	**0.21**	**0.01**	**6.53**

Means with the same letter are not significantly different in accordance with Duncan Multiple Range Test (DMRT) at 5% probability level.

Table 5: Qualitative traits evaluated in 10 accessions of pepper

Characters	Accessions NHRod-Frt/R1	NHBawa-Frt/R1	NHSMB-F1/R1	NHSMB-F1/R4	NHSMB-F2/R1	NHSMB-F3/R1	NHSMB-F3/R4	NHRod-D/R2	NHRod-C/R1	NHTTS-5/R3
SC	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
NA	Green	Green	Green	Purple	Purple	Green	Green	Purple	Green	Green
PGH	Erect	Erect	Intermediate	Erect	Erect	Intermediate	Intermediate	Intermediate	Erect	Erect
BH	Intermediate	Intermediate	Dense	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate
LC	Green	Light green	Light green	Light green	Light green	Variegated	Green	Green	Light green	Green
LS	Lanceolate	Lanceolate	Lanceolate	Lanceolate	Lanceolate	Ovate	Ovate	Ovate	Ovate	Lanceolate
LM	Entire	Entire	Entire	Entire	Entire	Entire	Entire	Entire	Entire	Entire
LP	Sparse	Sparse	Sparse	Sparse	Sparse	Sparse	Sparse	Sparse	Sparse	Sparse
LD	Intermediate	Sparse	Dense	Sparse	Intermediate	Sparse	Intermediate	Sparse	Intermediate	Sparse
SS	Cylindrical	Cylindrical	Cylindrical	Cylindrical	Cylindrical	Cylindrical	Cylindrical	Cylindrical	Cylindrical	Cylindrical
SP	Sparse	Sparse	Sparse	Sparse	Sparse	Sparse	Sparse	Sparse	Sparse	Sparse
NFX	1	1	2	2	1	1	1	1	2	1
CM	5	7	7	3	7	7	7	5	7	7
FS	Blocky	Elongate	Triangular	Triangular	Elongate	Elongate	Elongate	Triangular	Almost round	Campanulate
SE	Exserted	Exserted	Exserted	Exserted	Exserted	Exserted	Exserted	Exserted	Same level	Same level

SC: Stem Colour; NA: Nodal Anthocaynin; PGH: Plant Growth Habit; BH: Branch Habit: LC: Leaf Colour; LS: Leaf Shape; LM: Lamina Margin; LP: Leaf Pubescence; LD: Leaf Density; SS: Stem Shape; SP: Stem Pubescence; NFX: Number of Flowers per Axil; CM: Calyx Margin; FS: Fruit Shape; SE: Stigma Exsertion

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EMERGENCE AND SEEDLING GROWTH OF *Irvingia gabonensis* AS AFFECTED BY POSTHARVEST HANDLIING

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ABSTRACT
A nursery trial was set up to determine the appropriate storage period and postharvest practices for optimum seed germination of Irvingia gabonensis. The experiment which was carried out at the nursery of National Horticultural Research institute, Otukpa Benue State, was a factor experiment in randomized complete block design (RCBD) with eight treatments replicated three times. The treatments include: fruits picked and planted immediately (T1), fruits picked, depulped and planted immediately (T2), fruits picked and stored for 1 week before planting (T3), fruits picked, depulped and stored for 1 week before planting (T4), fruits picked, stored for 1 week then depulped before planting (T5), fruits picked and stored for 2 weeks before planting (T6), fruits picked, depulped and stored for 2 weeks before planting (T7), fruits picked, stored for 2 weeks then depulped before planting (T8). Data collected were subjected to analysis of variance (ANOVA) and significant means were separated by Duncan Multiple Range Test (DMRT) at 5% probability level. Storage and post harvesting handling significantly affected percentage emergence, seedling height, number of leaves and seedling vigour. At 9 weeks after sowing (WAS), T2 had significantly higher germination percentage (95%) then T1 (70%), T7 and T8 did not germinate throughout the period of observation. It can then be concluded that Irvingia gabonensis are best sown immediately the fruits are picked from orchard or forest floor and depulped.
Keywords: *Depulped, fruits, germination, Irvingia gabonensis, storage.*

INTRODUCTION

Irvingia gabonensis (bush mango) is one of the most important Non-Timber Forest Products (NTFPs) in West and Central Africa especially in Southern Nigeria (Ladipo, 2000; Lowe *et al.,* 2000; Atangana *et al.,* 2002). It is ranked as the most important species for its food and commercial value in Cameroon and West Africa (Leakey, 1999; Ladipo, 2000). It is an African indigenous fruit tree that produces edible fruits and seeds (Atangana *et al.,* 2002). Bush mango is a valuable source of income for farmers and traders in Nigeria, where the fruit is traded locally (Ladipo, 2000). The kernels, which fetch a higher price than the fruits are traded regionally and internationally, which has given it the potential for a true commercial crop, and this has led to a more intensive collection in the forests. The most important part of *I. gabonensis* to most people is its nutritious seeds, which have also been found useful in the reduction of cholesterol and body weight in obese patients (Ngondi, 2005). The seeds constitute an important part of the rural diet in Nigeria, the sun-dried seeds are ground into flour and used as soup thickeners (Ekpe *et al.,* 2007). Despite the nutritional importance of *I. gabonensis*, there is a scarcity of large-scale plantations of the species for mass seed and fruit production. Most of the trees have been growing in the wild, as they have not been domesticated. Although, bush mango is recently being domesticated, less than 10 percent of the total annual harvest of fruits or kernel is harvested from planted trees while the rest are collected from the natural forests (Ladipo, 2000). Constraints to domestication of the species include the long gestation period of seed sown trees (Moss, 1995; Ladipo *et al*., 1996), poor germination capacity (Nya *et al*., 2000) variability of fruits and kernel characteristics, variability in tree size (Ladipo *et al*.,1996, Schreckenberg *et al*., 2001) and limited knowledge base (Tchoundjeu *et al.,* 2002). According to Nya *et al.* (2006), one major difficulty in *Irvingia* domestication is related to its poor seed germination potential which is less than 50% germination capacity when freshly collected and sown. The objective of this study was therefore to the appropriate storage period and postharvest practices for optimum seed germination of *Irvingia gabonensis.*

MATERIALS AND METHODS

The experiment was carried out at the nursery of National Horticultural Research institute, Otukpa (7º6´4.30776" N and 7º38´47.25924" E 436 m a.s.l) in Ogbadibo Local Government Area of Benue State, Nigeria. Two hundred and forty (240) matured fruits of *Irvingia gabonensis* were collected from existing orchard in the Institute for the trial. The trial was a one factor experiment set up in randomized complete block design (RCBD) with eight treatments replicated three times. The treatment include: Fruits picked and planted immediately (T1), Fruits picked, depulped and planted immediately (T2), Fruits picked and stored for 1 week before planting (T3), Fruits picked, depulped and stored for 1 week before planting (T4), Fruits picked, stored for 1 week then depulped before planting (T5), Fruits picked and stored for 2 weeks before planting (T6), Fruits picked, depulped and stored for 2 weeks before planting (T7) and Fruits picked, stored for 2 weeks then depulped before planting (T8).

Ten fruits were planted into each plot of 30 cm x 30 cm with sawdust as the growth medium. The nursery was watered regularly and kept weed free. All the ten plants in each plot were tagged for data collection starting from 4 weeks after sowing (WAS). Data collected included emergence count, plant height and number of leaves. The seed emergence criterion was visible protrusion on the sawdust surface of at least 0.5cm of the cotyledon and hypocotyls of the seedlings. Data collected were subjected to analysis of variance (ANOVA) and significant means were separated by Duncan Multiple Range Test (DMRT) at 5% level of probability, using SAS.

RESULTS

Result from this study showed that germination of Irvingia started from 4 weeks after sowing (WAS) but significant effect of storage and depulping was observed at 5 WAS where seed germination has occurred in all the treatments except T7 and T8. These two treatments (i.e. T7 and T8) did not germinate throughout the period of observation (10 WAS). At 5WAS, T3 and T5 had the highest germination percentage (30%), though these were not significantly different from T1 and T2 which had 25% germination percentage (Figure 1). At 6 WAS, T1 and T2 had the comparable germination percentage (60%) which were significantly higher than other treatment, this was followed by T5 which had 50% then T3 which has 45% germination (Figure 1). At 7 WAS, germination percentage of T2 has increased to 80% while that of T1 only increased to 65%, T5 increased to 55% and T3 increased to 50% (Figure 1). At 8 WAS, only the germination percentage of T2 increased to 90% while there was no increase in other treatments (Table 1). At 9 WAS, only T1 and T2 had increase in germination percentage (70% and 95% respectively), no increase in germination was observed on other treatments. Beyond 9 WAS, no increase in germination was observed in any of the treatments, indicating that they have reached their maximum germination percentage at 9 WAS. At this stage, T2 had significantly higher germination percentage (95%) than any of the treatments, this was followed by T1 which had (70%) T5 and T3 which had 55% and 50% respectively. T4 and T6 had germination percentage of 45% and 20% respectively while T7 and T8 did not germinate at all throughout the period of observation (Figure 1).

Storage and post harvesting handling significantly affected seedling height, number of leaves and seedling vigour of Irvingia at both 6 and 8 WAS (Table 1). At 6 WAS, seedlings of T3 were observed to be significantly taller (20.78 cm) than other treatments, this was followed by T5 (19.62 cm) then T2 (18.64 cm) while T6 had the shortest seedlings of 15.00 cm. As growth advanced to 8WAS, T5 were the tallest (21.33 cm) but not significantly different from T3 (21.32 cm) and T1 (20.98 cm). T6 was also the shortest with height of 17.93 cm (Table 1). At 6 WAS, T6 produced the highest number of leaves (4) while T1, T2 and T4 produced the least number of leaves (3). At 8 WAS, T4 produced the highest number of leaves (5) while other treatments produced 4 leaves (Table 1). At 6 WAS, T2 had the highest seedling vigour (11.18) while T6 had the lowest (3.00) but at 8 WAS T2 and T6 had the highest and the lowest seedling vigour (18.23 and 3.59 respectively) while no significant difference existed among other treatments in terms of seedling vigour (Table 1).

DISCUSSION

From this study, germination of Irvingia seeds started at 4 WAS which could be as a result of the hard seed coat. This observation supports the report that germination of *I. gabonensis* seeds takes upwards of 14 days and first requires that the seeds are extracted from the fruit and dried for at least 2 days (Ainge and Brown, 2001). This study also revealed that fruits picked, depulped and planted immediately had the highest percentage emergence (95%) this corroborates the report of Okafor (1997) who reported 80% germination for seeds that are extracted from the fruit and dried for at least 2 days. It was observed from this study that fruits of Irvingia depulped before planting immediately after picking had higher percentage of emergence than those that were not depuled. This could probably be as a result of the fact that removal of the fruit mesocarp exposed the seeds early to suitable environments like water and oxygen for seed germination as reported by Mbakwe (2004). Nzekwe et. al. (2002) observed that the long periods taken by seeds of undepulped fruits to begin germination were expended on the decay of the fruit mesocarp. MacDonald, (1986) opined that the fleshy tissues or pulp should be removed to prevent damage to the embryo from spontaneous heating or an imbibiting substance. Vihotogbé *et. al.* (2014) opined that sowing fresh seeds in less depth than 1 cm hole guarantees better performances (germination rate of 98 -100%) for any provenance and for both bitter and sweet trees. This study further revealed that fruits depulped before storage or after storage for 2 weeks before planting did not germinate throughout the period of observation, this implies that Irvingia fruits stored for two weeks (i.e. 14 days) before planting is not likely to germinate. This result support the report of Joseph and Aworh (1991 and 1992) that, fresh fruits of *I. gabonensis* have a shelf life of less than 2 days if picked when ripe and not more than 10 days if harvested at the mature green stage due to high respiration rate, moisture loss and microbial attack. Also, Lowe *et al*. (2000) reported that attempting to dry these high oil content seeds (up to 70%; Joseph, 1995) in a tropical high moisture environmental condition exposes them to rapid moulds colonisation, jeopardising the viability of seeds after few days of conservation under ambient conditions.

CONCLUSION

This study revealed that *Irvingia* fruts picked, depulped and planted immediately has the higher percentage germination followed by those picked and planted immediately without depulping. It can then be concluded that *Irvingia* seeds are best sown immediately the fruits are picked from orchard or forest floor and depulped.

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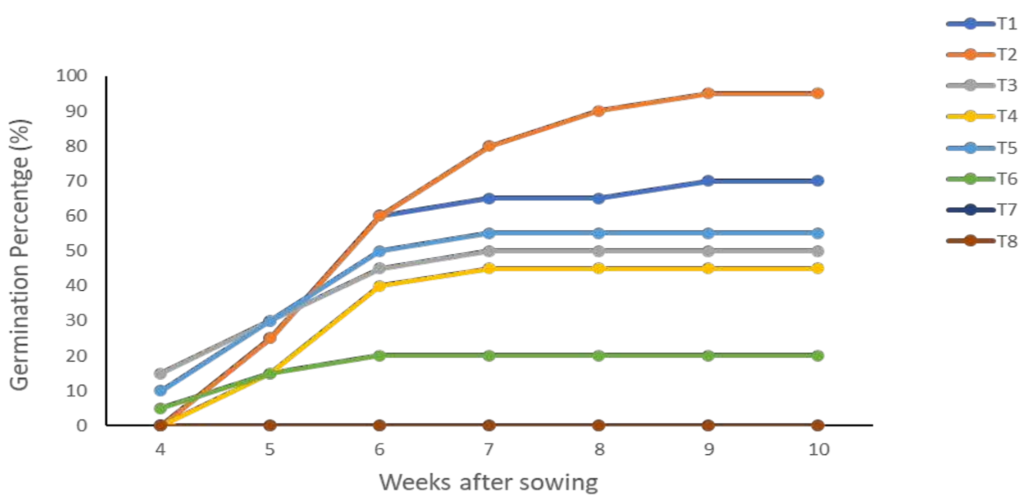

Fig. 1: Germination percentage of Irvingia gabonensis as affected by postharvest handling and storage

Table 1: Growth of *Irvigia gabonensis* seedlings as affected by postharvest handling and storage

Treatments	Plant height (cm)		Number of leaves		Seedling vigour	
	6WAS	8WAS	6WAS	8WAS	6WAS	8WAS
T1	17.26c	20.98a	3.25b	3.69b	10.35ab	13.55b
T2	18.64bc	20.25ab	3.22b	3.81b	11.18a	18.23a
T3	20.78a	21.32a	3.53ab	4.21ab	9.41ab	10.68b
T4	17.40c	20.82ab	3.00b	4.57a	6.99bc	9.65b
T5	19.62ab	21.33a	3.50ab	3.91ab	9.98ab	11.89b
T6	15.00d	17.93b	4.00a	4.00ab	3.00cd	3.59c
T7	0.00e	0.00c	0.00c	0.00c	0.00d	0.00c
T8	0.00e	0.00c	0.00c	0.00c	0.00d	0.00c
$LSD_{0.05}$	1.74	2.94	0.54	0.68	4.01	4.27
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PHENOLIC CONTENT AND ANTIOXIDANT ACTIVITIES OF DIFFERENT TEAS AND THEIR SYNERGIES POTENTIALS.

Ademoyegun, O. T. and Owolade, S. O.

ABSTRACT

Plant nutrients having antioxidant sources have been a major focus of research in recent years because they were regarded as magic bullets that could help to prevent many human diseases such as cancer, arthritis, Alzheimer, cardiovascular diseases e.t.c. In the present research the seven plant namely: Moringa leaves "Moringa oleifera", roselle calyx "Hibiscus sabdarifa", Ugu leaves "Telfaria occidentalis", Ginger rhizomes "Zingiber officinale", Tumeric rhizomes "curcuma longa", Lemon grass "Cymbopogon citratus" and Bitter leaves "Vermonia amygdalina" have been selected as all these plants show antioxidant potential individually. People used to drink tea often by insert tea bag into boiled water. These infusions release the extract into the hot water. Ginger tea is most often tea like to drink because of its smell and health benefits. Ginger rhizome extract was combined with the extracts of fore-mentions plants extracts in ratio 1:1 in weight, and only ginger rhizomes as control. The results of the study showed ginger and bitter leaves combinations displayed significant polyphenolic strength, antioxidant potential in DPPH and Nitrous oxide assay, while ginger and moringa leaves shown the highest potential in reducing power assay. Organoleptic studies showed ratio 1:1 of ginger and turmeric exhibited highest in colour and for overall acceptability, aroma and taste combination of ginger with Roselle calyx extracts exhibited the best. Generally, the ratio of ginger 1:1 with others extracts proportion, showing the highest radical quenching ability and strongest synergism in in-vitro. Thus, this study provides the scientific basis for combining aqueous infusions to attain maximum antioxidant potential.

Keywords*: Phenolic, antioxidant assays, teas, synergies, ginger.*

INTRODUCTION

The health benefits of tea are widely recognized by medical and nutritional experts (Adesokan *et al*., 2013 and Shirwaikar *et al.*, 2006). Indeed, tea is well known as a nutritional source of bioactive compounds, namely polyphenols that provide antioxidant activity. These chemicals can play an important role in adsorbing and neutralizing free radicals, quenching singlet and triplet oxygen, or decomposing peroxides. They act as radical scavengers and are able to inhibit lipid peroxidation and other free radical-mediated processes, protecting the human body from several diseases attributed to the reactions of radicals. The combination of various plant products may exhibit different types of interactions (synergistic and additive) among their different phytochemicals, and may change their biological properties Wang *et al.,* 2011. Although these combinations are flooded in the market, limited scientific data is available that whether these combinations will act in a synergistic or additive manner. It was found that Chamomile flowers and tumeric tea showed synergistic antioxidant interaction Kilima *et al.*, 2014. Whereas, binary combinations of ginger rhizome extract (GRE) and green tea polyphenols (GTP) demonstrated synergistic to additive interactions.

Some studies also pointed out that the ratio of the herbs would influence the antioxidant properties Monga *et al.*, 2017. It is important to investigate the modulation of antioxidant properties depending on the proportions of herbs in a mixture that can be used to design functional foods and pharmaceutical products at different concentrations Asesokan *et al.*, 2013. The ratio of the extracts significantly influenced the antioxidant capacity of a binary mixture and the type of interaction between their bioactive components Ademoyegun *et al.*, 2013. Among these studied combinations, green tea and O. gratissimum combination showed the highest antioxidant potential and maximum synergistic interaction (Awah FM 2010). Ginger rhizome is a valuable medicinal plant that has been used since ancient times. It is well known due to its medicinal properties such as antioxidant, antifungal, antimicrobial, anti-inflammatory, antiviral and anticancer Ademoyegun *et al.,* 2013 and Joshi *et al.,* 2017. However, there is no scientific literature about the interaction with other herbs tea at different ratios. The proportion of individual herb could play an important role in determining the chemo preventive potential or bio efficacy in a health-promoting herbal combination. The aim of the present study was to study the antioxidant potential of ginger base tea with different combination with others mentions above plants in ratio of one to one and using the ginger tea without combination as the control.

METHODOLOGY

Preparation of Leaf Extracts

The leaves of *the selected plants, the calyx of Roselle and rhizomes of ginger and turmeric* after collection were cleaned and then oven dried at 50°C for seven days. After that, the sample was coarsely grinded, sieved through 2 mm and then stored in an air-tight container till further used. After which 2g of the ginger powder was sealed inside the tea bag (G) and 1g of ginger powder was combined with 1g of others prepared powder was different combined, sealed in the tea bag. Which are ginger with bitter leaves (GB), ginger with lemon grass (GL), and ginger with Moringa (GM), ginger with Roselle (GR), ginger with turmeric (GT) and ginger with Ugu (GU). The herbal infusion was prepared by the hot water extraction method was used to prepare the herbal tea. Two bags of which were infused in 200 ml of distilled water at the temperatures 100°C for 10 minutes. Afterward, the sample infusion mixture was let cool for 5 minutes, the infusion teas were used to carry out the mentioned analysis with the organoleptic test.

Sensory Analysis

Acceptance test was conducted on three herbal teas infused at different temperature by 48 untrained panelists of students and staffs at National Horticultural Research Institute. Panellists used plain water between samples. The hedonic scale of 1 - 9 was used to evaluate the overall acceptability, flavour, aroma, aftertaste, mouthfeel, and color of the tea, where 1 = extremely dislike and 9 = extremely like. Scoresheet was given to each panelist. The analysis was done on each of the attributes by calculating the mean point from the result.

Determination of Phytochemical Contents

The phytochemical contents such as the total phenolic content and total flavonoids contents were determined using folin-ciocalteu and aluminum-chloride methods respectively.

Determination of Free radical Scavenging Activity

The free radical scavenging activities were determined using DPPH assay; FRAP assay, total antioxidant assay, and Nitrous oxide scavenging assay according to standard methods.

Statistical Analysis

The statistical analyses were performed by a one-way ANOVA using Microsoft Excel 2016. The results were expressed as means ± SD to show variations in the various experiments. Differences are considered significant when $p < 0.05$.

RESULTS

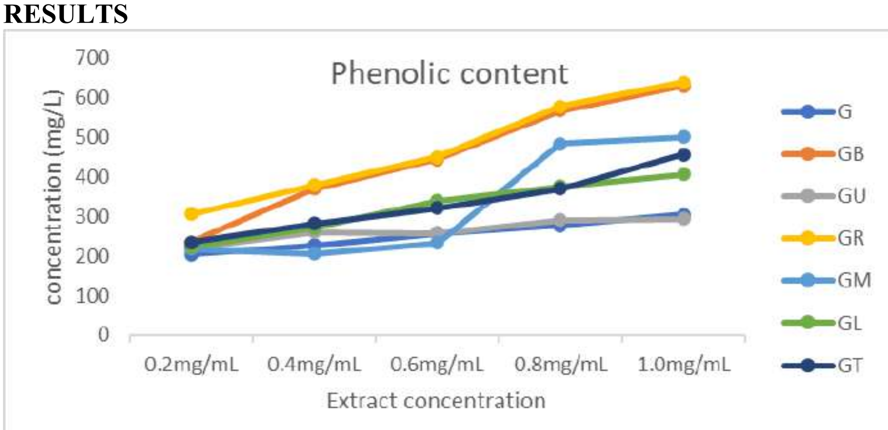


Figure 1: Phenolic content of the seven tea extracts at different concentration.

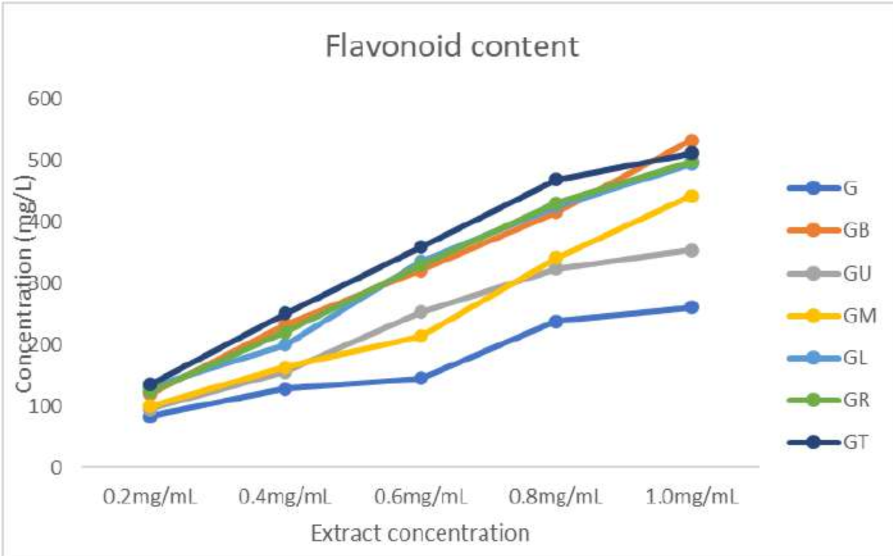


Figure 2: shown the flavonoid content of the seven tea extracts at different concentration.

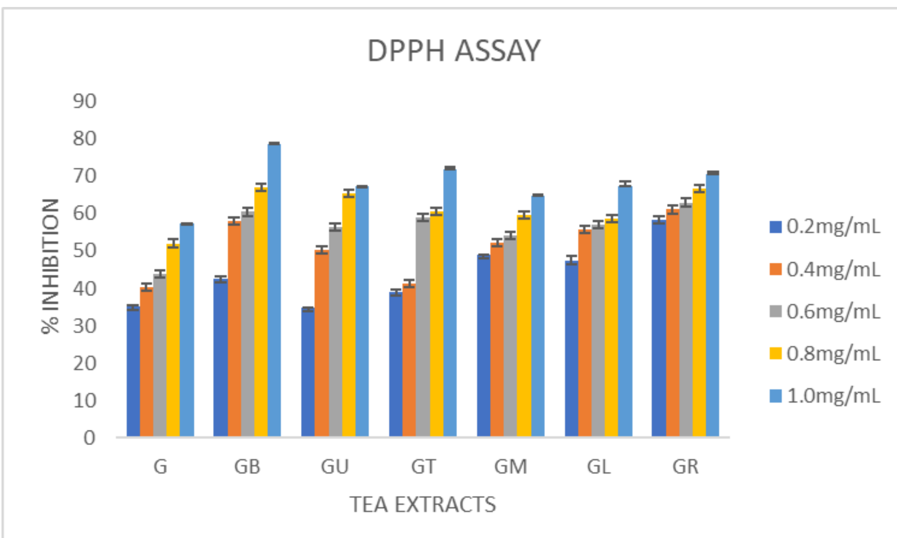


Figure 3: 1, 1-Diphenyl-2-picrylhydrazyl (DPPH) radical scavenging activity (RSA)
The ability of the extracts to scavenge DPPH free radicals

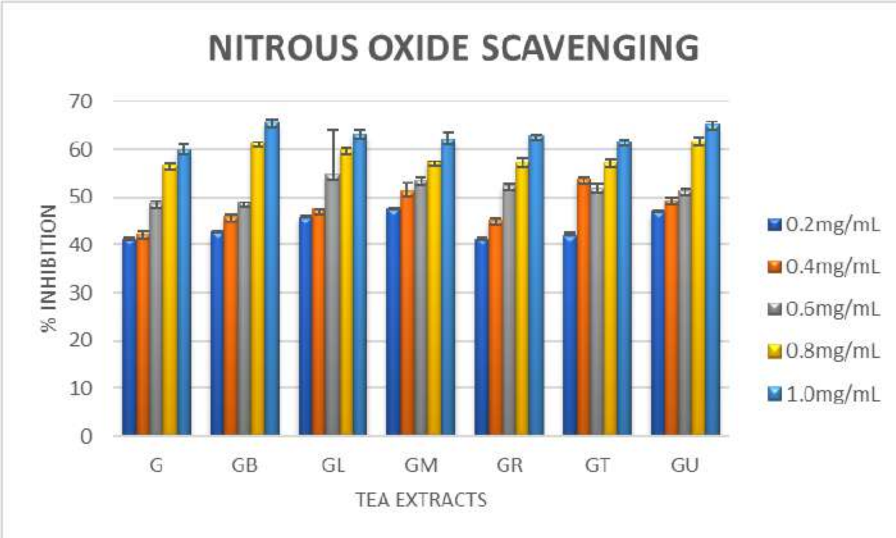


Figure 4: Nitric oxide scavenging activities of the seven tea extracts at different concentration.

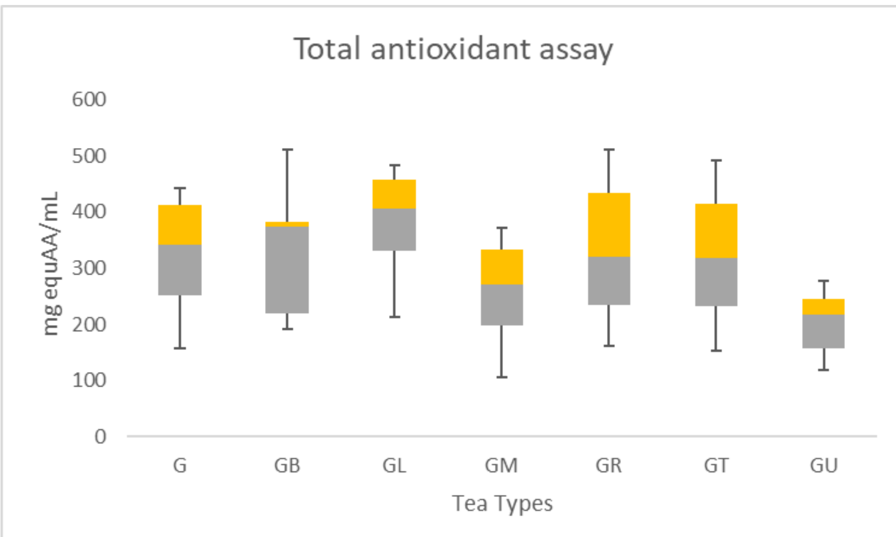


Figure 5: Box and whisker plots represent the mean concentration range (lowest, 25 percentile, median, 75 percentile and highest) of different concentration extracts of tea types graphically shown the total antioxidant assay

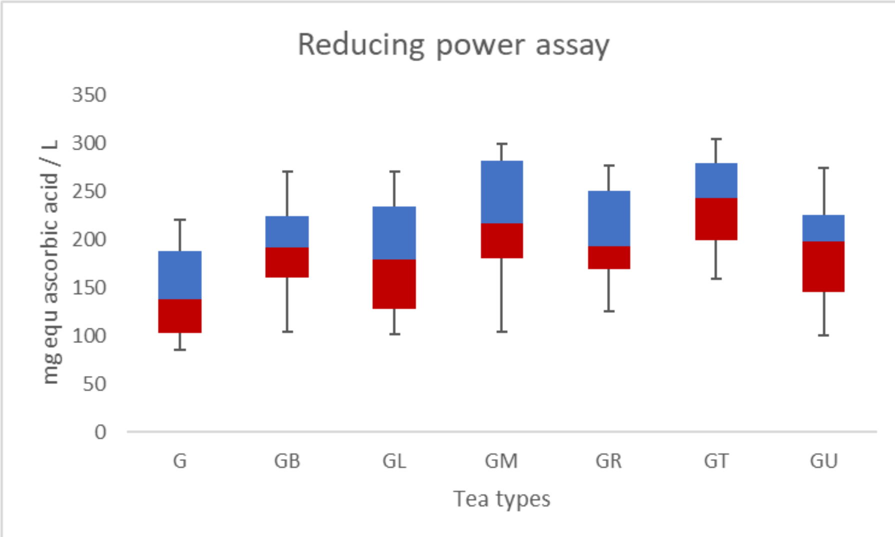
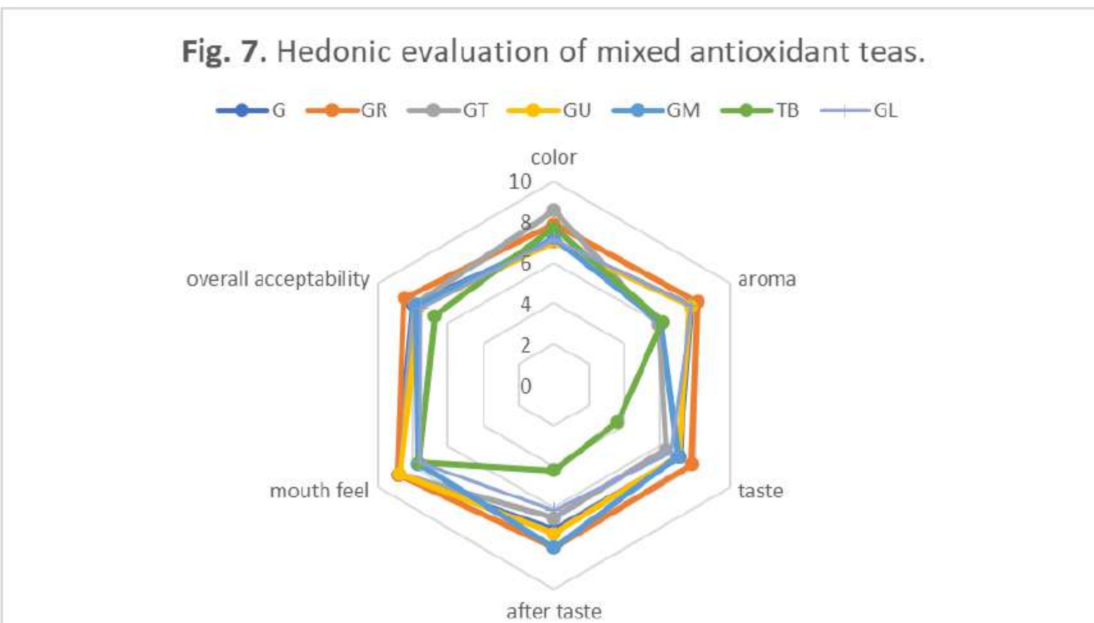


Figure 6: Box and whisker plots represent the mean concentration range (lowest, 25 percentile, median, 75 percentile and highest) of different concentration extracts of tea types graphically shown the reducing power assay.



DISCUSSION

In our study we determined the total phenolic and flavonoid content of infusion tea extracts of ginger (control) and ginger mixed with others herbs and both of the extracts showed high phenolic and flavonoid content. Antioxidant activity of these infusion tea extracts may be attributed to the high phenolic and flavonoid content. In our study the mixed tea extracts showed comparatively higher antioxidant activity than the ginger tea extract only (control), which is in accordance with the total phenolic and flavonoid content in fig 1 and 2. Figure 3 and 4 showed the ability of the infusion tea extract to scavenge the free radical pose by the stable radical of DPPH and the nitrous oxide scavenging. The results showed the potential of both the control and effect of synergies others mixed on both scavenging the DPPH and nitrous oxide scavenging radical. Ginger with Moringa (GM), Ginger with Turmeric (GT), Ginger with Bitter leaves (GB) and Ginger with Roselle (GR) showed distinct and higher scavenging potential than the infusion ginger tea only (control).

Fig 5 and 6 showed the graphical presentation of the different concentration extracts of the tea types from the minimum value, median and the maximum value in milligram ascorbic acid equivalent per millimeter. For the total antioxidant called phosphpmolybdate assay showed the control and others mixed tea having different potential antioxidant among them, but for the reducing power assay, the infusion ginger tea only (control) has the lowest antioxidant value compared with others infusion that combined ginger with other teas extracts. Sensory evaluation is an important criterion in the development of new products. It meets consumer requirements in terms of organoleptic quality. The enrichment of Ginger with Roselle (GR) improved taste, aroma and overall quality. Taste and aroma were the most important sensorial descriptors that influenced the overall appreciation of antioxidant teas. Infusion tea of Ginger with bitter leaves scored lowest and was completely rejected in all sensory attributes by panelists as shown in the hedonic evaluation fig 7 probably of the bitterness exhibited by the leaves of *vernomia amygdalina*.

CONCLUSION

The present study thus lent credence to the fact that addition of such herbal additives might reduce oxidative stress to some extent, which could be helpful for human consumption. This was also partially substantiated by the potentiation of the free radical inhibitory properties and antioxidant potential of the infusions.

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USAGE OF INFORMATION AND COMMUNICATION TECHNOLOGY TOOLS AMONG HORTICULTURAL CROP FARMERS IN AKINYELE LOCAL GOVERNMENT AREA, OYO STATE

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ABSTRACT
The study assessed the usage of Information Communication Technology (ICT) tools among horticultural crop farmers in Akinyele Local Government Area, Oyo state. Agbeka area of the Local Government was purposively selected for the study from which 30 farmers were randomly sampled. Data was collected using well-structured questionnaire and analyzed with descriptive statistics (frequencies and percentages). The results revealed that most of the farmers were males (60.0%), in the 31-40 years age group (66.7%), 46.7% possess secondary education, 93.3% had farming as primary occupation, and 83.3% had 1-10 years of farming experience. Mobile phone was used by 66.7% of the farmers. These mobile phones were used by 46.7% of the farmers to transact business with their customers, and as sources of information on credit facilities; 30.0% use mobile phones as electronic diary and reminder for meetings and other events. As regard the constraints faced in effective use of ICT tools, 40.0% of the farmers stated that high cost of devices and inadequate funds was always a constraint. The study thus recommends that the government should make other ICT tools apart from mobile phones accessible to farmers. This would enhance production and improve their income and ultimately welfare.
Keywords: *Information and Communication Technology (ICT), ICT tools, horticulture*

INTRODUCTION

Information and Communication Technology (ICT) plays a principal part in every aspect of human activities, including horticulture. In growing and interchanging information, ICT provide the future to increase efficient yield, competitiveness and extension in various forms of agricultural sectors. Farmers that take part in commercial agriculture in large scale might be look forward to be using cameras, computing devices, digital imaging, the internet and Wide Area Networking (WAN), Wi-Fi, SMS services, computing devices, Wireless Access Protocol (WAP) based internet access (Oke *et al.*, 2019). Oke *et al*, 2019 noted that farmers make use of forms of Information and Communication Technology such as mobile phones, computer and the internet.

The ICT tools includes mobile phones, computers, internet, and the older tools such as radio, television, and video are communication channels used by the farmers of today (Nwobodo *et al*., 2023). The difficulty in obtaining information due to a general trimming in funding for the extension has also entailed that farmers take interest of the ICTs in communicating production, marketing and financial information with other actors in agricultural value chains. Moreover, approach to production and marketing information can be greatly enhanced through the use of ICT tools. However, poorly disseminated information and knowledge as a result of certain constraints may hinder agricultural development of any community (Li, 2013; Ajayi, 2022). In Oyo State, like other areas, farmers are faced with some constraints which are limiting them in the use of ICTs in order to gain access to relevant information on improved technologies for enhanced productivity and improved income. Some of the constraints to the use of ICT among farmers are irregular power supply, high cost of ICT devices, poor network connection, inadequate funds, poor training on ICT use, language barrier, lack of awareness on ICT tools, negative attitude towards ICT tools just to mention a few (Shreya, 2020).

Thus, this study investigated the usage of information and communication technology tools among horticultural crop farmers in Akinyele Local Government Area, Oyo State. Specifically, the study described the personal characteristics of farmers in the study area; assessed the ICT tools used in their farming activities as well as the constraints to effective use of ICT.

MATERIALS AND METHODS

This study was carried out in Akinyele Local Government Area (LGA) of Ibadan, Oyo State, Nigeria. According to Oyo State Government website, Akinyele Local Government has the population of 211,811 in 2006 with 105,594 males and 106,217 females at 4.14% population growth rate. It is 222km^2. The local government is divided into three which are Akinyele main local government headquarters which is at Moniya, Akinyele East at Ikereku and Akinyele south is located at Igbo Oloyin. The LGA is dominated by Farming as Agriculture claims major engagement of the population. Akinyele LGA in its entirety comprises a number of Historic and Ancient settlements of Yoruba origins established. The study area is specifically located at Agbeka Dam, Agbeka Area which comes from Ajeja and it flows through Agbeka in Akinyele. Thus, Agbeka area was purposively sampled for the study as it is well noted for the production of horticultural crops; 30 farmers were randomly sampled from the area. Well-structured questionnaire was used to elicit information from the respondents most of who were farmers. Information collected include personal characteristics of the respondents, the ICT tools used in their horticultural activities and constraints to effective use of ICT. Descriptive statistics such as frequencies, percentages, mean scores and standard deviation were adopted to analyze the data collected were used to analyze the data collected.

Personal characteristics of the farmers

The results (Table 1) reveals that most of the farmers were males (60.0%) in the 31- 40 years age group (66.7%), married (76.7%), possess secondary education (46.7%), and had farming as their occupation (93.3%). Also, 83.3% of them have spent 1-10 years in farming, 50.0% source seedlings from the open market and 80.0% produce on 1-5 acres of farmland. This implies that the horticultural farmers sampled were young, married, male farmers who were educated and are

expected to have some knowledge on horticultural practices they are engaged in. This finding supports Oke *et al.*, (2019) which confirmed that males are more engaged in farming with most of them being in the 31 to 40 years age group. Also, sixty percent of the sampled farmers grow tomato, while 30.0% grow cucumber as well as other horticultural and non-horticultural crops.

Table 1: Personal characteristics of farmers (n=30)

Variable	Frequency	Percentage
Sex		
Male	18	60
Female	12	40
Age		
21-30	5	16.7
31-40	20	66.7
41-50	1	3.3
51-60	4	13.3
Marital Status		
Married	23	76.7
Single	7	23.3
Education Status		
Primary Education	1	3.3
Secondary School	14	46.7
Tertiary Education	13	43.3
Occupation		
Civil Servant	2	6.7
Farming	28	93.3
Farming Experience (in years)		
1-10	25	83.3
11-20	3	10
21-30	2	6.7
Sources of Seedlings		
Research Institute	13	43.3

Universities	1	3.3
Open Markets	15	50
Regenerated seed from other farmers	1	3.3
Crops Grown		
Cassava	2	6.7
Plantain	2	6.7
Cucumber	9	30
Tomatoes	18	60
Green beans	6	20
Pepper	1	3.3
Vegetables	2	6.7
Watermelon	3	10
Okro	4	13.3
Cabbage	3	10
Lettuce	1	3.3

Source: Field survey 2023

Information Communication Technology Tools used by farmers

The result further showed that mobile phones were the most used ICT tools by 66.7% of the farmers, forty percent of them opined that they use the internet (Table 2). Nwobodo *et al.*, (2023) also confirmed that mobile phones were used by 93.1% of sampled rice farmers in Nasarawa and Benue states. However, all the farmers do not make use of computer or newspaper as an ICT tool. This could imply that mobile phones are not only used for communication by the farmers, they are also useful tools in horticultural crop farming.

Table 2: Information Communication Technology Tools used by farmers (n=30)

ICT Tools	Yes	No
Radio	5 (16.7)	25 (83.3)
Mobile Phone	20 (66.7)	10 (33.3)
Television	2 (6.7)	28 (93.3)
Computer	-	30 (100)
Internet	12 (40)	18 (60)
Newspaper	-	30 (100)

Source: Field Survey 2023. Percentages in parentheses

Usage of ICT tools

The study elicited information from the farmers about the extent of their usage of ICT tools (Table 3). The results revealed that 60.7% of the farmers rarely use radio as a medium of advertisement, 46.4% rarely use radio to listen to horticultural related programmes. This is unlike the findings of Oke *et al*. (2019) which revealed that 46.3% of sampled maize farmers occasionally used radio to listen to horticultural related programmes. Moreover, 46.7 percent of the farmers always use mobile phones to transact business with their customers, and use mobile phones as sources of information on credit facilities. This is similar to the finding of Oke *et al*, 2019 which found that 62.5% of the maize farmers use mobile phones to source for information from extension agents. Thus, it infers that mobile phones are used by farmers to source for information. One-third of the farmers also use mobile phones as always as electronic diary and reminder for meetings and events. This result buttresses the fact that mobile phones are the most used ICT tool by the farmers.

Table 3: Usage of ICT tools by farmers(n=30)

Usage of ICT Tools	Always	Occasionally	Rarely	Never
The use radio to listen to horticultural related programme	-	9 (32.1)	13 (46.4)	6 (21.4)
I use radio as a medium of advert	2 (7.1)	2 (7.1)	17 (60.7)	7 (22.9)

I use mobile phone to transact business with customers	14 (46.7)	15 (50.0)	-	1 (3.3)
I use mobile phone for sources of information on credit facilities	14 (46.7)	11 (36.7)	4 (13.3)	1 (13.3)
I use mobile phone as electronic diary and reminder for meetings and events	9 (30.0)	15 (50)	6 (20)	-
Have you ever received market information via ICTs	4 (13.3)	15 (50)	4 (13.3)	7 (23.3)
Do you have any challenges associated with using ICTs to access information	6 (20)	9 (30)	13 (43.3)	2 (6.6)

Source: Field Survey 2023. Percentages in parentheses

Constraints to Effective Use of ICT tools

The major constraints are of inadequate funds (X=1.87), high cost of ICT devices (X=1.93) and poor network connection (X=2.38) in the effective use of ICT tools were some of the constraints experienced by the farmers (Table 4). Lack of awareness on ICT tools (X=2.59), irregular power supply (X=2.60), poor training on ICT use (2.87) and language barrier (X=3.33) are the minor constraints to the effective use of ICT tools. This implies that cost related to ICT tools is a major constraint to its effective use. Obinna *et al*. (2023) confirmed that inadequate fund was the major constraint to effective use of ICT tools among maize farmers.

Table 4: Constraints to Effective Use of ICT tools (n=30)

Constraints	Always	Occasionally	Rarely	Never	Mean (X)	Std. Dev.
Irregular power supply	3 (10)	15 (50)	9 (30)	3 (10)	2.60	1.037
High cost of ICT devices	12 (40)	13 (43.3)	5 (16.7)	-	1.93	1.048
Poor network connection	2 (6.9)	20 (69)	6 (20.7)	1 (3.3)	2.38	0.903
Inadequate Funds	12 (40)	14 (45.2)	4 (46.7)	-	1.87	0.973
Poor training on ICT use	3 (10)	12 (40)	14 (46.7)	1 (3.3)	2.87	1.137
Language Barrier	-	6 (20)	12 (40)	12(40)	3.33	0.884
Lack of Awareness on ICT tools	7 (24.1)	10 (34.5)	12 (41.4)	-	2.59	1.268

Source: Field Survey 2023. Percentages in parentheses. X=2.5; X<2.5 are major constraints and X>2.5 are minor constraints

CONCLUSION

The findings of this study revealed that although farmers play a key role in horticultural sector and application of ICT to aid production, there is need for government at all levels to amass political will to empower farmers with financial assistance and other useful inputs in the use of ICT to enhance production.

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RESPONSE PATTERN OF TIGER NUT (*Cyperus esculentus*) TO POULTRY MANURE RATES AND POPULATION IN POT

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ABSTRACT
This research investigated the effects of poultry manure application rates and plant population on growth and yield of tigernut (Cyperus esculentus) in pot. Two combined treatment factors including three poultry manure rates (0, 2.5, and 5.0 t/ha) and three plant populations (1, 2, and 3 plants per pot) were evaluated. Growth and yield parameters were measured in response to the treatment combination. The results revealed that increased application of poultry manure significantly (p<0.05) influenced the growth and yield of tigernut, although not significantly. Poultry manure at the rate of 5.0t/ha had the highest leaf count, number of tillers and plant height as well as most of the yield parameters measured except overall number of tubers where poultry manure at the rate of 2.5 t/ha did better. Furthermore, increasing plant population similarly increased growth and yield of tigernut. The growth parameters measured were significantly (p<0.05) influenced by population except leaf length at four weeks. On the other hand, the yield parameters except above ground biomass and length of longest root were significantly (p<0.05) influenced by population. The pots with three plants demonstrated better performance in terms of growth and tuber yield. It was conclusive that increasing application of poultry manure and plant population to the limit of this experiment had a better result on growth and yield of tigernut.
Keywords: *Poultry Manure, Plant Population, Tigernut Tubers*

INTRODUCTION

Tigernut, scientifically known as Cyperus esculentus, is a tuber crop from the Cyperaceae family. These tubers, ranging from 0.3 to 1.9 cm in diameter, are rich in dietary fiber and carbohydrates (Adejuyitan, 2011). It's a versatile crop, capable of growing both annually and perennially, reaching heights of up to 3ft (90cm) from its tuber. Tigernuts or yellow nutsedge (Cyperus esculentus) has many names in English, it is called tigernut, yellow nut sedge, earth almond, ground almond, and yellow nutgrass. In different regions, it's referred to as Habelaziz in Arabic, Chufa in Spanish, and Ayaya or Zulu nuts in Africa. In Nigeria, it's known as Akiawusa in Igbo, Ofio in Yoruba, and Aya in Hausa (Bamishaiye *et al*., 2011). Despite its nutritional potential, Tigernuts are often underutilized and considered a mere weed in many areas.

Tigernut cultivation typically occurs between April and May, influenced by the previous harvest (https://www.greses.net/en/tigernuts/cultivation/). Planting can be either direct into the field or started in a well-prepared nursery medium before transplanting. Vegetative propagation via rhizomes, preferably those with sprouts, is recommended (Lee, 2021). Tigernuts are deemed a superfood due to their rich nutrient profile, including calcium, magnesium, potassium, sodium, phosphorus, zinc, and vitamins E, C, and folic acid. They are also a source of natural energy, thanks to their starch and sucrose content (Jose, 2018). Tigernuts require enough planting space for growth because of its multiple shoots production. Tubers should therefore be planted adequately to avoid overpopulation, which reduces yield. Recently, there's a growing interest in organic manure due to the rising cost of inorganic fertilizers. Poultry manure, also known as chicken manure, stands out as an excellent soil amendment. It enriches the soil with organic matter and nutrients, improving soil quality (Van *et al*., 1993). Poultry manure has been reported to contain more plant nutrients than all other organic manures (Ayoola *et al*., 2006). Organic matter plays a crucial role in soil fertility in tropical regions, making poultry manure a valuable resource (Ikpe *et al*., 2002). This study is needed to provide agronomic information on the growth and yield of tigernuts in response to different poultry manure rates and plant population.

MATERIALS AND METHOD

Experimental site: The experiment was conducted in a controlled environment at Nsukka, Enugu state between July and November 2022. Collection and preparation of sample: Freshly harvested and dried tiger nut tubers were obtained from Jos, Plateau State, located in the North Central region of Nigeria. A nursery medium was prepared, comprising sawdust that underwent thorough washing to eliminate impurities. The cleaned sawdust was then packed into four black polyethylene bags. Prior to planting in the nursery medium, the seeds underwent a 24-hour water soaking process to break dormancy and assess their viability through the floatation test. Planting, emergence and transplanting: The tiger nut tubers were planted on July 15, 2022, and it began to emerge on July 19, 2022, three days after planting. The emergence process continued steadily for the next two weeks until it was ready for transplant. The seedlings were transplanted from the nursery to the treatment combination pots on July 29th, 2022. A total of 45 polyethylene bags, each containing approximately 10-12kg of soil, were prepared for this purpose.

Experimental design: The experiment was a 3×3 factorial experiment, employing a completely randomized design. Factor A represented plant population density with 1, 2, and 3 plants per pot, while factor B represented poultry manure rates at 0, 2.5, and 5 t/ha. This resulted in a total of nine treatment combinations, each of which was replicated five times. Therefore, the experiment comprised a total of 45 experimental units. Treatment application: The experiment was a two-factor experiment, incorporating plant population density and poultry manure rates as the variables of interest. The initial treatment, pertaining to plant population density, was administered on the day of transplant. Specifically, 15 pots were assigned to each of the following: one plant population, two-plant population, and three-plant population. The second treatment, involving poultry manure rates, was applied on August 12, 2022, precisely two weeks after transplanting. The rates used for this treatment were 0, 2.5, and 5.0 tons per hectare.

Data collection: Parameters measured included the number of leaves, number of tillers, plant height, whole plant biomass weight, above ground biomass, below ground biomass, tuber fresh weight, length of longest leaf and root, number of leaf and number of tubers.

Soil and plant analysis: The soil and poultry manure used for the experiment were analyzed and shown in Table 1.

Statistical analysis: All the data collected in the experiment were subjected to Analysis of variance (ANOVA) following the procedures outlined for a two-way design (completely randomized design) using Genstat 12.0. Differences between means were determined using Fischer's Least Significance Difference (F-LSD) at 5% Probability level.

RESULT

Table 1 shows that percentage of clay, silt and sand (fine and coarse) in the soil sample was 22%, 11%, 35% and 32% respectively, sand having the highest value followed by particles of clay with silt being the least. The pH of the soil sample measured in KCl indicates that the soil is slightly acidic while pH of the poultry manure (PM) sample measured both in water and KCl showed neutrality. The organic Carbon, organic matter content, Nitrogen content and exchangeable bases were higher in the PM sample. The cation exchange capacity and percentage base saturation recorded a moderate value. The soil had a higher phosphorous content than the PM sample analyzed. Table 2 revealed the effect of plant population on the growth of tigernut. The growth parameters measured included leaf length, number of leaves, and number of tillers were not significantly ($p>0.05$) influenced by poultry manure. However, statistical data measured revealed a gradual increase in the growth parameters over time. The number of leaves decreased between the 10th and 12th week after transplanting (WAT).

Among all treatments, poultry manure at the rate of 5.0t/ha showed the highest values for all growth parameters. The growth parameters were significantly ($p<0.05$) influenced by population except leaf length at the 4 WAT. The mean data indicated that 3-plant population had the highest value for all growth parameters measured across week of transplant. The growth parameters measured were not significantly ($p>0.05$) influenced by the interaction of poultry manure and plant population except leaf

length at 4 and 6 WAT. No particular trend was observed, however three plant population and poultry manure at the rate of 5t/ha manifested a more pronounced effect on growth. Various yield parameters, such as above ground biomass, below ground biomass, length of longest leaf and root, tuber fresh weight, number of leaves, number of tubers, and whole plant biomass weight were measured. These parameters were not significantly ($p>0.05$) influenced by the different rates of poultry manure used.
Based on the statistical data analyzed, poultry manure at the rate of 5.0t/ha had the highest values, except for number of tubers where poultry manure at 2.5t/ha showed the highest value. Most of the parameters measured were significantly ($p<0.05$) influenced by population. However, the 3-plant population outperformed the rest as seen in Table 3. The yield parameters were not significantly ($p>0.05$) influenced by the interaction effect of poultry manure and plant population. From the statistical data measured, the application of poultry manure at 5 t/ha to pots with two plants had a pronouced effect on the above ground biomass, below ground biomass, tuber fresh weight and whole plant biomass. Applying 2.5 t/ha of poultry manure to pots containing three plants resulted in the highest number of tubers. On the other hand, pots with three plants that didn't receive poultry manure, and pots with two plants that received 2.5 t/ha of poultry manure, produced the longest leaf and root, respectively.

DISCUSSION

This study revealed a notable effect of poultry manure and plant population on growth and yield of tiger nut tubers. Increasing application of poultry manure led to increase in growth and yield of tiger nut. Statistical data analysis however revealed a non significant effect at the probability level tested but from the mean of the data measured, an increase in poultry manure led to increase in number of leaves, number of tillers, leaf length and yield except for number of tubers produced where application of poultry manure at 2.5t/ha resulted in higher number of tubers. Therefore, application of poultry manure beyond 2.5 t/ha may have become counterproductive to yield (Oladele *et al*., 2019). Generally, increasing the application of poultry manure provides essential nutrients to the plants, leading to improved growth and yield. Additionally, the organic matter present in poultry manure can enhance soil structure, increase water-holding capacity, and create an optimal environment for root development and nutrient absorption (Mohamed *et al*. 2010).
The findings from the population studies suggest that increasing plant population density to the limit of this experiment can have a positive impact on tiger nut growth and yield. Higher plant density can increase competition for resources such as water, nutrients, and sunlight. This competition can stimulate the plants to grow taller, develop more roots, and produce more biomass, which can translate into higher yields (Tollenaar and Lee, 2002). A higher plant density can also have a positive effect on soil health. Study by Goodfriend *et al*., (2000) on the response of soil microorganisms to planting density of Salicornia bigelovii revealed that increased root density of plants could stimulate microbial activity in the soil, which can improve soil structure and nutrient availability. This, in turn, can lead to healthier and more productive plants.

CONCLUSION

This study aimed to assess the optimal rate of poultry manure for cultivating tiger nut and determine the ideal plant population density for tiger nut tuber growth. The aforementioned findings inferred that the application of poultry manure at a rate of 5 t/ha and a plant population of three plants exhibited a significant enhancement in the growth and yield of tiger nuts grown in pots.

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Table 1: Physiochemical properties of soil sample and poultry manure

SAMPLE DESCRIPTION		Values	
Textural class	Sandy clay loam	SOIL	PM
Clay (%)		22	-
Silt (%)		11	-
Fine sand (%)		35	-
Coarse sand (%)		32	-
pH(H2O)		6.3	7.8
pH(Kcl)		5.6	7.1
Organic Carbon (%)		1.733	41.105
Organic Matter (%)		2.987	70.830
Total Nitrogen (%)		0.154	1.961
Exchangeable Na (meq/100g)		0.06	0.13
Exchangeable K (Meq/100g)		0.13	0.16
Exchangeable Ca (Meq/100g)		1.20	3.20
Exchangeable Mg (Meq/100g)		0.80	2.88
CEC (Meq/100g)		13.60	-
Base saturation (%)		16.10	-
Exchangeable Acidity Al (Meq/100g)		0.20	-
Exchangeable Acidity H (Meq/100g)		1.40	-
Available Phosphorous (ppm)		8.46	0.346

Source: (Department of Soil science laboratory, University of Nigeria, Nsukka)

Table 2: The main effect of plant population on leaf length, number of leaves and number of tillers of tigernut grown in pot.

			WAT			
a. PM (t/ha)	**2**	**4**	**6**	**8**	**10**	**12**
			LL (cm)			
1	-	55.8	60.7	67.2	72.1	70.4
2	-	54.4	66.9	76.8	82.9	83.0
3	-	56.3	69.0	81.6	86.7	84.5
LSD(0.05)	-	NS	5.6	6.3	8.1	12.1
			NL			
1	7.5	11.3	13.6	15.8	16.8	16.5
2	16.4	24.5	34.1	40.7	42.1	36.7
3	26.3	39.6	52.9	58.6	58.7	52.7
LSD(0.05)	2.6	3.4	6.2	7.9	10.1	10.1
			NT			
1	-	0.7	0.7	0.8	0.8	0.7
2	-	1.8	2.3	2.4	2.3	2.5
3	-	3.4	4.7	4.9	4.8	5.1
LSD(0.05)	-	0.6	1.1	1.0	1.0	0.7

PP= Plant population; WAT= Weeks after transplanting; LL= Leaf length; NL= Number of leaf; NT= Number of tillers; NS= Non-significant; LSD= Least significance difference.

Table 3: The main effect of (A) different poultry manure rates and (B) plant population on the yield parameters of tigernut grown in pot.

a.PM(t/ha)	**AGB(g)**	**BGB(g)**	**LLL(cm)**	**LLR(cm)**	**TFW(g)**	**NL**	**NT**	**WPBW(g)**
0	16.6	28.9	69.3	13.9	26.5	26.7	38.7	46.1
2.5	20.7	33.0	68.8	15.0	29.8	30.9	42.8	54.8
5.0	21.6	33.8	75.8	15.5	32.0	31.7	41.7	56.7
LSD(0.05)	NS	NS	NS	NS	NS	NS	NS	NS
b. PP								
1	13.4	18.0	57.6	13.6	16.5	17.2	20.0	32.1
2	21.6	35.4	75.3	16.1	32.2	31.9	39.8	58.5
3	23.8	42.3	81.0	14.9	39.6	40.2	63.2	67.0
LSD(0.05)	NS	13.5	16.1	NS	12.3	10.8	16.8	23.8

PM= poultry manure; YP=Yield parameters; AGB: Above ground biomass; BGB= Below ground biomass; LLL= Length of longest leaf; LLR= Length of longest root; TFW= Tuber fresh weight; NL= Number of leaves; NT= Number of tubers; WPBW= whole plant biomass weight; NS= Non-significant; LSD= Least significance difference

STORAGE DURATION, NURSERY SUBSTRATES AND STERILIZATION INFLUENCED SEEDLING EMERGENCE AND EARLY SEEDLING GROWTH OF TIGER NUT (*Cyperus esculentus*)

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***ABSTRACT**:*
Two experiments were conducted at Department of Crop Science, University of Nigeria, Nsukka to study the effect of storage duration, nursery substrates and seedling emergence and early seeding growth of Tiger nut. The experiment on storage duration involved freshly harvested tiger nut tubers subjected to varying storage duration of one, two and three weeks of air drying at room temperature and another stored in a refrigerator for an extended period. Result revealed a non-significant (p>0.05) effect, however tubers dried for two and three weeks had better emergence compared to other storage duration. The second experiment on substrates and sterilization was a 3 x 3 factorial involving 3 levels of substrates (rice husk, sawdust and a combination of rice husk and sawdust) and 3 Sodium hypochlorite (NaOCl) sterilization levels of 0, 5 and 10%. Seedling emergence was significantly influenced by substrate at 1 and 2 weeks after sowing, while sterilization enhanced triple shoot production. Seeds sown in combination of rice husk and sawdust at 10% NaOCl dilution gave the highest number of emergence. Seed storage at two weeks under room temperature and combination of sawdust and rice husk at 10% sterilization level were found most suitable, and hence, recommended.
Keywords: *Early seedling growth, Emergence, Sterilization, Storage Duration, Substrates, Tiger nuts tubers*

INTRODUCTION

Tiger nut, scientifically known as *Cyperus esculentus*, is a tuber crop belonging to the Cyperaceae family. These tubers range in size from 0.3 to 1.9 cm in diameter and notably high in dietary fiber and carbohydrates (Adejuyitan, 2011). It's a versatile crop, capable of growing both annually and perennially, reaching heights of up to 3ft (90cm) from its tuber. Tiger nuts are known by various names like earth almond, ground almond and yellow nut grass. In different regions, it's referred to as Habelaziz in Arabic, Chufa in Spanish, and Ayaya or Zulu nuts in Africa. In Nigeria, it's known as Akiawusa in Igbo, Ofio in Yoruba, and Aya in Hausa (Bamishaiye *et al*., 2011). Despite its nutritional potential, Tiger nuts are often underutilized and considered a mere weed in many areas. Seed is an important means of dispersal of *C. esculentus.* It can be propagated through the basal bulb, tubers or the rhizomes (Holm *et al*., 1977). Tiger nut are superfood due to their rich nutrient content, which includes calcium, magnesium, potassium, sodium, phosphorus, zinc, vitamins E, C, and folic acid. Their starch and sucrose content make them a natural energy source (Jose, 2018).

The germination vigour of seeds can decline with increasing seed age due to the breakdown of the seed's metabolic system, even when stored under optimal conditions. This can lead to slower or even inhibited germination and result in weaker seedling development and reduced establishment. This decline in sprouting ability as tubers age poses a significant obstacle to Agricultural production, resulting in loss of production potential. To prevent staggering germination, the choice of sterilization agent is crucial to obtain high germination rate and ensure proper plant growth. Sterilization plays a key role in breaking dormancy in tubers and removing toxic inhibitors found in the seeds. (Mohammad *et al*., 2012; Marcello *et al*., 2020). Another critical factor after seed storage duration and sterilization agent is the choice of substrate or growth medium. Substrates play a pivotal role in developing the root system and providing essential nutrients for the plant. This is among the most significant external factor influencing both seed germination and seedling growth in the nursery,

ultimately favoring production at low cost in a short period of time (Nogueira *et al*., 2012; Dutra *et al*., 2012).
In this study therefore, we evaluated the effects of four storage durations and a factorial combination of three substrate types and three sterilization levels on seedling emergence and early seedling growth. The specific objective was to determine the best storage duration, growth medium and sterilization level that would increase emergence and early seedling growth quality.

MATERIALS AND METHOD

The two experiments were conducted at the Department of Crop Science Teaching and Research farm, University of Nigeria, Nsukka, Enugu State, Nigeria between September and December 2022. The experiment on storage duration was a completely randomized design, with four distinct treatments: tubers dried for 1, 2 and 3 weeks, and tubers stored in a refrigerator for 5 months and were replicated three times. The tubers were soaked for 24 hours and planted on a weekly basis and each set lasted for a period of four weeks. The second experiment was a factorial laid out in a completely randomized design. The factors were substrates (rice husk, sawdust and rice husk + sawdust) and sterilization (0, 5 and 10% NaOCl dilution). There were therefore, 9 treatment combinations, each replicated 3 times, and each replicate were sown with 10 seeds. The tubers were also soaked for 24 hours and viable seeds selected through flotation method. The tiger nut tubers were then sterilized with NaOCl, which is the common household bleach. Ninety seeds were soaked for 10 min in each level of sterilization treatment. The substrates were properly washed and soaked for 24 hours to remove debris before planting.
Data were collected daily for each experiment, which included the number of seedling emergence and the number of tillers produced. Data were also collected at four and six weeks through destructive sampling. Parameters such as the number of leaves, fresh weight of the leaf, whole plant biomass weight, length of the longest leaf, length of the longest root, seed rot (by carefully examining tubers that did not sprout for signs of rot), seedling vigor (assessed through observations of leaf count and the length of the longest leaf), and the number of tubers formed were recorded.
Data measured were subjected to Analysis of variance (ANOVA) using the procedures outlined for a one-way design (completely randomized design) for the first experiment and a factorial laid out in a completely randomized design for the second experiment using Genstat 12.0. Differences between means were determined using Fischer's Least Significant Difference (F-LSD) at 5% probability level.

RESULTS

Statistical analysis from the experiment on seed storage revealed that tubers dried for three weeks prior to planting showed the highest percentage emergence during the first and second week after planting and tubers that were dried for two weeks had the highest percentage emergence at third and fourth week after planting. The tubers that were stored in a refrigerator had the lowest emergence rate (Table 1). The analysis of variance (data not shown) revealed that the main effect of substrate on emergence was significant at one and two weeks after sowing while sterilization had no significant effect ($p>0.05$) at 1, 2 and 3 weeks after sowing (Table 2). The combined effect of substrate and sterilization was only significant at one week after sowing (Figure 1). Seeds sown in rice husk + sawdust and 10% sterilization gave the highest number of emergence. On the multiple shoot production shown on Table 3, substrate significantly influenced single shoot and double shoot production but had a non-significant effect on triple and quadruple shoot. Seed sterilisation greatly influenced triple shoot production but had no effect on other variates, while the interaction effect was only significant ($p<0.05$) on single shoot production. Seeds sown in rice husk + sawdust at 10% seed sterilization gave the highest on single and triple shoot production.
Effect of substrate and sterilisation on tiger nut growth at 4 and 6 weeks is shown on Table 4. At 4 weeks, substrate greatly influenced fresh weight of leaves and number of tubers but had no significant difference on other growth parameters. At 6 weeks, substrate had no significant effect on length of longest root and number of tubers. The table showed that at 4 weeks, sawdust performed better numerically than other substrate followed by rice husk + sawdust while at 6 weeks, combination of rice husk and sawdust had higher influence on length of longest root and number of tubers. Sterilisation had significant effect on all yield parameters at 4 weeks except on the length of the

longest root and number of tubers. While at 6 WAS, there was no significant difference. Plants in 10% dilution had better growth in all growth parameters except on length of longest root, and then followed closely by 5% dilution. Combined effect of substrate and sterilisation is shown on Table 5. Fresh weight of leaves at 4 weeks was significantly influenced. Other growth parameters were not influenced by substrate and sterilisation. Rice husk + sawdust at 10% sterilisation influenced the fresh weight of leaves and whole plant biomass. Longer leaf length and root were observed in plants grown in sawdust and sterilised at 5% sodium hypochlorite dilution. On the average, sawdust at 0% sterilisation gave greater yield followed by rice husk at 10% dilution.

DISCUSSION

The results obtained from this experiment showed variation in emergence rate among the different sets of tiger nut tubers. This could be attributed to alterations in the physiological and biochemical processes that occurred while the tubers were drying and in storage (FAO, 1981). Drying of tubers leads to a reduction in water content, which, in turn, stimulates metabolic processes that initiate growth upon planting (FAO, 1981). Tubers that were dried for one week had lower emergence rates than those dried for two and three weeks. This could be due to the fact that one week of drying may not have been enough to achieve the optimum water content required for optimal emergence. When tubers are not dried enough, they may contain excess moisture, which can result in fungal and bacterial infections that can lead to rot and low emergence rate. Moreover, the tubers stored in the refrigerator for five months experienced prolonged exposure to cold temperature leading to a reduced temperature which could have induced dormancy and slowed down metabolic processes. Dormancy is a survival mechanism adopted by some plants to ensure that germination occurs under favorable conditions. However, this process could delay emergence, as was observed in this study (FAO, 1981).

Sawdust as a standalone mix had a significant effect on germination and emergence but had poorer quality than rice husk. This could stem from the elevated C/N ratio, which results in nitrogen immobilization. This is in relation with Garcia *et al*., (1992) who reported that a higher C/N ratio increases the likelihood of nitrogen being unavailable to plants. Rice husk had longer leaves and more greenish than the seeds sown in sawdust alone, as a result of its high nutrient content and high moisture retention capacity. A combination of sawdust and rice husk gave higher emergence than the other substrates, which could be reflection of the effect of the combination of high moisture retention and significant air spaces in the media, that is the combination of the properties of both sawdust and rice husk. Sawdust numerically performed better in increasing the fresh weight of leaves, number of tubers and other above ground properties while a combination of both rice husk and sawdust influenced length of longest root.

Sterilization at 10% had higher percentage of emergence when compared to other levels, and also had higher number of triple shoot emergence and influenced other growth parameters. It increased the foliage of the tiger nut, gave greater yield, higher fresh weight of leaves, length and more number of leaves. This result is in agreement with Baiyeri and Mbah (2006), which reported that sterilization likely improved the foliage development of African breadfruit seedlings due to reduced competition with pathogens, which might have otherwise slowed down the rate of growth and development of those seedlings.

Findings from the experiments show the efficacy of seed storage duration, substrates and sterilisation in increasing seedling emergence, production of multiple shoots and early seedling growth. Tubers can be cultivated within a period of two to three weeks after harvest and air-drying at room temperature. Sodium hypochlorite (NaOCl) solution was found to be the best at 10% dilution level. Rice husk and sawdust combination at 10% NaOCl dilution is ideal as it significantly had higher emergence and promoted triple shoot production. Also sawdust at 5% seed sterilisation could be used as a close substitute, but there should be incorporation of fertilizer to make up for the low nitrogen content.

Table 1: Emergence pattern of freshly harvested tiger nut tubers as influenced by storage duration.

	WAP			
SD (wks)	1	2	3	4
		Emergence (%)		
1	38	43	43	47
2	40	57	80	83
3	57	63	67	67
Fridge	30	30	30	30
SED	28.5	33.7	32.8	34.5

WAP= weeks after planting; SD=Storage duration; SED = Standard error of difference.

Table 2: Main effect of (a) substrate and (b) sterilization on seedling emergence.

Substrate	Weeks after sowing		
(A)	1	2	3
Rice husk	8.9	40	67.8
Sawdust	24.4	65.6	75.6
Rice husk + Sawdust	25.6	70	78.9
LSD (0.05)	11.9	12.64	NS
(B)			
Dilution	1	2	3
0%	20.0	56.7	72.2
5%	15.6	57.8	72.2
10%	23.3	61.1	77.8
LSD (0.05)	NS	NS	NS

Table 2: Main effect of (a) substrate and (b) sterilization on multiple shoots production

Substrate	Single shoots	Double shoots	Triple shoots	Quadruple shoots
Rice husk	1.1	3.1	2.3	0.2
Sawdust	1.2	4.6	1.8	0
Sawdust + Rice husk	2.3	2.7	2.9	0
LSD (0.05)	0.91	1.56	NS	NS
(B)				
Dilution				
0%	1.4	3.9	1.9	0
5%	1.4	3.9	1.8	0.1
10%	1.8	2.6	3.3	0.1
LSD (0.05)	NS	NS	1.29	NS

Table 3: Main effect of (a) substrate and (b) sterilization on tigernut growth at 4 and 6 weeks after sowing.

Substrate	Weeks After Sowing							
	4 WAS						6WAS	
	FWL	LLL	LLR	NOL	NOT	WPBW	LLR	NOT
Rice husk	1.8	36.6	11.6	33.6	2.3	8.4	9.8	4.7
Sawdust	3.6	41.1	14.3	34.4	4.6	9.4	10.5	4.2
Rice husk + Sawdust	2.2	37.6	12.4	34.1	1.6	8.7	11	6.4
LSD (0.05)	1.48	NS	NS	NS	1.89	NS	NS	NS
(B)								
Sterilization								
0%	1	31.1	11.7	29.4	2.3	7.4	10.9	5.3
5%	2.8	40.9	13.4	33.9	2.6	8.6	9.9	4.9
10%	3.8	43.3	13.1	38.8	3.6	10.6	10.5	5.1
LSD (0.05)	0.7	5.53	NS	4.74	NS	1.74	NS	NS

Table 4: Interaction of substrate and sterilization on tigernut growth at 4 and 6 weeks after sowing

SUBSTRATE	DILUTION	WEEKS AFTER SOWING							
		4 Weeks						6 Weeks	
		FWL	LLL	LLR	NOL	NOT	WPBM	LLR	NOT
Rice husk	0%	0	30.8	11.7	26.3	1	6.3	9.9	2.7
Rice husk	5%	4.3	38.8	11.1	37.3	3.3	9.7	10.2	5
Rice husk	10%	1	40.1	12	37	2.7	9.3	9.4	6.3
Sawdust	0%	2	31.9	12.7	31	5.7	8.7	10.6	6.7
Sawdust	5%	4	48.7	17	31	3	8.7	10.9	2.3
Sawdust	10%	4.7	42.8	13.2	41.3	5	11	10.1	3.7
Rice husk + Sawdust	0%	1	30.7	10.8	31	0.3	7.3	12.2	6.7
Rice husk + Sawdust	5%	0	35.2	12.2	33.3	1.3	7.3	8.6	7.3
Rice husk + Sawdust	10%	5.7	47	14.2	38	3	11.3	12.2	5.3
LSD (0.05)	LSD (0.05)	2.56	NS	NS	NS	NS	NS	NS	NS

FWL= Fresh weight of leaves; LLL= Length of longest leaf; LLR= Length of longest root; NOL= Number of leaves; NOT= Number of tubers; WPBW= Whole plant biomass weight; LSD= Least significant difference; NS= non-significant.

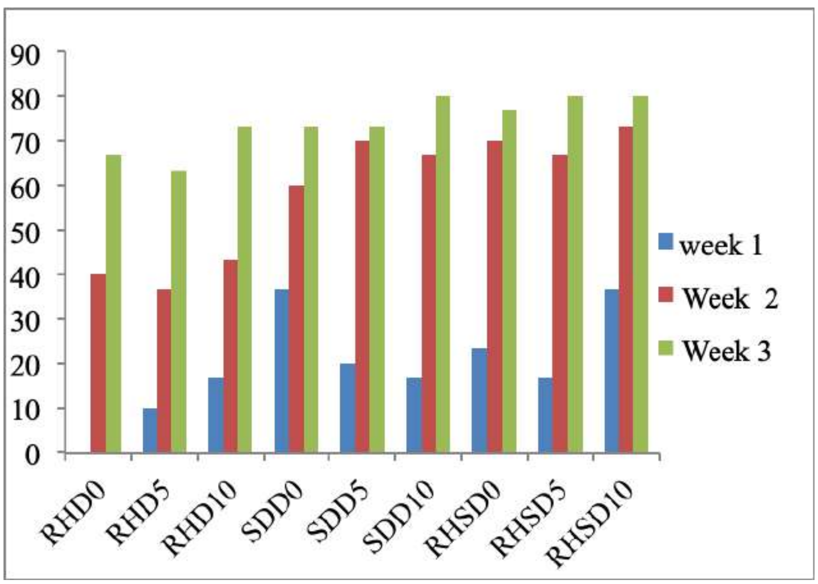

Figure 1: Interaction between substrate and seed sterilisation (NaOCl dilution) on seedling emergence.

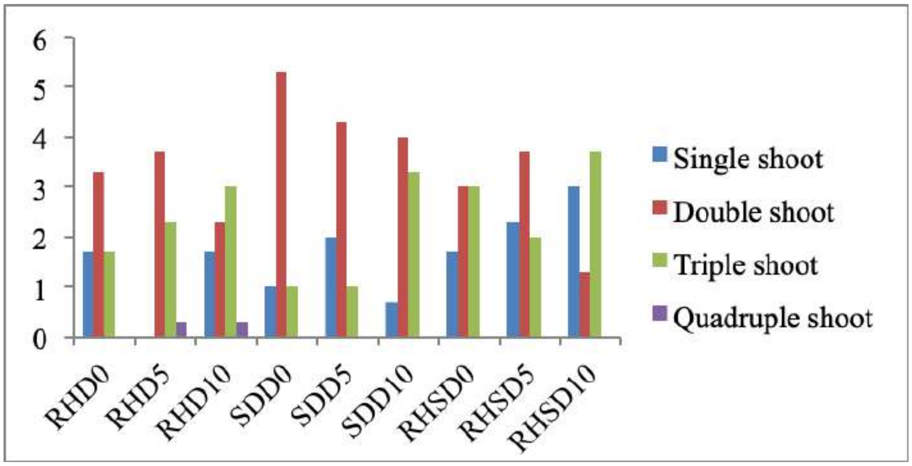

Figure 2: Interaction of substrate and seed sterilisation (NaOCl dilution) on multiple shoots production of tigernut.

RHD0: rice husk + 0% dilution; RHD5: Rice husk +5% dilution; RHD10: Rice husk + 10% dilution. SDD0: Sawdust + 0% dilution; SDD5: Sawdust + 5% dilution; SDD10: Sawdust + 10% dilution. RHSD0: Rice husk + sawdust at 0% dilution; RHSD5: Rice husk + sawdust at 5% dilution; RHSD10: Rice husk + sawdust at 10% dilution.

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MITIGATION OF DEOXYNIVALENOL TOXIN IN BLACK-TEA COMMODITY OBTAINED FROM IBADAN, OYO STATE AND MAMBILLA, TARABA STATE, NIGERIA USING CURCUMA LONGA SPICE.

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ABSTRACT

Tea is a globally accepted beverage consumed for its health and stimulating benefits. However, poor knowledge of processing and handling of this product leads to fungal contamination and one of such metabolites was deoxynivalenol toxin, a contaminant of health concern. Curcuma longa spice is known to possess antimicrobial potentials; although, there is fewer scientific report on the use of this spice at mitigating mycotoxins in Nigeria grown tea. This study, quantify and reduce deoxynivalenol toxin in tea using Curcuma longa spice. Black teas were sampled from ten different warehouses, five each from Ibadan, Oyo state and Mambilla, Taraba state respectively. The obtained samples were screened for deoxynivalenol toxins using HPLC. DON-spiked tea was treated with curcuma longa spice and stored for six months at room temperature and efficacy of the spice treatment at reducing DON contaminant level was evaluated.

Keywords: *Black-tea contamination, deoxynivalenol, reduction, Curcuma longa, quantitation*

INTRODUCTION

Tea, leave of *Camellia sinensis* plant, is a popular and widely relished beverage for its characteristic antioxidant property and specific aroma, considered suitable for human wellness around the world (Li *et al*., 2013). Tea is an everyday drink cherished by everyone, an evergreen bush, largely grown in East Asia and prepared by hot water infusion of the cured leaves of the camellia. Its consumption has a growing outlook among the middle class of the urbanized population and within the new order societies of developing markets (Chang, 2015; Hilal and Mubarak, 2013). Many agricultural commodities used in food and beverage production may be contaminated by mycotoxinogenic fungi, which synthesize mycotoxins, as a result of poor agricultural practices, inadequate knowledge of processing, poor handling, packaging, transport and storage conditions. Uncontrolled fungal growth; aided by poor storage conditions, may increase risk of mycotoxin contamination (Marin *et. al*., 2013).

Objective

The objective of this work was to detect, quantify and reduce DON contamination in black-tea commodity obtained from Ibadan, South western part of Nigeria and Mambilla, North eastern Nigeria, using Curcuma longa spice.

Justification for the study

This effort comes to bare as a result of the limitations of age long conventional approach, such as significant alteration in food colour, flavor, texture and nutritional contents of such food materials (Haque et al, 2020). Moreover, issues of thermal stability of mycotoxins and chemical residues during food processing, necessitated increased innovative approach, devoid of direct application of heat on food matrices. Embracing the use of spices such as Curcuma longa, a botanical rich in phenolic compounds becomes promising in reduction of mycotoxins contamination in food and beverages (Ajewole, 2023).

MATERIALS AND METHODS

Black-teas intended for human consumption were collected randomly from five (5) different warehouses in Ibadan and Mambilla respectively and 10 samples from each warehouse. These were pooled together, screened and quantified for deoxynivalenol toxin, a contaminant of health concern. Deoxynivalenol contaminated tea was treated with *Curcuma longa* spice, and stored at ambient temperature for six months. High performance liquid chromatography method with DONtest in DON WB instruction manual for sample extraction was employed. This method was modified by evaporating the sample extract to dryness over nitrogen gas and thereafter reconstituted in 0.5 mL mobile phase.

RESULTS AND DISCUSSION

Deoxynivalenol (DON) toxin was detected in black-tea commodities at an amount higher than the specified threshold for substances intended for direct consumption or use. About 90% of the black tea commodity from Mambilla had deoxynivalenol contaminant ranging from 1.30 µg/kg to 5.18 µg/kg while about 20% of the black-tea commodity obtained from Ibadan were contaminated, with DON. Contamination ranged from 2.19 µg/kg to 2.50 µg/kg. Mitigation approach employed, revealed tropical spices has potential to reduce DON contamination in stored black tea commodity. *Curcuma longa* powder added to black tea at concentration of 4000 µg/g, reduced DON contamination by 53.2% and at 1000 µg/g, DON was reduced by 40.6%.

Table 1: Quantitation of deoxynivalenol toxin (DON) in tea

Sample	**Variety**	**FDA Advisory Limit (µg/kg)**	**DON (µg/kg)**
MC5B	Black tea	≤1.0	5.18^{a}
MC3B	Black tea	≤1.0	1.30^{e}
Contro2	Black tea	≤1.0	ND
MC2B	Black tea	≤1.0	1.50^{e}
MC7G	Green tea	≤1.0	ND
MC4B	Black tea	≤1.0	2.81^{b}
MC9G	Green tea	≤1.0	ND
MC1B	Black tea	<1.0	2.30^{cd}
IC5B	Black tea	≤1.0	ND
IC2B	Black tea	≤1.0	2.50^{c}
IC4B	Black tea	≤1.0	ND
IC1B	Black tea	≤1.0	2.19^{d}
IC3B	Black tea	≤1.0	ND
Control	Black tea	≤1.0	ND

ND – Not Detected, superscrip 'a, b, c, d, cd, e' show sample significant different (P<0.05) from other samples along same vertical column

Table 2: Effects of *Curcuma longa* spice treatments on deoxynivalenol (DON) reduction in spiked tea stored for six months

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Concentration (µg/g)	Spiked tea (5 ppb)	DON (µg/kg)	* % RE
00	5	2.97	40.6
2000	5	-	-
3000	5	2.50	50.0
4000	5	2.34	53.2

*RE- reduction efficiency. *- values obtained after treatment with spice powder

CONCLUSIONS

Although significant differences exists in deoxynivalenol contamination in black tea commodities from Ibadan and Mambilla, sixty percent (60%) of the black tea commodity screened were contaminated with DON and at a threshold above FDA advisory limit (≤ 1.0 µg/kg). Therefore, need to mitigate contamination during storage cannot be over-emphasized. Also, processors can take advantage of the potentials of *Curcuma longa* spice in mitigating DON contamination of black tea during handling and storage. Spiced black tea can also be taken as a novel product.

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EFFECTS OF NITROGEN AND PHOSPHORUS FERTILIZERS ON THE GROWTH, FRUIT YIELD AND NUTRITIONAL QUALITIES OF TOMATO (*Lycopersicon lycopersicum*) IN OGBOMOSO

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ABSTRACT
The trial was conducted to assessed the growth, fruit yield and nutritional quality of tomato as affected by different fertilizers rates at the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso. The treatments investigated were three nitrogen fertilizer rates (0, 30 and 60kg/ha and five phosphorus fertilizer rates (0, 15, 30, 45 and 60kg/ha) and their various combinations. The factorial experiment was laid out in a completely randomized design replicated three times. Data collected on plant height, number of leaves, yield attributes and nutritional qualities were subjected to analysis of Variance. The findings revealed that the application of N and P fertilizer rates had a significant (p0.05) impact on the growth, fruit yield, and nutritional value of tomato. The optimum growth parameters, fruit yield and quality were obtained at 60 kg N and 45 kg P_2O_5*/ha and at combine application of 30 kg N and 45 kg* P_2O_5*/ha. The highest fruit yield and nutritional quality of tomato was recorded at combine application of 30 kg N and 30 kg* P_2O_5*/ha fertilizers rates. Therefore, these fertilizers rates could be recommended for the cultivation of tomato in the study region.*
Keywords*: Fertilizer, nutritional quality, tomato, yield attributes.*

INTRODUCTION

One of the three significant annual fruits and vegetables of the tropical zone that originated in South and Central America is the tomato (*Lycopersicum lycopersicum*), a member of the solanaceae family (Julel, 2001). Tomato is the most popular and consumed vegetables worldwide. Like other vegetables, tomatoes are particularly important to human diets because they make up for some of the nutrients that are missing from their dietary sources, such as the minerals and vitamins found in tomato fruits (Biwasi, 1999). Additionally, it is calorie and nutrient dense. It is a good source of vitamin A, B, and C and iron. Lycopene and vitamin C, two nutrients that are major sources of antioxidants, may be found in tomatoes.

The plant nutrients are given to the soil as amendments in the form of manures and fertilizers because soil is unable to supply a suitable amount of N, P, and K for the best growth and output of tomatoes (Abdel-Samad *et al*., 1996a). Because tomatoes consume a lot of nitrogen from the soil, nitrogen is the most limiting nutrient for tomato growth and is needed in significant quantities for optimum production. Lack of nitrogen in the soil can cause browning of the leaves at the tomato plant's base and stunted, spindly growth. It might decrease fruit output. Without nitrogen, essential processes in the growth and reproduction of plants would not be feasible (Morris, 1993). Nitrogen is a component of protein and amino acids.

Phosphorus is a fundamental component of adenosine triphosphate (ATP), which serves as the energy currency in plant cells. Tomato plants require energy for various physiological processes, including photosynthesis. Adequate phosphorus levels enable the efficient conversion of sunlight into energy, promoting robust growth and higher yields (Krupa *et al*., 2022).

MATERIALS AND METHOD

The experiment was carried out at the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso (latitude of 8^0 10N and longitude of 4^0 10E). The region experiences yearly rainfall of more than 100mm, a maximum temperature of 33^0, and a low temperature of 28^0. The treatments involved tomato variety UC82B subjected into three Nitrogen fertilizer rates (0, 30 and 60) and their various combinations. The experimental design was Completely Randomized Design (CRD) with three replicates. The experimental site was manually cleared and 45 beds were made with the use of hoe. These were divided into three replicates with each replicate containing 15 beds. The size of each bed was 2m by 2m ($4m^2$) with the spacing of 0.5m within and 1m between replicates. The nursery for tomato was established four weeks before planting date. The seedling were raised in the nursery bed and transplanted after four weeks to the field. Uniform and healthy seedlings were transplanted into the field in other to ensure uniformity at the spacing of 50cm x 50cm giving a plant population of 4000 stands per hectare. Supplementary water supply was carried out after transplanting and continued during the drying period of the experiment. A basal recommended application of 45 kg K_2O/ha (Curah and Proctor, 1990; Olaniyi, 2019), and application of N and P to their respective plots was applied by ring method, at 3 weeks after transplanting (WAS). Weeding was carried out manually by using hoe. Insect pest were controlled with cypermethrin insecticide at 10 ml per 10 litres of water, sprayed at two weeks interval with the use of knapsack sprayer.

Four plants were randomly selected within the net plots, in each plot and tagged. Data were collected at two weeks after transplanting continued fortnightly interval. The tagged plants were assessed for growth parameters: plants height were measured with the use of meter rule and number of leaves obtained by counting each green and functional leaves on each plant, yield attributes; number of fruits by counting the harvested fruits, fruit diameter by measured with the use of venier caliper and fruit weight by the use of sensitive weighing scale; and nutritional quality was assessed by collecting 6 fruit samples from each treatment and taken to the laboratory for the determination of nutrient elements, crude protein, fat, dietary fibre, antioxidants such as vitamin A, B and C and lycopene (AOAC, 1999).

Data collected were analysed using Standard Analysis System (SAS, 1990) for analysis of variance and means separated using least significant difference at 5% probability level.

RESULT AND DISCUSSION

The tomato growth responses (Table 1) revealed that the sole application of N and P rates had significant ($p \leq 0.05$) influence on the plant height and number of leaves of tomato at various sampling occasions. The mean plant height and number of leaves increased as the sampling occasions increases up to 8 weeks after transplanting. The highest plant height and number of leaves was obtained at sole application of 60 N kg/ha and 45 P_2O_5 kg/ha fertilizers rates. The interaction effects of N and P fertilizers rates showed a significant influence on both the plant height and number of leaves at all sampling occasions (Table 2). The highest plant (28.00cm) and number of leaves (128.30) was recorded at 30 N by 45 P_2O_5 kg/ha combined application of N and P rates.

Table 1: The sole effect of Nitrogen and Phosphorus on the height of tomato plants at different sampling periods.

		Plant Height (cm)		Number of Leaves	
		Weeks After Transplanting			
Treatments		4	8	4	8
Nitrogen (kg/ha)	0	9.87	23 80	19.70	69.00
	30	10.90	25.40	29.30	79.30
	60	14.20	34.30	31.30	84.00
LSD (p≤0.05)		3.00	11.11	10.38	34.51
Phosphorus (kg/ha)					
	0	9.87	23.80	19.70	69.00
	15	12.67	24.50	18.70	73.30
	30	13.17	20 50	19.70	74.70
	45	13.23	24.10	20.30	83.70
	60	10.30	24.10	21.70	78.00
LSD (p≤0.05)		5.42	7.14	9.68	28.91

Table 2: The interaction effects of Nitrogen and Phosphorus fertilizers rates on the plants height of tomato at different sampling periods.

	Plant Height (cm)		Number of Leaves	
	Weeks After Transplanting			
Nitrogen x Phosphorus Rates (kg/ha)	4	8	4	8
15N x $15P_2O_5$	12.87	9.50	34.30	30.30
15N x $30P_2O_5$	14.23	25.50	28.00	68.70
15N x $45P_2O_5$	14.43	25.80	25.30	80.00
15N x $60P_2O_5$	16.83	24.80	27.70	116.30
30N x $15P_2O_5$	15.60	26.20	26.00	115.70
30N x $30P_2O_5$	16.23	26.50	25.30	117.30
30N x $45P_2O_5$	14.63	28.00	39.30	128.30
30N x $60P_2O_5$	10.07	27.10	29.30	92.00
LSD ($p \leq 0.05$)	6.44	10.93	16.49	66.30

The sole application of N and P fertilizer rates significantly influenced ($p \leq 0.05$) the nutrient elements, nutritional value and antioxidant contents of tomato (Table 3). The value of these nutritional qualities increases as the fertilizer rates increases, except at 60 kg/ha P_2O_5. The highest crude protein, nutrient elements, carotene, lycopene and vitamin C was obtained at sole application of 60 kg N/ha and 45 kg P_2O_5/ha fertilizer rates. According to Schann (1992), minerals, protein and vitamin content of crops were well improved by soil fertilizers. The various interaction effects of combined N and P fertilizer application rates had significant ($p \leq 0.05$) influence on the nutrient elements, crude protein, carotene, lycopene and vitamin C contents (Table 4). Although, the highest value of most of these quality attributes was recorded at 30 N by 45 kg P_2O_5 /ha, but there were no significant difference between the values obtained at this rate and that recorded at 30N by 30 kg P_2O_5/ha combined applied fertilizer rates. Ronga *et al.,* (2020), also documents that N and P affects the quality of fruits.
The application of N and P rates had significant influence ($p \leq 0.05$) on the yield and yield components of tomato fruits (Table 5). The fruit yield (t/ha) increases as N and P application rates increases, except at 45 kg/ha P_2O_5. The highest fruit of tomato was obtained at sole application of 60 N kg/ha and 60 P_2O_5/ha. This observation is in line with (Edosa *et al.,* 2013), which stated that N and P applications enhances the yield and yield-related traits of tomato. The various interaction effects of combined N and P fertilizer application rates had significant ($p \leq 0.05$) influence on the fruit and yield components of tomato (Table 6). This is in line with (Gemechis *et al*., 2012) which states that the interaction effect of N and P fertilizer rates had a significant effect on marketable and total fruit yield, mean fruit weight, and fruit length. . The highest fruit yield (0.85) was recorded at 30N by 30 kg P_2O_5/ha combined applied fertilizer rates. Nitrogen and Phosphorus are the two essential macronutrients to crops which improve their growth, yield and product quality (Chen *et al*., 2008).

Table 3: The main effects of different Nitrogen and Phosphorus fertilizer rates on the nutritional quality of tomato.

	Nutritional Value (g/kg)								
Nitrogen (Kg/ha)	CP	P	K	Ca	Mg	Fe	Carotene	Lycopene	VT.C
0	8.40	1.80	176.50	5.52	0.51	0.48	0.24	1.96	17.16
30	8.70	1.72	182.70	5.75	0.54	0.50	0.22	1.98	17.60
60	1.06	1.96	196.10	7.90	0.62	0.58	0.37	5.40	19.70
LSD ($p \leq 0.05$)	3.48	0.03	1.64	0.09	0.03	0.02	0.03	0.51	0.28
Phosphorus									
0	8.40	1.80	176.50	5.52	0.51	0.48	0.24	1.96	17.20
15	1.10	2.24	210.10	8.20	0.60	0.62	0.42	5.70	21.40
30	1.02	2.10	196.80	7.20	0.53	0.58	0.31	3.60	20.60
45	0.94	1.92	186.50	6.75	0.58	0.54	0.25	2.70	18.90
60	1.13	2.30	211.70	8.30	0.64	0.56	0.33	6.20	37.50
LSD ($P \leq 0.05$)	2.46	0.09	8.22	0.22	0.04	0.07	0.22	0.02	23.53

Table 4: The effects of combined Nitrogen and Phosphorus rates on tomato fruit nutritional quality.

	Nutritional Value (g/kg)								
Nitrogen x Phosphorus (kg/ha)	**CP**	**P**	**K**	**Ca**	**Mg**	**Fe**	**CAROTENE**	**LYCOPENE**	**VTC**
15N x 15 P_2O_5	0.86	1.90	191.40	6.82	0.61	0.54	0.24	2.64	18.23
15N x 30 P_2O_5	0.44	0.64	171.10	3.40	0.10	0.12	0.14	0.80	9.60
15N x 45 P_2O_5	0.64	2.30	214.50	8.50	0.66	0.64	0.34	6.40	22.60
15N x 60 P_2O_5	0.92	1.98	198.10	7.80	0.63	0.59	0.39	4.86	19.60
30N x 15 P_2O_5	0.89	1.86	180.40	6.84	0.52	0.48	0.21	2.42	18.74
30N x 30 P_2O_5	1.14	2.44	216.50	6.70	0.64	0.66	0.28	6.80	21.80
30N x 45 P_2O_5	1.16	2.38	218.70	6.64	0.65	0.68	0.27	6.86	21.60
30N x 60 P_2O_5	0.77	1.64	171.60	5.94	0.36	0.38	0.34	2.24	14.40
LSD ($p \leq 0.05$)	0.26	0.04	30.07	0.18	0.09	0.04	0.01	0.02	0.72

Table 5: The main effect of Nitrogen and Phosphorus fertilizer rates on the yield and yield components of tomato fruits.

	Fruit Yield and Yield Components				
Nitrogen (kg/ha)	**Diameter of Fruits (cm)**	**Length of Fruits (cm)**	**No of Flowers**	**No of Fruits**	**Fruit Yield Yield (t/ha)**
0	0.77	0.40	10.30	6.70	0.31
30	0.97	1.90	10.00	11.00	0.34
60	1.10	1.43	9.00	12.60	0.85
LSD ($p \leq 0.05$)	1.79	1.69	6.35	0.35	2.37
Phosphorus					
0	0.77	0.40	0.40	6.70	0.31
15	0.80	0.67	0.67	5.00	0.24
30	1.03	2.27	2.27	8.00	0.43
45	0.97	1.40	1.40	9.30	0.30
60	1.30	2.07	2.07	4.40	0.77
LSD ($p \leq 0.05$)	0.98	1.56	1.56	0.30	0.69

Table 6: The combined effects of Nitrogen and Phosphorus fertilizer rates on the fruit yield and yield components of tomato.

	Fruit Yield and Yield Component				
Nitrogen x Phosphorus (kg/ha)	**Diameter of Fruits (cm)**	**Length of Fruits (cm)**	**No of Flowers**	**No of Fruits**	**Fruit Yield Yield (t/ha)**
15N x $15P_2O_5$	0.37	1.53	12.00	5.00	0.49
15N x $30P_2O_5$	0.43	1.47	14.33	11.00	0.72
15N x $45P_2O_5$	1.23	1.87	9.00	10.00	0.67
15N x $60P_2O_5$	1.47	1.33	10.67	8.00	0.40
30N x $15P_2O_5$	1.53	2.10	11.33	7.10	0.47
30N x $30P_2O_5$	1.87	2.40	9.33	14.80	0.85
30N x $45P_2O_5$	1.00	2.37	11.67	11.70	0.81
30N x $60P_2O_5$	1.33	1.67	11.33	7.90	0.35
LSD ($p \leq 0.05$)	1.02	1.20	3.46	0.20	0.51

CONCLUSION AND RECOMMENDATION

In conclusion, the result shows that for optimum growth, fruit yield and nutritional quality of tomato, sole application of Nitrogen fertilizer at 60kg N/ha, Phosphorus fertilizer at 45kg P_2O_5/ha, and combined application of Nitrogen and Phosphorus fertilizer at 30kg/ha and 30kg/ha are appropriate and thus could be recommended for the tomato cultivation in the study area.

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ANTIOXIDATIVE POTENTIAL OF COFFEE-PINEAPPLE JELLY

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ABSTRACT
The potential of coffee as good source antioxidants which is needed in curbing degenerative diseases is well known, yet its utilization in terms of incorporation into a variety of food products is limited. However, its inclusion in jelly was explored in this study with the aim of making jelly a functional food. Pineapple fruits were washed, peeled, sliced, blended, sieved and packaged. Dried coffee beans were roasted at 180°C for 26 minutes, milled and incorporated into the extracted juice in the ratio of 2.5, 5. 7.5 and 10% of coffee inclusion into whole mass of jelly samples. The jelly samples were produced by cooking the mixtures to a desired texture following a standard procedure. The jelly samples were cooled and packaged. The antioxidant and sensory properties of the resulting jelly samples were evaluated following standard procedures. The DPPH of the coffee pineapple jelly samples ranged between 69.50 -93.27%. The total antioxidant capacity of the coffee- pineapple jelly samples varied from 4.76-5.88 mg/g. The reference sample (jelly without coffee inclusion) had the lowest DPPH and flavonoid values as compared with the formulated coffee jelly samples but possess higher value as its total antioxidant. Conclusively, panelists preferred sample with 2.5% coffee powder inclusion, which also contained appreciable antioxidant properties, that might contribute to daily intake of phyto-chemicals needed in curbing degenerative or life threatening diseases.
Keywords: *Coffee powder, Pineapple, Jelly, Antioxidant properties, Sensory properties*

INTRODUCTION

Fruits and vegetables processing into squashes, juices, jams, jellies, marmalades, pickles, fruit in syrup and so on, offers several ways of consuming fruits and vegetables (Khanum *et al.,* 2007).. The demand of such products is on increase. Jam and jelly, and fruit-in–syrup are being consumed increasingly by more people as dessert (Khanum *et al.,* 2007). Fruit jellies are semi solid preserves produced from mixtures of fruit juice and sugar. Jelly making provides a good way to preserve fruit flavors for enjoyment throughout the year (Syed Masood *et al*., 2017). A good jelly should be transparent, well set, not too stiff, but should have the original flavour of the fruit and possess attractive colour. It should not be gummy, sticky, syrupy or have crystallized sugar. They are nutritious foods and can play a significant part in a healthy diet because they offer good taste and a variety of nutrients found naturally in fruits. Fruit jelly is a relatively easy-to-prepare product for the beginning canner and may be made at home without special equipment. (Syed Masood *et al.,* 2017). In recent times, jellies are achieving high popularities among the community, but they are not fulfilling the nutritive value and appear to be very hazardous to human health (Syed Masood *et al*., 2017).

Pineapple (*Ananascomusus*) is from Bromeliaceae family and it is one of the fruits from the tropics with the highest production in the world, estimated at around 20% (Lu *et al.,* 2014)

The largest fruit producers are countries such as Thailand, Philippine, Indonesia, India, China, Costa Rica, Brazil, Nigeria and South Africa (Lobo and Paull., 2017). World pineapple production was around 25 million tonnes, in 2017, while in Brazil about 284,000 tons were produced, corresponding to about 11% of all fruit production (FAO., 2019). In Brazil, most of pineapple production (97%) is typically for fresh consumption, being one of the six most consumed fruits (IBGE, 2013). This fruit has a high nutritional profile, with appreciable levels of vitamins, minerals, fiber, flavonoids and carotenoids (Ancos *et al.,* 2017). Generally, pineapple can possibly be consumed dehydrated, canned, as a juice, jam and compote. After harvesting, the fruit has a reduced shelf life, which leads to nutritional and economic losses.

Plant foods had been reported as natural sources of anti-oxidants (Shukla and Singh, 2007). Coffee is one of the most common beverages and largest traded commodities worldwide (Lachenmeier, 2020). Based on its aromatic flavor and the beneficial effects of caffeine, millions of people consume coffee on a daily bases. Coffee contains appreciable amount of bioactive compounds (Król, *et al.*, 2020). The bioactive compounds present in coffee are mainly phenolic antioxidants in the hydrocinnamic family, which are caffeic, chlorogenic, p- coumaric and ferulic acids (Gorecki and Hallman, 2020). It is worthy to note that the consumption of coffee reduces incidence of cancer, liver cirrhosis and type 2 diabetes (Van-Dam and Feskens, 2002). Therefore, there is need to research into the potential of improving the value pineapple jellies using coffee powder. The aim of this research is to determine anti-oxidative potentials and sensory properties of coffee – pineapple jelly.

MATERIALS AND METHODS

Materials

Coffee beans were obtained from Cocoa Research Institute of Nigeria, Idi Ayunre, Ibadan, Oyo State, while other ingredients were purchased from Oja Oba Market, Ibadan, Oyo State.

Methods

The mixture of pineapple juice and coffee powder (coffee inclusion between 2.5 to 10%) was boiled for 15 minutes and sugar, pectin, citric acid and ascorbic acid were added, followed by stirring using a glass rod. The mixture was rapidly cooled to ambient temperature by immersing the plastic container in the refrigerant.

Antioxidant Potential

DPPH scavenging assay

The scavenging activity of DPPH radicals in the sample solution was determined using the method of Shen *et al.* (2010).

Ferric reducing power

The reducing power was measured spectrophotometrically by assessing the ability of the sample to reduce iron chloride (Pulido et al., 2000).

Total flavonoid content

The total flavonoid content of the coffee- pineapple jelly samples were estimated by the method described by Zhishen et al. (1999) with slight modification.

Total antioxidant capacity

The total antioxidant capacity of the samples was determined using the method described by Prieto *et al.,* (1999) with minor changes.

Determination of ascorbic acid (TAA*)*

The method of AOAC 967.21 was adopted to determine ascorbic acid content. The principle of the method bases on the oxidation of ascorbic acid into dehydroascorbic acid and colourless lenco derivatives using 2,6 dichlorophenolindophenol (DCPIP) (Puwastien *et al.*, 2011).

Statistical analysis

SPSS version 23.0 software (Coakes, 2017) was used to analyze the data obtained in this study.

RESULT AND DISCUSSION

The DPPH result of the coffee pineapple jelly samples is presented in Table 1. There were significant differences in the samples except samples with 7.5 and 10% coffee inclusion. The value of the DPPH of the coffee pineapple jelly samples ranged between 69.50 -93.27 % with the control sample having the lowest value, whereas the sample with 7.5% coffee powder possessing the highest value. All formulated samples had higher DPPH values than the reference sample of 100% pineapple juice. Sample with higher coffee inclusion exhibited higher DPPH values. The flavonoid content of the samples ranged between 0.75 - 4.43 mg/g. The control sample exhibited the lowest flavonoid content, while the highest flavonoid content is found in the samples with 10% coffee powder inclusion. The result obtained showed that the flavonoid content increases with increasing level of coffee powder addition. The addition of coffee powder showed significant effect in the flavonoid content of the coffee jelly samples.

Sample with 2.5% coffee inclusion had the lowest FRAP value; it is also significantly different from the reference sample and other formulated samples. However, the sample with 2.5 % inclusion of coffee had comparable total antioxidant value with the reference sample, but significantly different from the other formulated samples. Ascorbic acid contributes to the product appearance and palatability (Cvetkovic and Marija 2009). There are no significant differences in all the formulated coffee pineapple jelly samples. It was observed that all the formulated samples were significantly higher than the vitamin C content of the reference sample. The vitamin C content of the samples ranged between 11.46 - 12.37 mg/100g. This value is lower than the vitamin C content (15.00 to 58.00 mg/100g.) reported by Mumtaz *et al.,* (2019) who studied jams and jellies available in Bangladesh, but higher than the range (7.74 to 9.9 mg/100g) reported by Chalchisa *et al.,* 2022 who worked on the effect of sugar, pectin, and processing temperature on the qualities of pineapple jam. The control was significantly different from all the formulated samples. This means that the coffee powder addition influences the vitamin C content of the formulated jelly samples.
The total anti-oxidant capacity result of the coffee pineapple jelly samples ranged between 4.76-5.88 mg/g. There were significant differences in the total antioxidant capacity of the coffee- pineapple jelly samples except the control. There is no significant difference between the total anti-oxidant capacity of the control sample and the sample with 2.5% coffee powder inclusion. The antioxidant capacity reduced with increased addition of coffee powder. This might be due to the absence of mailard reaction. This reason was in line with the report stated by Tadros *et al.* (2011), *that* in theory, attempts to inhibit the Maillard (non enzymatic browning) reaction as a possible means to minimize the formation of acrylamide might lead to a decrease in the antioxidant capacity of coffee.

Table 1: Anti-oxidant properties of coffee pineapple jelly

Samples	DPPH (%)	FRAP (mg/g)	Flavonoid (mg/g)	Total Antioxidant (mg/g)	Vitamin C (Ascorbic acid) (mg/100g)
100 P; 0 C	69.50^{d}	6.35^{a}	0.75^{e}	5.88^{a}	11.46^{b}
97.5; P:2.5C	80.08^{b}	1.04^{b}	1.22^{d}	5.70^{a}	12.31^{a}
95 P: 5 C	71.50^{c}	8.15^{a}	2.61^{c}	5.31^{b}	12.37^{a}
92.5 P: 7.5C	93.27^{a}	4.89^{a}	3.46^{b}	5.24^{b}	12.37^{a}
90 P:10 C 10	91.87^{a}	6.12^{a}	4.43^{a}	4.76^{c}	12.32^{a}

Key: P= Pineapple C= Coffee powder

CONCLUSION

The study revealed that panelists preferred sample with 2.5% coffee powder inclusion, which also contained appreciable antioxidant properties, that might contribute to daily intake of phyto-chemicals needed in curbing degenerative or life threatening diseases.

DECLARATION OF INTEREST

No known potential conflict of interest was reported by the authors in this manuscript.

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DETERMINATION OF BIO CONSTITUENTS OF NIHORT BOTANICAL PESTICIDES (Lyptol, Minty and Raktin) AND THEIR RELATIVE STABILITY OVER A PERIOD OF TIME

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ABSTRACT
Bioactive component of NIHORT formulated botanical pesticides; Nihort-Raktin (a.i Azadirachtin) and Nihort-Lyptol (a.i Cineole) and Minty (a,i menthol) and their relative stability over the period of 6 months was investigated. Freshly prepared NIHORT Lyptol, Raktin and Minty collected from Biopesticide Centre of National Horticultural Research Institute were used for the study. The biopestides were stored on the shelf for the period of six months while Phytochemical analysis was being carried out at 0, 3 and 6 months interval. Phytochemical analysis revealed the presence of phenols, flavonoids, tannins, saponins, Phytate, Cardiac glycoside, Oxalate, anthraquinones and terpenoids at varying concentrations in all the biopesticides. At 0 and 3 month storage period, bio constituent in NIHORT Lyptol was consistently and significantly higher, followed by NIHORT Raktin and NIHORT Minty in that order. It was observed that saponin, oxalate and terpenoid could not be determined in all the bio pesticides at six months after storage. Generally, there was decrease in the phytochemical constituents of the all the bio pesticides as storage period increased.
Keywords*: bioactivity, biopesticides, phytochemical, storage*

INTRODUCTION
Bio pesticides are certain type of pesticides that are derived from natural materials like plants, bacteria, fungi, virus and certain materials (Saxena and Pandey, 2001). For many years, plants and plant-derived metabolites have served as the starting point for the discovery and development of new antimicrobial agents. They are less toxic than conventional pesticides and only affect target pest without any hazard to animals and humans. They are group of pesticides which is effective in very small quantities and often decompose quickly; resulting in lower exposure and largely avoiding the pollution problems caused by conventional pesticides (Raja, 2014). Chemical pesticides have provided protection required for crops to help satisfy the world demand for food, feed, and fiber but over years, increase in usage has led to various issues such as resistance in pests and diseases, negative impact on human and animal health, ecological imbalance, pest resurgence and residues in foodstuff (Karim *et al*., 1999). In view of these problems, there is need to look for new and promising alternatives that are biodegradable, specific towards target organism, low likelihood of resistance development and at the same time suitable for incorporation into integrated pest management practices, and practically no known health risks (Bailey and Mupondwa, 2006). This work was carried out to assess the bio constituents of NIHORT biopesticides (Lyptol, Raktin and Minty) and their relative stability over a period of time.

MATERIALS ANS METHODS
Freshly prepared NIHORT Lyptol, Raktin and minty collected from Bio pesticide centre of National Horticultural Research Institute were used for the study. The bio pesticides were stored on the shelf for the period of six months while Phytochemical analysis was being carried out at 0, 3 and 6 months interval. Total phenolic content extracts was measured using the Folin–Ciocalteu reagent method as described earlier (Kaur and Kapoor, 2002). Total flavonoid was determined using the aluminium chloride colorimetric method as described by Chang *et al*., 2002.Tannin was determined according to the method of AOAC with some modifications. The Spectrophotometric method of Brunner (1984) was used for saponin analysis. Extraction of phytate from the sample was carried out following a modified procedure of Harland and Oberleas (1977). Steroid content was determined using the

method described by Trease and Evans (1989). The quantity of cardiac glycoside in the sample was evaluated using Baljets reagent (95ml of aqueous picric acid + 5ml 10% aqueous NaoH) as described by El-olemy *et al* (1994) while oxalate was determined as described by Oke (1966).

RESULTS AND DISCUSSION

Phytochemical analysis of NIHORT Lyptol, NIHORT Raktin and NIHORT Minty revealed the presence of phenols, flavonoids, tannins, saponins, Phytate, cardiac glycoside, oxalate, anthraquinones and terpenoids. At 0 month, NIHORT Lyptol had the highest quantity of all the pyhtochemicals except phytate where highest quantity 70.3 mg/100g was recorded in Raktin. NIHORT Minty ranked second in terms of phytochemical quantity while the least was recorded in Raktin (Table 1). High bio constituent displayed by Nihort Lyptol in this study was in accordance with the reports of Huang *et al*, (2015) where it was stated that Eucalyptus genus is known as important reservoir of a wide range of secondary metabolites many of which harbor a diverse range of biological activities. At 3 month after storage, similar trend was observed in NIHORT Lyptol in terms of phytochemicals quantity where amount of total phenolic total, total flavonoid, tannin, cardiac glycoside, steroid, anthraquinone and terpenoid was significantly $P \leq 0.05$ higher compared to NIHORT Raktin and NIHORT Minty (Table 2).

However, amount of saponin, Phytate, and oxalate was lowest in NIHORT Lyptol. NIHORT Raktin ranked second in terms of Total phenolic, total flavanoid, tannin, saponin, phytate, cardiac glycoside, steroid, anthracquinone and terpeoid. However, saponin and phytate and oxalate contents was significantly $P \leq 0.05$ higher in Minty compared to the amount recorded in NIHORT Lyptol and NIHORT Raktin (Table 2). At 6 month, bio constituent in NIHORT Lyptol was consistently and significantly higher. It was observed that saponin, oxalate and terpenoid could not be determined in all the bio pesticides at six months after storage. However, Total phenolic, tannin, phytate, cardiac glycoside and steroid, was highest in NIHORT Lyptol, followed by NIHORT Minty and NIHORT Raktin in that order (Table 3). Generally, there was decrease in the phytochemical constituents of the all the bio pesticides as storage period increased. Great potentials of azadirachtin as a natural source of bio agents have been documented (Girish *et al.,* 2008). Extracts of various parts of neem and their potential antifungal, anti viral and antibacterial due to their bio constituents deposit have been reported by earlier investigators Llyod *et al*., (2005). In addition, biological activity of Menthol as good source of anti bacteria and anti fungal due to their bio constituent have been reported (Moghtader, 2013).

CONCLUSION

All these bio pesticide can present feasible and viable alternative to synthetic fungicides. This will help to combat fungicides resistance by pathogens, minimize the effect of pesticides on non target organism and also reduce pesticides residues in the environment and commodities.

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Table 1: Phtyochemical screening of freshly harvested NIHORT biopesticides

Treatments	Total phenolic mg/100g	Total flavonoid mg/100g	Tannin mg/100g	Saponin mg/100g	Phytate mg/100g	Cardiac glycoside mg/100g	Oxalate mg/100g	Steroid mg/100g	Anthroquinone mg/100g	Terpenoid mg/100g
Lyptol	372.57	185.77	157.56	16.62	62.99	116.11	5.23	196.09	92.68	0.43
Minty	65.29	40.22	63.77	4.63	64.96	25.14	5.50	34.36	37.52	0.44
Raktin	66.82	83.48	71.55	7.70	70.32	55.93	6.03	35.17	42.09	0.50
LSD (0.05)	29.37	16.04	10.68	2.30	5.17	10.05	0.52	15.46	6.29	0.05

Table 2: Phytochemical screening of NIHORT biopesticides at 3 months after storage

Treatments	Total phenolic mg/100g	Total flavonoid mg/100g	Tannin mg/100g	Saponin mg/100g	Phytate mg/100g	Cardiac glycoside mg/100g	Oxalate mg/100g	Steroid mg/100g	Anthroquinone mg/100g	Terpenoid mg/100g
Lyptol	283.13	127.71	129.06	16.35	27.79	85.14	7.43	149.01	85.14	1.08
Minty	61.86	37.33	116.00	34.23	58.19	24.89	15.56	32.56	24.89	0.97
Raktin	73.93	47.33	125.51	29.23	49.70	31.56	13.29	38.91	31.56	1.05
LSD (0.05)	2.46	8.09	3.03	2.17	3.68	5.38	0.98	1.29	5.39	0.03

Table 3: Phytochemical screening of NIHORT bio pesticides at 6 months after storage

Treatments	Total phenolic mg/100g	Total flavonoid mg/100g	Tannin mg/100g	Saponin mg/100g	Phytate mg/100g	Cardiac glycoside mg/100g	Oxalate mg/100g	Steroid mg/100g	Anthroquinone mg/100g	Terpenoid mg/100g
Lyptol	169.04	21.38	35.03	ND	17.61	7.13	ND	112.69	16.45	ND
Minty	39.92	3.89	25.37	ND	4.16	2.35	ND	26.62	2.99	ND
Raktin	28.43	9.06	20.23	ND	2.96	1.29	ND	18.95	5.43	ND
LSD (0.05)	6.49	1.38	4.52	ND	0.68	0.46	ND	4.33	1.06	ND

INDUSTRIAL REVOLUTIONISM AND HORTICULTURE IN NIGERIA

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ABSTRACTS
The world is fast changing since the advent of Information and Communications Technology. The development brought unprecedented changes to the ways people go about carrying out operations and the resultant effects of deploying technologies to operations are outrageous. Horticulture, being an important source of food, raw materials and employment is not left behind in the torrent as technologies leaves no stone unturned. Industrial Revolution 4.0 is trending with pronounced effect on all human activities in the developed nations of the world as evident in reports and scholarly publications. This paper describes artificial intelligence and other components of Industrial Revolution 4.0.; reviews the contributions of artificial intelligence to horticultural development around the world; and identifies merits and demerits of deploying artificial intelligence to carrying out horticultural activities in Nigeria.
Keywords: *Artificial intelligence (AI); Horticulture; Industrial Revolution 4.0. (Fourth Industrial Revolution or 4IR); Nigeria*

INTRODUCTION

Artificial intelligence is transforming the agricultural sector by optimizing processes and resources. AI is an evolving set of technologies that are used to solve a variety of applied problems and has been extensively applied in farming recently. Horticulture, a branch of agriculture produces fruits, vegetables and ornamental plants for subsistence, commercial and industrial uses. The importance of this sub-field of agriculture to humanity cannot be overemphasized. Horticulture provides nutritional, economic, health and aesthetic benefits to local, national and international communities. Horticultural activities require the interactions of human and material resources. The qualities of tools, machines, materials and human elements deployed to horticultural procedures determine the quality of outputs. Applications of AI to the horticulture industry are diverse. From planting, watering, and harvesting to experimenting with new systems, machines can often be created to be more efficient than people. The horticulture industry requires people with artificial intelligence acumen to enable them to improve yield. Artificial Intelligence technologies are helpful to yield healthier crops, provide information on prevailing weather conditions such as temperature, rain, wind speed, wind direction, solar radiation, pest control, monitor soil, and growing conditions, organize data for farmers, help with the workload and improve food supply chain (Manaware, 2020).

Artificial intelligence (AI) also called machine intelligence is a domain in computer science that instructs machines on how to replicate human physical actions and react like humans. In the past, machines were fabricated to ease human activities but artificial intelligence is removing human involvement even in human activities: such that, only machines do what hitherto, were done by human or a combination of human and machines. In Nigeria, we are familiar with mechanized horticulture but deploying AI to horticulture seems to be untapped goldmine. There are reports of wonders that AI is doing in horticulture in the developed parts of the world but most developing countries are lagging behind. It is very important we join the moving train of industrial revolution. This paper assesses the adoption of Artificial Intelligence as component of industrial Revolution 4.0 in Nigeria with reference to horticulture.

Artificial Intelligence and Industrial Revolution 4.0

Industrial Revolutionism refers to eras that introduced and developed technologies that have to do with changes in technologies that are connected to digital transformation. Schwab (2016) and Zambon et al (2019) posited that Industry 4.0, also known as Fourth Industrial Revolution or 4IR was preceeded by the First Industrial Revolution that used water and steam power to mechanize production. The Second used electric power to create mass production. The Third used electronics and information technology to automate production. Now a Fourth Industrial Revolution is building on the Third, the digital revolution that has been occurring since the middle of the last century. It is characterized by a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres. . Industrial Revolution 4.0 is developed based on three main factors as Artificial Intelligence (AI), Internet of things (IoT) and Big Data (Big Data), of which the foundation is the application of Information and Communication Technology (ICT).

Industrial Revolution and Horticulture

Industrial revolution has to do with changes brought about by new technologies that were developed and adopted to the way people live and work. Industrial revolutionism affects horticulture as a sub-field of agriculture in many ways. Recall that, farming operations were subsistence and manual. Since the advent of industrial revolution 1.0, when farming moved from subsistence or manual to commercial and mechanized; industrial demand for agricultural outputs became more popular (Industrial Revolution 2.0); to digital, where computers were introduced industrial activities (Industrial Revolution 3.0) and now we have industrial revolution 4.0 that is popularly described as advanced Industrial Revolution 3.0 that is totally. Stages of industrial revolutions according to Times Agriculture (2023):

1. The first stage is the agricultural revolution, which took place from 1750 to 1850. In this period, technologies were developed that allowed for increased food production.
2. The second stage is the industrial revolution proper, which took place from 1850 to 1900. This was when factories began to replace farms as the main source of employment.
3. The third stage is electrical age, which took place from 1900 to 1945 and electricity became widely available and was used to power machines in factories.
4. The fourth stage is the digital age which took place from 1945 to the present day. This is when computers and other electronic devices began to be used in the industries.

Different scholars described stages of industrial revolution and how agriculture was affected differently but the important thing to note is that industrial revolution had significant impact on horticulture. Invention of steam engine, combine harvester electric generator, tractor, refrigerators, microwave oven, planter, etc changed the ways crops were planted, harvested and processed. Industrial Revolution led to a decline in agricultural productivity at some time, as people farms to work in factories or relatively more lucrative industry. It led to the development of new technologies and machines that have improved the ways we produce and process horticultural crops; increased productivity and efficiency through the use of chemicals, machinery and modern transportation system; led to environmental and health challenges; and facilitated research and development in horticulture among others.

According to Marucci et al (2017), revolutions in agriculture can be hypothesized to have gone hand-in-hand with the innovations in the industrial sector in recent years. Agricultural technology revolution started with Agriculture 1.0 with animal power; then the combustion engine defined Agriculture 2.0, passing to Agriculture 3.0 in recent years with guidance systems and precision farming, starting when military GPS-signals were made accessible for public use. Agriculture 4.0 farm activities are connected to the cloud. Zambon et al (2019) posited that following European agricultural machinery in 2017, the next step with Agriculture 5.0 includes digitally-integrated enterprise, which rely their production processes using robotics and some forms of artificial intelligence and Internet of Things (IoT) where all kinds of devices-smart objects-are connected and interact with each other through local and global, often wireless network infrastructures. Therefore, precision agriculture results to be the most recent discipline of this development as an important driver for Big Data. Radical changes in farm management can be expected due to the access to clear information and decision-making abilities that before were not possible.

Artificial Intelligence and Horticulture around the world

According to Nijhuis and Hermann (2019), in Brazil, one firm was developing a swarm of miniature autonomous robots that could plant seeds. Controlled by a farmer's handheld tablet, which is operated with the help of satellites and cloud-based software, the swarm will be able to put each seed in the right place with greater precision than current approaches can. Not incidentally, the technology will eliminate the need for planter bars, tractors, and tractor operators. Because the swarm can adjust seed locations for changing conditions, it will increase yield, with lower costs, faster planting speeds, and a reduced impact on the environment.

Many pesticide and fertilizer companies, for example, are using Industrial Revolution 4.0 technologies to provide better products and roll them out faster than before. That might sound like a success story, but precision farming — which uses IoT sensors, high-resolution 3D aerial imagery from drones, and AI-powered analytics to analyze the characteristics of soil and the behavior of crops down to the square inch — may soon significantly reduce the need for fertilizers and pesticides altogether. According to Dushyant (2021) applications of AI in Agriculture includes: Computer vision technology, IOT and drone data can be combined to ensure rapid actions by farmers for disease detection, crop readiness identification and field management; health monitoring of crops; decrease use of pesticides; automation of techniques in irrigation; drone based technology for soil and field analysis, crop spraying and monitoring, irrigation and health assessment; models for farmers' services through chatbot, Agri-E calculator for suitable crop selection along with resource estimation, crop care services, Price prediction and market guidance, Crop loan and insurance service; and Robot Drone Tractor.

Challenges and opportunities of Industrial Revolution 4.0 in Horticulture

Horticultural mechanization brought tremendous gains in efficiency and productivity but digitization brought much more. Automation is faster and more effective than mechanization. Like the revolutions that preceded it, the Fourth Industrial Revolution technology made possible new products and services that increase the efficiency and pleasure of our personal lives. Ordering a cab, booking a flight, buying a product, making a payment, listening to music, watching a film, or playing a game—any of these can now be done remotely. In the future, technological innovation will also lead to a supply-side miracle, with long-term gains in efficiency and productivity. Transportation and communication costs will drop, logistics and global supply chains will become more effective, and the cost of trade will diminish, all of which will open new markets and drive economic growth. These, we are experiencing at a relatively low pace in Nigeria when compared to the developed worlds.

On the contrary, industrial revolution could yield greater inequality, particularly in its potential to disrupt labour markets. In addition to being a key economic concern, inequality represents the greatest societal concern associated with the Fourth Industrial Revolution. As automation substitutes for labor across the entire economy, the net displacement of workers by machines might exacerbate the gap between returns to capital and returns to labor. On the other hand, it is also possible that the displacement of workers by technology will, in aggregate, result in a net increase in safe and rewarding jobs. In the future, talent, more than capital, will represent the critical factor of production. This will give rise to a job market increasingly segregated into "low-skill/low-pay" and "high-skill/high-pay" segments, which in turn will lead to an increase in social tensions. Technology is therefore one of the main reasons why incomes have stagnated, or even decreased, for a majority of the population in high-income countries: the demand for highly skilled workers has increased while the demand for workers with less education and lower skills has decreased. The result is a job market with a strong demand at the high and low ends, but a hollowing out of the middle. The largest beneficiaries of innovation tend to be the providers of intellectual and physical capital—the innovators, shareholders, and investors—which explains the rising gap in wealth between those dependent on capital versus labor.

Dushyant (2021) posited that AI systems need a lot of data to train machines and to make precise predictions. Though Artificial Intelligence offers vast opportunities for application in agriculture, there still exists a lack of familiarity with high tech machine learning solutions in farms across most parts of the world. Data infrastructure takes time to mature, it requires a significant amount of time to build a robust machine learning model because temporal data is hard to get for vast agricultural land unlike spatial data.

CONCLUSION

The future of industry is progressing towards a 5.0 industry, while the primary sector is still inadequate. The 4.0 revolution in agriculture is still limited to rare pioneering firms. Horticulture in Nigeria is yet to be optimizing artificial intelligence as it is in countries such as Brazil, China, India, US and other developed nations of the world. Despite the attractive prospects of deploying AI to horticulture, Nigeria is still managing to measure up to Industrial Revolution 3.0 while others are getting ready for Industrial Revolution 5.0. We need to shape a future that works for all of us by putting people first and empowering them. In its most pessimistic, dehumanized form, the Fourth Industrial Revolution may indeed have the potential to "robotize" humanity and thus to deprive us of our heart and soul. But as a complement to the best parts of human nature—creativity, empathy, stewardship—it can also lift humanity into a new collective and moral consciousness based on a shared sense of destiny. It is incumbent on us all to make sure the latter prevails.

RECOMMENDATIONS

This paper recommends that stakeholders, policy and decision makers should invest in relevant technologies to promote productive, innovative and sustainable horticulture in Nigeria by identifying the position of horticulture in Nigeria as regards industrial revolutions; assessing gaps and opportunities; set path to close the gaps, optimize the opportunities and evolve culture to align the horticultural practices with trends in industrial revolutionism.

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DIETARY IMPACT OF HORTICULTURAL CROPS AND LIVESTOCK FARMING HOUSEHOLDS' FOOD SECURITY: A CASE STUDY OF FULANI HOUSEHOLDS IN OYO STATE, NIGERIA

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ABSTRACT

Despite the fact that horticulture crops are entirely composed of vitamins and minerals, evidence suggests that the majority of households lack access to and affordability for essential nourishment. Therefore, this study investigates the complex link between household food security and consumption of horticulture crops utilizing original information collected from 293 Fulani households in Oyo State. To guarantee that the samples of households for the study were representative, a multi-stage stratified random sampling approach was used. Descriptive statistics and a fractional regression model are two econometric methods that were used to analyze the goals that were established. The study also found that 32.8 percent of households consume horticultural crops moderately, 18.0 percent consume them lightly, and 49.2 percent consume them substantially. The ATE results show a significant negative coefficient (0.1179; p = 0.015), indicating a decline in food security of roughly 12%.

Keywords: *Consumption, Health, Leaf, Fruit, Stratified*

INTRODUCTION

The idea of an abundance of grains, roots, and tubers—the basic crops that offer reasonably priced sources of dietary energy—has long been linked to food security. But as the idea of food security has ingrained nutrition security into it and the need of dietary diversity for optimum health has risen to the forefront, this picture is shifting. Consuming a variety of food groups in the proper amounts is necessary for a healthy, high-quality diet. Horticultural crops have a significant impact on food; their nutritional value is crucial for a healthy lifestyle. Fruits and vegetables are the most important sources of the micronutrients needed for a healthy diet. Vegetables are rich in nutrients such as potassium, which supports healthy blood pressure, dietary fiber, which lowers blood cholesterol and may lower the risk of heart disease, folate (folic acid), which reduces the risk of birth defects, vitamin A, which supports healthy eyes and skin, and vitamin C, which not only supports healthy teeth and gums but also aids in iron absorption. According to Jena et al. (2018), vegetables are the main contributors to achieving global nutritional security by delivering nutrients, vitamins, and minerals. They are also the main drivers of a balanced human diet. They have the potential to alleviate poverty by creating jobs and generating revenue, as well as through increasing farm productivity and profitability.

By increasing the variety of edible foods, they can support sustainable lives by ensuring the food security of households. Ruel (2003) has also demonstrated that agricultural households may have access to a broader variety of highly healthy meals, such as vegetables and products of animal origin (milk, eggs, and meat), as well as to food that is relatively affordable. Since households with direct access to food may eat more food and have a more varied diet richer in essential micronutrients. In order to avoid chronic diseases (particularly heart diseases, malignancies, and diabetes) and provide necessary micronutrients (notably calcium, iron, iodine, vitamin A, and zinc), the World Health Organization (WHO) advises a minimum intake of 400 g per day (WHO, 2015). Consumers today, including those with higher earnings, are thought to be falling short of this goal. It is necessary to pay more attention to the nutritional value of horticulture crops, their dietary impact on household food security, and how to make them accessible to consumers.

METHODOLOGY

The study assesses dietary impact of horticultural crops and households' food security in Oyo State. In this study, primary data was used and it was obtained through a quantitative survey using structured questionnaire. Adopting a multistage sampling, the study sampled about 293 households from different clustered Fulani households in Oyo State, Nigeria. Both descriptive and inferential statistics (Average Treatment Effect and Fractional regression model) were used in the study to estimate food security status of the respondents.

Analytical framework

Fractional regression model as a response model was used in this study to estimate parameter which could influence food security in the study area. The explicit form of the regression model was presented below:

$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \ldots\ldots\ldots + \beta_nX_n + e$

Where; Y_1 = Consumption index

$\beta_1, \beta_2 \ldots \beta_n$= (coefficient) which measures a corresponding change in dependent variable brought by a unit in independent variable. β_0 and $_{Ei}$ = intercept and error term respectively; X_1= Age of respondent (years); X_2 = Gender; X_3= Marital status; X_4= Educational level (years); X_5= Household size; X_6 = Primary occupation; X_7 = Years of livestock farming experience; X_8 = profit from sales of livestock; X_9 = Amount spent monthly on food; X_{10} = Purpose of livestock farming; X_{11} = Type of livestock reared

RESULT AND DISCUSSION

Table 1 revealed the summary statistics of some of the variables used in the study. The table showed the description of the variables together with the mean and standard deviation. From the result, the average age of the respondents stood at 46.3 years; this implied that most of the households' head were young and still within the productive age group. Marital status was measured based on the current status of the household head. This result showed that large number of the respondents were married. The average years of education was 7; indicating that most of the respondents had only primary school education as majorly Fulani tribe value-less formal education, believing that they are nomads. Furthermore, the result showed significant number of years of experience in livestock farming, the average years of experience stood at 34.8 years. Most Fulani were born to rear livestock, they are involved in cattle rearing and it has become generational profession.

Table 1*:* Summary statistics

Variables	Description	Mean	Std.dev
Age of respondents	The actual age of the household head as at the time of survey	46.3	26.9
Marital status	If the household head is married 1, otherwise 0	1.2	0.2
Gender	If the household head is male 1, otherwise 0	0.7	0.3
Educational level	The number of years spent in formal education	7.3	2.5
Years of experience in livestock farming	The number of years of experience in livestock farming	34.8	27.1
Food accessibility	If the households member could access food	1.8	0.9
Household size	Actual number of family members	8.3	4.2
Household income	Income generated by all household members	43376.4	12635.1

Source: Author computation, 2023

Horticultural crops consumption

The result presented in Table 2 showed the consumption pattern of horticultural crops in the study area. Respondents were asked the frequency of consumption of these crops. From the table, it is evidence that most of the crops were consumed by the households, though there is variation in acceptability and or the frequency of consumption of some of these crops. The study showed that more than 84 percent of the respondents consume amaranth/spinach, only 45.4 percent frequently consume corchorus while more than 93 percent claimed to frequently consume watermelon, 63.4, 60.4, 48.5, 100, 95.2, 96.9, 100, 98.6, 77.5, and 96.9 frequently consume lettuce, fluted pumpkin, cucumber, tomato, okra, spices, carrot, garden egg, garlic and ginger respectively.

Table 2: Consumption pattern of Horticultural crops among the respondents

Horticultural crops	Frequent	Seldom	Never
Amaranthus/Spinach	248 (84.6)	43 (14.7)	2 (0.7)
Corchorus	133 (45.4)	93 (31.7)	67 (22.9)
Water melon	275 (93.9)	13 (4.4)	5 (1.7)
Lettuce	186 (63.4)	103 (35.2)	4 (1.4)
Fluted pumpkin	177 (60.4)	108 (36.9)	8 (2.7)
Cucumber	142 (48.5)	127 (43.3)	24 (8.2)
Tomato	293 (100.0)	0 (0.00)	0 (0.00)
Okra	279 (95.2)	11 (3.8)	3 (1.0)
Spices (Bell pepper)	283 (96.6)	4 (1.4)	6 (2.0)
Carrot	293 (100.0)	0 (0.00)	0 (0.00)
Garden egg	289 (98.6)	0 (0.00)	4 (1.4)
Garlic	227 (77.5)	50 (17.1)	16 (5.4)
Ginger	284 (96.9)	2 (0.7)	7 (2.4)

Source: Author computation, 2023; Percentage in Parenthesis

Table 3 showed the classification of respondents' consumption pattern. Composite score was employed as a qualitative measure of food consumption. The result revealed that 49.2 percent of the respondents fell within the high consumption group. This indicated that about have of the population consume horticultural crop very well. About 33 percent of the respondent fell within the mid-range of the classification which depicted adequate consumption of horticultural while only 18 percent fell short the threshold of consumption; this may likely be an indication of a relatively unstable or poor income level of the respondents. The result, in contrary with Maxwell (2003) provides low direct access to a larger number of nutritionally richer foods (horticultural crops), a more varied diet and can also increase the stability of household food consumption against seasonality or other temporary shortage. This ultimately have a positive impact on the food security situation of the households.

Table 3: Consumption pattern of Horticultural crops among the respondents

Category	Frequency	Percentage
High	144	49.2
Medium	96	32.8
Low	53	18.0

Source: Author computation, 2023

Average Treatment Effect – Potential framework approach

In assessing the dietary impact of horticultural crops on household food security, this study considered problems that could be associated with selection biasness and particularly non-compliance or problem of endogeneity and used endogenous treatment-effects model to assess the impact. The Average Treatment Effect (ATE) on the sub-population was about 0.12. This implies that food security recorded reduction of about 12 percent as a result of inadequate consumption of horticultural crops of the respondents in the study area. This could translate to retrogression in quest to half food insecurity in the country as suggested by the development goals (SDGs).

Table 4: Endogenous treatment-effects estimation

Variable	Coefficient	Std. Err.	z	P>|z|
ATE				
Yes vs No	0.1179	0.0617	1.91	0.015**
PO mean				
0	0.5222	0.1024	5.09	0.000***

Source: Author computation, 2023

The result presented on Table 5 revealed the determinants of food security in the study area. The coefficient of marital status, years of experience in livestock farming, household size and food access were statistically significant on the model. This implied that the variable significantly affect food security of the respondents in the study area. From the table, the coefficient of marital status was positive and statistically at 10% level of confidence. The result indicated that married household heads are likely to be more food secure than the unmarried household heads; also, increasing years of livestock farming will increase the chance of the respondents to be more food secure provided all other factors are held constant. The coefficient of household size was negative and significant; the result implied that older livestock farmers are less likely to be food secure than the younger ones. And lastly, increased food accessibility will enhance food security among livestock farmers in the study area. This is evident from the result as more livestock farmers who have easy access to food will be more food secure than those with lesser food access provided that every other factors are constant.

Table 5*:* Parameter estimate of determinants of Food security in the study area

Variables	Coefficient	Std.Err	z
Age of respondents	0.0228	0.0047	-0.28
Marital status	0.1418	0.0810	1.75*
Gender	0.0588	0.0463	1.27
Educational level	0.0051	0.0077	0.66
Years of experience	0.0228	0.0085	2.65**
Asset Ownership	0.0143	0.0102	1.40
Household size	-0.0015	0.0008	1.82*
Food access	0.9410	0.3962	2.38**
Household Income	0.2416	0.3211	0.75
_cons	-4.8156	2.2786	-2.11**

Source: Author computation, 2023

CONCLUSION

The study analyzes the dietary effects of livestock farming and horticulture crops on households' food security in Oyo State, Nigeria. The Fulani communities in the state were the focus of the survey because they make up the majority of Nigeria's livestock breeders. To get sufficient data for the investigation, various Gaa Fulani were however visited. The study found that inadequate intake of horticulture crops among respondents led to a decline in food security, and that improving access to food will have a big impact on food security in the study area. The study area should therefore strengthen proper sensitization of the nutritional benefits of horticulture crops.

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INCIDENCE AND SEROLOGICAL DETECTION OF VIRUSES IN MAJOR EXISTING SUGARCANE GROWING FARMS IN KWARA STATE NIGERIA

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ABSTRACT
A study was conducted in Kwara state to assess the extent of viral disease problems on existing and resurging sugarcane farms. A field survey was conducted in September 2019, collecting 50 sugarcane leaf samples from seven villages where sugarcane is planted. Serological indexing for SCMV, MDMV and MCMV by ELISA using their polyclonal antibodies was carried out at the Virology and molecular diagnostic Laboratory of the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria. ELISA results revealed (0%) MCMV and two viruses, (4%) 2 of 50 SCMV and (22%) 11of 50 MDMV, were associated with single infection of mosaic diseases of sugarcane in Kwara State. The study found a high prevalence of mixed infection of (70%) 35 of 50 SCMV and MDMV in the main sugarcane producing areas, with the highest incidence in Oro. This report provides insight into the current virus incidence in Kwara state.
Keywords: *Sugarcane Mosaic Virus, Maize Dwarf Mosaic Virus, Maize Chlorotic Mottle Virus and ELISA*

INTRODUCTION

Sugarcanes belong to the grass family Poaceae, an economically important flowering plant family that includes maize, wheat, rice, sorghum, and many forage crops. It is native to the warm temperate and tropical regions of India, Southeast Asia, and Guinea. It is one of the main sources of energy for humans; it is used in making commercial sugar for industrial sweetening and glucose syrup drips for medical purposes. It can be fermented to produce ethanol, which is used to make alcoholic drinks like rum and Chelsea gin, but also to make biofuel (Xu et al., 2005). It is a source of occupation for millions of people and is primary to the cost-effective expansion plan of sugar-producing countries (Xu *et al*., 2008; Dangora *et al*., 2014; FAO, 2015). All sugarcane species can interbreed, and the major commercial cultivars are complex hybrids (Monsoon *et al*., 2016). Sugarcane is grown in all the agro-climatic zones within the three senatorial districts in Kwara state, and this is due to the fact that the state is blessed with vast arable land in addition to favorable environmental and climatic conditions that are quite optimum for sugarcane cultivation (Wada *et al., 2003 ;* Olufolaji *et al., 2014).*

Some parts of the state still retained the commercial sugarcane farms inherited from sugar industries that were closed down. A drastic reduction has been recorded in the sugarcane farmer population over the years. This could be attributed most importantly, to biotic factors such as fungi diseases such as smut (*Sporisorium scitamineum),* red rot (*Colletotrichum falcatum*), leaf blast, and virus diseases such as sugarcane mosaic, ratoon stunting disease, and sugarcane wilt (Wada *et al*., 2017). Sugarcane mosaic disease, caused by sugarcane mosaic virus (SCMV), Johnsongrass mosaic virus (JGMV), maize dwarf mosaic virus (MDMV), and sorghum mosaic virus (SrMV), is an economically important viral disease of sugarcane worldwide (Dangora *et al*., (2014)). Sugarcane mosaic virus disease has been identified as one of the most important and deadliest pipe diseases in the world. SCMV is transmitted by mechanical means and aphids. Diagnostic symptoms include young leaf spots and bright green or yellow-green leaf spots (Saleem *et al*., 2011). As these viruses are transmissible through infected seed canes, they pose the risk of accidental introduction into previously disease-free regions.

The four distinct sugarcane viruses, SCMV, JGMV, MDMV, and SrMV induce similar pale green and yellow chlorotic stripes symptoms on the leaf blade and a white stripe on the stem in infected sugarcane and are indistinguishable based on the visible symptoms. Furthermore, symptom expression may also be confused for environmental disorders, as they both cause disruption in plant metabolism (Dangora *et al.*, (2014)).Virus diseases have been severally implicated up to date in sugarcane-producing areas in Guinea-Savanna, Nigeria (Dangora *et al.*, (2014)). Given the seriousness attached to a return to massive cane farming of late, this study was focused on finding out the extent of the viral disease problem on the existing and resurging farms in Kwara State. To this end, a field survey exercise was carried out on the major existing sugarcane-growing farms across Kwara State. In all, seven villages that were detected to still retain the sugarcane cultivation heritage within the state were visited, out of which the remaining five existing commercial sugarcane farms were also included in the survey.

MATERIALS AND METHODS

Indexing for virus diseases of sugarcane was carried out in seven villages that cover three ADP zones; three of the locations are commercial farms, and four are local sugarcane farmers. Oro, Egosi, and Oke-iya Ipo were visited on September 19, 2018; Shonga, Tsaragi, and Bacita were visited on September 25, 2018; and Lafiagi, Lade, and Patigi were visited on September 26, 2018. Field assessments were carried out by diagonal equidistance trekking on a W-shaped path across the field; fifty observations were observed per field (Aliyu *et al*., 2012; Oke *et al*., 2023a). Plants were assessed at every 5th step for disease incidence and severity of viruses. The survey and sample collection exercise was carried out on at least 1 hectare (1ha) of each of the commercial farms selected for the survey exercise. The incidence and severity of the viral diseases were determined based on the symptomatic expression of the viruses on the plants on each farm included in the survey.

Incidence and severity

Disease severity for each plant was calculated based on the actual number of leaves showing mosaic symptoms, divided by the total number of leaves on such a plant, expressed in percentage.

i.e. $$\text{Disease Severity on each plant} = \frac{\text{Number of diseased leaves}}{\text{Total number of leaves on the plant}} \times 100\%$$

Severity Rating

Virus symptom severity was scored on a scale of 1–5 based on the extent of leaf damage and percentage number of leaves showing symptoms, whereby 1 = 1-20% (very mild); 2 = 21–40% (mild); 3 = 41-60% (moderately severe); 4 = 61-60% (severe); and 5 = 81–100% very severe and dead (Alegbejo, 2006; Oke *et al*., 2012).

Unbiased, twenty leaves were randomly collected from the fresh apical region of the plant, whether symptoms were present or not. And the leaves were chopped into pieces with a sterile razor and kept on silica gel in sample vials for 24 hours. And were kept on Agdia-made silica gel in sample bottles and brought to the virology and molecular diagnostic laboratory of the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria, for serological diagnosis. Virus detection was carried out using a double antibody sandwich enzyme-linked immunosobent assay (DAS-ELISA), essentially as described by Dangora *et al.*, (2014), Ayo-John and Odedara (2017), and Oke *et al. (2023).*

The tests were conducted using different antibodies to detect various viruses such as SCMV (Sugarcane Mosaic Virus), MDMV (Maize Dwarf Mottle Virus), and MCMV (Maize Chlorotic Mottle Virus), respectively. One hundred microliters (100μl) of diluted IgG for each of the viruses in coating buffer containing 1.59 g sodium carbonate (Na_2CO_3) and 2.93 g sodium bicarbonate ($NaHCO_3$) per liter, pH 9.6, was dispensed to each well of the microtitre plates and incubated at 37 °C for 2 hours, after which the content was decanted. The plates were washed with phosphate buffered saline (Tween20, soaked for 3 minutes repeatedly three times, and blotted and dried. The PBS Tween 20 consists of 8.0 g of sodium chloride (NaCl), 0.2 g of monobasic potassium phosphate (KH_2PO_4), 1.15 g of dibasic sodium phosphate (Na_2HPO_4), and 0.2 g of potassium chloride per liter of distilled water, pH 7.4. From each of the sugarcane leaf samples, 100 mg were ground in 1 ml of extraction buffer (1:10 w/v). One hundred microlitre aliquots of this test sample obtained from the fields were dispensed into each of the wells and incubated at 4 °C overnight with a negative control provided. The plate's contents were discarded, washed three times, as stated above, and tapped dry. One hundred microlitres of appropriately diluted enzyme-labeled antibody IgG-alkaline phosphatase in conjugate buffer (1.0 g polyvinyl pyrrolidone (PVP) and 0.1 g egg albumin per liter of PBST) were dispensed into each well and incubated at 37 ^{o}C for 2 hours. The plate's contents were discarded, washed three times, and tapped dry. One hundred microliters (100 ul) of freshly prepared substrate with 50 mg para-nitrophenyl phosphate (Sigma, Fluka) dissolved in 50 ml of substrate buffer was dispensed into each well. The plates were incubated for one hour at room temperature and 4 ^{o}C overnight. Reading was carried out using an ELISA plate reader (MICRO READ 1000 ELISA plate analyzer) at a 405 nm absorbance wavelength filter against the blank air. The samples whose values exceeded twice the reading of the healthy control were considered positive for the viruses indexed (Xu et al., 2021).

RESULTS AND DISCUSSION

The survey results indicated sugarcane virus prevalence in all the 7 villages visited, the symptoms observed were ranged from pale green streak, yellow stripe to yellow chlorosis on a dark green leaves. The virus prevalence trends reveals low percentage incidence and severity across all the commercial farm with lowest incidence of 6.67% in Lafiagi and 35% disease severity, follow by 13.33% incidence and 40% severity at Shonga a local farm at Edu LGAs .The highest percentage incidence of 68 % and 70% severity was observed in Lade a local sugarcane farm in Patigi LGAs and followed by 65% incidence at Oro Irepodun LGAs and 69 % severity in Egosi Oke Ero LGAs (Table1).This presence of virus prevalence in all the surveyed sites could be attributed to the fact that, the prevailing virus pathogens are endemic in that locality and couple with presence of the alternative host as indicated by Oke *et al*.,(2023). The sugarcane mosaic diseases have been implicated as most devastating of sugarcane as exhibited in Makarfi LGA Kaduna, most especially where most susceptible landraces were dominated (Dangora *et al.*, (2014)).

The Table2 below shows the ELISA (Enzyme Linked Immuno Sorbent Assay) result obtained from the evaluation on the sugarcane plantations in Kwara state. Fifty leaves sample collected from survey sites were subjected to ELISA. The result shows that from the three viruses probe, only two virus were found to be associated with the mosaic of sugarcane diseases in Kwara State and they are the SCMV (Sugarcane Mosaic Virus) and MDMV (Maize Dwarf Mosaic Virus). The result indicated 2 positive single infection of SCMV (4%), 11 single infections of MDMV (22%), 35 mixed infection of SCMV and MDMV (70%) and 2 samples were negative to any of them (Table 2). Only two locations Egosi and Shonga were found with single infected sugarcane of SCMV and single infection of MDMV were implicated in Egosi, LADE, Lafiaji, Shonga and Tsarangi, with highest prevalence 3 out of 11 in both Egosi and Lafiaji. Very high prevalence of mixed infection SCMV and MDMV was observed in this 35 (70%), with the highest incidence 9 of 35 was observed in Oro, followed by 7 in Egosi and 6 in Unilorin research farm.(Table 2). The prevalence of mixed infection of SCMV and MDMV was observed to cut across all the survey regions under this study. This could be attributed to the presence of abundant viruliferous insect vectors and various alternatives host, which as the reservoir for the viruses' .This agrees with findings of Taiwo et al., (2006), in survey carried out to study viruses infecting maize in Lagos and its environment. Sharma and Mistra (2011) reported MDMV in China, South Africa and USA, Dangora *et al.*, (2014) implicated SCMV, Sorghum mosaic virus (SrMV) and MDMV through ELISA result as causative agent of steak and stripe diseases of sugarcane in Makarfi. Aphids gossypii was tagged responsible for the spread and to a large extent contaminated cutlass. The ELISA tithe values range from 0.016-0.206 for MCMVand none of the samples tested was found positive to the virusTable3.

Table 1: Incidence and Severity of mosaic disease of sugarcane in some farms across Kwara State.

VILLAGE	L GAs.	CULTIVARS	INCIDENCE (%)	SEVERITY (%)
Tsaragi	Edu	Commercial	20	60
Shonga	Edu	Local	13.33	40
Lafiagi	Edu	Commercial	6.67	35
Lade	Patigi	Local	68	70
Egosi	Oke-Ero	Local	60	69
Oro	Irepodun	Local	65	60
Unilorin	Ilorin south	Commercial	17	28

Table 2: Occurrence of diseases infecting sugarcane in Kwara state

LOCATION	**MCMV**	**SCMV**	**MDMV**	**SCMV and MDMV**	**NEGATIVE**
Egosi	0	1	3	7	1
LADE	0		1	4	
LAFIAGI	0		3	3	
ORO	0			9	
SHONGA	0	1	1	5	
TSARAGI	0		1	1	1
UNILORIN	0		2	6	
TOTAL	0 (0%)	2 (4%)	11 (22%)	35 (70%)	2 (4%)

Table 3: ELISA titre value of sugarcane virus diseases

Locations	**Positive control**	**Negative control**	**Range**
MCMV	0.467	0.147	0.016-0.206
SCMV	0.448	0.141	0.142-0.551
MDMV	0.548	0.187	0.136-2.159

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INCIDENCE, DISTRIBUTION AND SEROLOGICAL DETECTION OF VIRUSES IN TOMATOES FROM FARMS IN SOUTHWEST AND NORTHERN NIGERIA

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ABSTRACT
Disease surveillance and tomato seed collections were carried out between October and December 2018 to develop high-yielding tomato lines of good qualities, resistance, and tolerance to virus diseases. The survey itinerary comprises Kano, Plateau, Oyo, Ondo, Ogun, Ekiti, and Lagos states Nigeria. The location ranges from Ihunbo Ipokia (Latitudes 07.04889^{0}N, Longitude 003.71209^{0}E) to Darowar-Sallae Kadawa Kano (Latitudes 11.6707^{0}N, Longitude 008.4195^{0}E). The symptoms observed on a tomato plant in the Northern and North central axis are leaf curl, leaf cupping, chlorosis, and leaf purpling, while in the southwest shoe string, leaf curl, mosaic, mottling, yellowing, purpling, leaf crinkling and leaf bunching were observed. The highest percentage field incidence of 90% was observed in Rafiki Village Jos North, followed by 85% and 80% in UtisanMalla Kadawa Kano and Gaando Village Gboko Benue respectively. The lowest percentage incidence of 50% was observed in RiyonKwallak Village and disease severity ranges from 2.25-4.00, the leaf samples collected were subjected to Double antibody sandwich ELISA (DAS-ELISA), CMV incidence 100% cut across all the areas, ToMV 25%, PVY 10%, and mixed infection was also found CMV+ToMV 5%, CMV+PVY 10%., ToMV+PVY 10% and CMV+ToMV+PVY 5%.
Keywords: *DAS-ELISA, ToMV, PVY, CMV+ToMV, CMV+PVY, ToMV+PVY,and CMV+ToMV+PVY*

INTRODUCTION

Tomato (*Lycopersicon esculentum*) is grown worldwide and its consumption provides nutrients in diets and medicinal phytochemicals like anthocyanin, lycopene, and carotene (Causse *et al*., 2002). Tomato grown both in home gardens and commercially is the world's most popular fruit ahead of a banana (FAO, 2013). The tomato crop is important as a source of vitamins A and C and contains antioxidants with some anticancer in the human diet (Turku, 2007), benefits local farmers, enhances food taste (Ibitoye et. al.,2009), and with some anticancer properties is also rich in vitamin C (Zhang, et al., 2001). They are consumed raw and are useful in making soups. It is also one of the major crops planted by all tribes in Nigeria creating job opportunities, income, and food for both commercial and subsistent farmers (Olaniyi *et al*., 2010). Nigeria is one of the major importers of tomatoes in the world due to low farm yields and variations in production output during the different seasons of the year. Low yields are caused by disease pathogens, inadequate education, lack of modern farm equipment, and poor irrigation systems among others. Tomato is imported into the country in the form of fresh tomato fruits and pastes Ogundari and Aarifalo. (2013).
When compared with the U.S.A. and Taiwan, where yields as high as approximately 180 tons per hectare has been recorded (FAO, 2013), the yield of tomato in Nigeria is low. The average in the western part of the country is only about 5 tons per hectare and 20 tons per hectare in areas of Northern Nigeria (Olaniyi *et al*., 2010). Many Nigerians therefore continually depend on imported processed tomatoes from foreign countries to meet the consumption demand for Taofiq. (2017). Annually, one of the major challenges of tomato cultivation in Nigeria is the high incidence of viral symptoms on tomato farms leading to meager crop yield and poor market value of harvested fruits (Mohammed *et al*., 2017). Because of the potentially devastating impact of plant viruses on tomato crop production and the meager perennial yield in Nigeria, there is a need for a thorough national survey program to map out the prevailing viral diseases endemic ina specific geographical area must be identified and characterized before developing sustainable, environment-friendly

disease management programs Green and Kim (1991),. Viral diseases have been reported to cause great economic loss to the tomato crop (Balogun 2008). Viruses in tomatoes cause severe and irreversible damage to tomato plants reducing crop yield. One of the major perennial challenges faced by tomato farmers in Nigeria is the high prevalence of observable viral-like symptoms on farms leading to very low crop yield, the poor market value of harvested tomato fruits, and post-harvest losses (Abimbola,2014; Mohammed *et al*., 2017). The production of virus-tolerant tomato lines is expected to go a long way to increase tomato yield in the study area. Therefore, this study aimed to develop high-yielding tomato lines of good qualities, resistance, and tolerance to virus diseases.

MATERIALS AND METHODS

Disease surveillance and tomato seed collections were carried out between October–December 2016 to develop high-yielding tomato lines of good qualities, resistance, and tolerance to virus diseases. The survey itinerary is UtisuamMallam and DarowarsallaeKadawa Local government area, Markwaro – Chiki village Kura Local Government Area Kano Northern Nigeria; Viraldisease surveillance was also carried out on 3 local government areas in Plateau State. They include RafikiVillage Jos North, MiangoBassaVillage and Dosan Kura VillageBassa and RiyonKwallakVillageRiyon local government areas. In Benue State, two local government areas were surveyed. These include Tahembe in Tarka Local Government Area, Gaando and AgirigiGaando village Gboko Local Government Area North central Nigeria. In Southwestern, Nigeria surveys were carried out in Abesan, Ikola, Ayobo, IpajaUso, Erio, Ohunbo, Ojikan, Ojuore, Ijoko, Igbesa, Ipokia, Owode, Osiele, Toba, and Iwo. In Southeast Mbato, Abia, Ebonyi. The location ranges from Ihunboipokia (Latitudes 07.04889^{0}N, Longitude 003.71209^{0}E) to Darowar-SallaeKadawa Kano (Latitudes 11.6707^{0}N, Longitude 008.4195^{0}E).

The field sizes vary from0.4 to 5 hectares. The random samplings were carried out from surveyed sites, by taking equidistant 5 steps W shaped diagonally across the field (Aliyu *et al*., 2012) and tomato plants with mosaic, turned tiny, squeezed, shoestring, mottling, and other virus-like symptoms observed are considered (Oke *et al.,*2012). The survey was carried out on tomatoes within the flowering and early fruiting stages. Tomato plants were visually examined on the field for viral symptoms expression and 10 representative leaf samples were collected from each of the survey into well-labeled sample bags and later kept on India-made silica gel in sample bottles. The leaf samples were brought to the Virology and Molecular Diagnostic Laboratory of the International Institute of Tropical Agriculture. A total of 300 leaf samples were collected from the survey sites whosesymptoms vary from leaf mottle, mosaic, turned tiny, crinkling, leaf purpling, leaf curl,shoe-string, vein clearing, and fruit deformation.

Virus disease detection was carried out using a Double antibody sandwich Enzymes Linked Immunosorbent Assay (DAS-ELISA) Five of the 10 leaf samples collected from eachfield were subjected to DAS-ELISA according to Clark and Adams 1977; Ayo-Johnand Odedara,2017; Oke et al,2023. The test was conducted using different antibodies to detect various viruses such as Potato virus Y, Tomato mosaic virus (ToMV), Tomato spotted wilt virus (TSWV), Cucumber mosaic virus (CMV), and Tomato yellow leaf curl virus (TYLCV). The plates were incubated for one hour at room temperature and 4 ^{C} overnight. Reading was carried out using an ELISA plate reader (MICRO READ 1000 ELISA plate analyzer) at a 405 nm absorbance wavelength filter against the blank air. The samples whose values exceeded twice the reading of the healthy control were considered positive for the viruses indexed (Ayo-John and Odedara,2017).

RESULTS

The results of the investigation demonstrated thata total of (100%) of fields that all cut across the three States in the southwest and three States in Northern Nigeria were surveyed, which include, 10 local government areas of Nigeria (Table1). In northern Nigeria, the observable field symptoms are predominantly leaf curls, leaf purpling, leaf cupping, chlorosis, and yellowing of leaves with curl. while in southern Nigeria is more mosaic, mottling, shoestring, dieback, and leaf bunching, The highest percentage field incidence of 90% was observed in Rafiki Jos North, followed by 85% and 80% in UtisanMallaKadawa Kano and Gaando Village Gboko Benue respectively. The lowest percentage incidence in the north 50% was observed in RiyonKwallak Village and disease severity ranges from 2.25-4.00. the highest percentage incidence in the south 75% was observed in Ihunbo followed by 65% and 50% respectively in ipokia and ipaja. The lowest incidence of 32.5% was observed in OkeOgun and disease severity ranges from 2.75-4.00. In areas where leaf samples were not available seeds were collected from all the areas such as in Abia, Ebonyi, Mbato, Abesan,IpajaUso, Erio, Ohunbo, Ojikan, Ojuore, Ijoko, Igbesa, Ipokia, Owode, Osiele,Toba, and Iwo. In the serodiagnostic screening, the majority of the samples collected from all were tested positive for CMV 100% farm incidence, while 25% of the fields were infected with ToMV, mixed infection of CMV+ToMV 5%, CMV+PVY 10%., ToMV+PVY 10% and CMV+ToMV+PVY 5% were also observed (Table3). The mixed infection was found in, the Ojikan, Ihunbo, Rafiki, and Agirigi Table3.

DISCUSSION

The results of the survey showed that 100% of the fields were infected with the virus and virus-like diseases,ofvarious kindsunder field conditions at various surveyedsites(Table 1).Thiscould be attributed to conducive environmental conditions that favourthe multiplication of insect vectors and alternative host which serves as the reservoir virus pathogens over a long period (Taiwo et al 2006, Oke et al,2012, 2017). The symptoms exhibited by diseased plants in the fields resembled those reported elsewhere (Gonsalves and Providenti, 1989, Green and Kim, 1991; Jones *et al.,* 1991 Godson, 2009, Kayode 2018). The high virus disease incidence observed in northern Nigeria could be attributed high density of tomato cropping per plot which can enhance the spread of disease. While the south could attribute continuous cropping on the same plot over a long period and unfavorable weather conditions as reported by Oke *et al*, 2017; Ayo-John and Odedara2017 and Kayode et al (2018). The disease incidence varies from 33-3-90% and severity 2-25-4.00 in the survey period (Table1), this suggests that there are abundance of sources of inocula that may influenced by the presence of many alternative hosts of the disease and viruliferous insect vectors population dynamics in the environment (Atiri,2004, Taiwo, *et.al*.,2006, Oke, *et.al*.,2012).

Most of the fields surveyed during the investigation are susceptible to different attack viruses which implies that the disease will continue to be a threat in tomato-growing areas.The survey resultsrevealed the prevalence of CMV in 100% of the 6 states surveyed in both South and North Nigeria that were assayed could be attributed to the viral inoculums, endemic in the surveyed areas, and presence of the alternative hostsand effective insect vectors thatpresent in the survey area Taiwo et al2006(Table 2). In this study, mixed infection of CMV +ToMV, CMV+PVY, ToMV+ PVY, and CMV +ToMV +PVY Was observedto be prevalent in Jos/North LGA at Rafiki North Central Nigeria Table 2. This could be attributed to the availability of the viral inocula available in every state and LGAs. This coupled with the presence of viruliferous vectors in abundance that interact with the alternative host in the areas and the air current could enhance the movement of viruliferous Aphids vectors and others such as whiteflies from the region of higher infection density to a new area (Taiwo et al., 2006, Gautam *et al*, 2020).

Table 1: The prevalence of the viral incidence and severity in survey sites with the locations

State	LGAs	Location	GPS	Elevation	Symptoms	Percentage Incidence	Severity
Lagos	Alimosho	Ipaja	06.61654^{0}N 003.26126^{0}E	60m	Ms,mt, Ss	50% (5/10)	3.0
		Abesan	06.66903^{0}N 003.2672^{0}E	40m	Crinkling, ms,ss	33.3%	3.0
	Eti-Osa	Erinmope	06.54196^{0}N 003.9093^{0}E	43m	Mt,lc,ms	45%	3.25
		OkeOgun	06.53825^{0}N 003.9017^{0}E	17m	Ch,mt ,ms,md	32.5%	3.19
Ogun	Ipokia	Ihunbo	07.04889^{0}N 003.71209^{0}E	17m	Ms,mt,ss,lp	75%	4.0
		Ipokia	06.68771^{0}N 002.83880^{0}E	72m	Lp,ms,mt, Vc	65%	3.0
		Ajilete	06.70184^{0}N 002.95003^{0}E	42m	Ms,mt,ss, md	33.3%	2.75
	Odeda	Ojikan	07.39672^{0}N 003.26483^{0}E	50m	Ch,mt,ms, Lp,ss	35%	3.5
Oyo	Ido	NIHORT	07.40082^{0}N 003.38641^{0}E	169m	Mo ,ss,ylc, ms	30%(3/10)	3.0
		Apata	07.39887^{0}N 003.78655^{0}E	224m	Mt ,ss,ms	37.5%	2.75
		Elenusonso	07.45119^{0}N 003.77821^{0}E	214m	Ss,mt,ms,	40%(8/20)	3.18
Benue	Tarka	Tehembe	07.4957^{0}N 008.92940E	157m	Lc,lp,ylc	68%(17/25)	3.75
	Gboko	Agirigi	07.4682^{0}N 008.9233^{0}E	182m	Lp,ld,ch	70%(14/20)	3.5
		Gaado	07.4682^{0}N 008.9229^{0}E	160m	Lc,lp,ch,lc	75%(15/20)	3.25
Plateau	Jos/North	Rafiki	09.9093^{0}N 008.8075^{0}E	1228m	1lc,lp,ylc	90%(18/20)	3.25
		Miango	09.8141^{0}N 008.6922^{0}E	1136m	Mt ,lc,ss	75%(15/20)	2.75
	Riyon	Riyon	09.6329^{0}N 008.7666^{0}E	1181m	Lc,lp	50%(5/10)	3.0
Kano	Kadawa	Utisua-malla	11.6435^{0}N 008.4186^{0}E	492m	Lc,lp,ch	85%(17/20)	3.0
		Darowa-sallae	11.6707^{0}N 008.4195^{0}E	488m	Leaf cupping	65%(13/20)	2.25
	Kura	Marikochiki	11.7352^{0}N 008.4221^{0}E	473m	Lp,wilt,ch	61.1%(22/36)	2.5

Keynote symbols depicted symptoms as follows mosaic ms, mottling mt, leaf curl lc, shoe string ss, leaf purpling lp, leaf yellowing yl, wilting w, die back, db, nl ,necrotic lesions nl, wilting w, stunted growth sg, leaf bunching lb, bunching, no symptoms no,chlorosisch,

Table 2: Detection of viruses collected in the field tomato leaf samples using double antigen sandwich ELISA

STATE	LGA	LOCATIION	CMV	ToMV	PVY	C+T	C+P	T+P	C+T+P
Lagos	Alimosho	Ipaja	2	-	-	-	-	-	-
		Abesan	2	-	-	-	-	-	-
		Ikola	1	1	-	-	-	-	-
		Ayobo	1	-	-	-	-	-	-
Ogun	Ipokia	Ihunbo	1	-	-	-	-	1	-
		Ipokia	1						
		Ajilete	1						
	Odeda	Ojikan	5			1			
Oyo	Ido	NIHORT	1						
		Apata	3						
		Elenusonso	1	-	-				
Benue	Tarka	Tehembe	3						
Gboko	Gboko	Agirigi	2				1		
		Gaado	2						
Plateau	Jos/North	Rafiki	2	1	1		1	1	1
		Miango	2						
	Riyon	Riyon	5		1				
Kano	Kadawa	Kadawa	5	2					
		Darowasallae	1	4					
	Kura	Mariko chiki	1	2					
TOTAL			46	10	2	1	2	2	1
Prevalence	Rate		100%	25%	15%	5%	10%	10%	5%

Footnote CMV; Cucumber mosaic virus, ToMV; Tomato mosaic virus, PVY; Potato mosaic virus, C+T= CMV +ToMV, C+P= CMV+PVY, T+P= ToMV+ PVY, C+T+P= CMV +ToMV +PVY

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EFFECTS OF MULCH MATERIAL AND MULCHING RATE ON GROWTH, FRUIT YIELD AND NUTRITIONAL QUALITY OF TOMATO VARIETY (*Lycopersicon Lycopersicum* Mill) IN OGBOMOSO AND MOKWA, NIGERIA

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ABSTRACT
Field experiment was conducted at the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso and Niger State College of Agriculture, Mokwa, in 2014 cropping season to examine the effects of mulch materials and mulching rates on fruit yield and nutritional qualities of tomato variety. The experiment had fifteen treatments viz: three mulch materials (rice husk, groundnut shell and dry guinea grass) and five mulching rates (0, 5, 10, 15, and 20 in t ha^{-1}), replicated three times. The experiment was laid out as factorial arranged in Randomized Complete Block Design. Data were collected on plant height, number of flowers, number of fruits and total fruit yield. The determination of fruit phytochemical contents at full ripening, 6 fruit samples were randomly selected per plot and analysed for nutritional qualities such as Crude Protein, Carotene, Iron, Phosphorus, Potassium, Calcium, Lycopene, Magnesium, Vitamin C contents. Data was analysed using analysis of variance (ANOVA) SAS package and treatment means compared using least significant difference (LSD) at 5% probability level. Mulching is beneficial to performance of tomato. Mulch types had no effect on fruit yield of tomato. Plants mulched with 15 t ha^{-1} produced the highest yield (23.30 t ha^{-1}) while control plots had the least value (8.13 t ha^{-1}). Nutritional qualities (Lycopene, phosphorus, potassium) were best at mulching rate of 15 t ha^{-1}. It could be concluded that mulching is beneficial to tomato production; mulch rate of 15 t ha^{-1} performed better than other rates evaluated and could be recommended for the farmers within the study areas.
***Keywords**: Tomato, mulching material, mulching rate, growth, yield, nutritional quality*

INTRODUCTION

Tomato (*Lycopersicon lycopersicum*) belongs to the solanaceae family. It originated in Peru and Mexico, in the present day Central and South America from where it spread to other parts of the world (Zeidan, 2005). Tomato reached Europe from Mexico in the 16th century, and was initially used as ornamental plant. Its cultivation for edible fruits started at the end of the 18th century. Tomato was introduced to West Africa and Nigeria in particular, at the end of the 19th century (Villareal, 1980). It is currently considered to be one of the main vegetable crops in the world, and constitutes an economic force that influences the income of many growers in the world (Omar, 2005). In Nigeria tomato also finds its way into almost every kitchen. Tomato crop is very important in terms of diet and economy in Nigeria both during the rainy season (rainfed) and dry season using irrigation facilities. It is used as a condiment in stews and soup or eaten raw in salads. Industrially, the crop is made into puree, sauce, paste and powder (Balarabe, 2012).

Mulching is the process or practice of covering the soil/ground to make more favourable conditions for plant growth, development and efficient crop production. Mulch technical term means 'covering of soil' (Anon, 2009). While natural mulches such as leaf, straw, dead leaves and compost have been used for centuries, during the last 60 years the advent of synthetic materials has altered the methods and benefits of mulching. When compared to other mulches plastic mulches are completely impermeable to water; it therefore prevents direct evaporation of moisture from the soil and thus limits the water losses and soil erosion over the surface (Akhtar *et al*., 2001). In this manner it plays a positive role in water conservation and the suppression of evaporation also has a supplementary effect; it prevents the rise of water containing salt, which is important in countries with high salt content water resources (Enan, 2004). Mulching is a layer of material on the surface of the soil used to keep soil moist or to serve a wide variety of other purposes. Organic mulches are those derived from the dead plant and animal tissues, which apart from soil protection also serve as nutrient sources when they decay. Tomato plants subjected to mulching and fertilization exhibited the highest plant height when compared with the other treatment combinations (Liasu and Abdul Kabir, 2007).

Mulching has been identified by many researchers as a method to provide a favourable soil environment by minimizing crusting at the soil surface and keep it stable (Kayum *et al*., 2008). Influence of mulching on tomato production has been reported by many researchers (Hooda *et al*., 1999). This practice increases the infiltration of rain water and suppress the growth of weeds. Mulching is effective in reducing evaporation, conserving soil moisture and has been known to modify the hydrothermal regime of soil (Bhagat and Achanya, 1988). Mulching of tomato plants with Tithonia diversifolia leaves and fertilizer application together promoted growth and development i.e. number of nodes, number of leaves and height, as well as fruit production i.e. number of fruits, number of seeds per fruit, fruit size, fruit shape and duration of fruiting activity. In the experiment conducted by (Kayum *et al*., 2008), three tomato varieties namely, Ratan, BARI tomato-3 and BARI tomato-6 were experimentally evaluated to identify the potential mulch on growth and yield, where the experiment consisted of four mulching treatments: water hyacinth, straw, am-ada leaf and banana leaf with a control (no mulch).

The experiment was conducted under rainfed condition. The result showed that mulching significantly had effect on growth, yield components and thus on the yield of tomato. Mulching is effective in reducing evaporation, conserving soil moisture and has been known to modify the hydrothermal regime of soil (Bhagat and Achanya., 1988). The bad effects of water deficit could be overcome by irrigation or adopting in-situ moisture conservation techniques, such as use of mulches (Walter, 1988). Mulches are effective in reducing soil moisture loss from evaporation. Organic mulches are effective, but when moisture is applied by irrigation or through rainfall, the amount should be adequate to reach the soil. Organic mulches tend to settle with time. Some are less resistant and decompose after a short time. As such, it may be necessary to add fresh material to the original layer to make it effective in retaining moisture (George, 2004). The agronomic characteristics of tomato as influenced by irrigation and mulching were examined. Mulching and no mulching were evaluated. Rice straw was used as mulching material at the rate of 5 t/ha. The mulching significantly affected the fruit yield in such a way that mulched plots produced about two times more fruit yield than those without mulch (Gudugi *et al*., 2012).

The effects of L. Leucocephala and G. Sepium mulches (and their mixtures) on the growth and yield of okra was assessed. The mulches were applied at the rate of 0, 5 and 10 t ha^{-1}. The mulches did not significantly improve the chemical properties of the soil, but improved the growth rate and yield of okra. Generally, the higher the amount of mulch applied, the better the growth and yield of okra (Agbo, 2000). Mulching, using any of the materials like green leaves, dried leaves and coconut fronds significantly increased tomato fruit yield by 65.30% over the control and they attributed the increase to the slight improvement in the physical properties of soil (Ertek *et al*., 2004). Similarly, mulches applied at very low rates e.g. 2.5 t ha^{-1} or 5 t ha^{-1} can significantly increase growth and yields of highly valuable vegetable and fruits crops in the field (Norman and Edwards, 2005). Trash farming suppresses weed germination and retard growth and development of many weeds, reduces soil erosion and conserves soil moisture. In the low and intermediate rainfall areas, tomato is mulched with trash (FAO, 1999). This helps in conservation of soil moisture and fertility (Wood, 1991). Trash placed on the soil surface losses 55 – 60% of its organic matter after 270 days compared with 70 – 75% when it is incorporated in the soil (Linedale and Bull, 1995). Use of clear polythene and plastic present the potential advantage of soil solarisation (Schlesselma *et al*., 1985).

Application of organic materials such as dried papaya leaves could also make the plants grow fast and retard the growth of weeds around the plants. These organic materials which are added to the soil are collectively termed as organic mulch. Others organic mulches include grass clippings bark, sawdust and manure, hay, straw, shells, wood chips, shredded newspaper, cardboard and wool (Acayen *et al*., 2004). Despite many investigations in the area of nutrition, knowledge on how mulching material and mulching rates influence physical and phytochemical contents of tomato fruit is insufficient. This study determined plant growth, fruit yield and nutritional qualities of tomato variety in Ogbomoso and Mokwa, Nigeria as influenced by mulch material and mulching rates.

MATERIALS AND METHODS

The experiment was conducted at two locations; Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso (8°10^{1}N; 4°10^{1}E) and Niger State College of Agriculture, Mokwa (9° 18^{1}N and 5° 04^{1}E), during 2014 cropping season. The experimental plot was ploughed and harrowed after which lining out was carried out. There were 45 plots with three replications. Each replicate consisted of 15 plots. Each treatment was in a bed plot size of 2.5 m x 2.0 m (5.00 m^2). A plot contained 25 plants. The total experimental area was 405.00m^2 (0.041 ha^{-1}). The alley way between replicates was 1.0 m and within replicates was 1.0 m with inter and intra-row spacing of 50 cm x 50 cm. Three mulch materials that were used included: Rice husk, Groundnut shell and Dry guinea grass while the mulching rates involved: 0, 5, 10, 15 and 20 t ha^{-1}. The test crop used was UC82B tomato variety. The treatment was laid out as factorial arranged in Randomized Complete Block Design, replicated three times. The seeds were sourced from the Department of Crop Production and Soil Science, Ladoke Akintola University of Technology, Ogbomoso and from the Department of Agricultural Technology, Niger State College of Agriculture, Mokwa.

The tomato seeds were sown on nursery beds containing pulverized soil and the seedlings were raised for four weeks before transplanting to the field at the two locations. Watering in the nursery was done as at when needed. Healthy and vigorous seedlings were transplanted into the field in order to ensure uniformity. Watering was done using watering - can to supplement rainfall. Pesticide in form of cypermethrin was applied at the dosage of 25 ml per 15 litres of knapsack sprayer fortnightly to check caterpillars, worms and grasshoppers. Manual weeding was also carried out using hoe at three weeks interval starting from 2 WAT to reduce competition between weeds and plants. Data were collected on plant height, number of flowers, number of fruits and total fruit yield. The determination of fruit phytochemical contents at full ripening, 6 fruit samples were randomly selected per plot and analysed for nutritional qualities such as crude Protein, Carotene, Iron, Phosphorus, Potassium, Calcium, Lycopene, Magnesium, Vitamin C contents.

In order to assess these, 6 fruit samples were collected and dried in an oven at 85^{O}C for 72 hours. The dried fruit samples were separately ground with a Wiley mill, and passed through a 0.5 mm sieve for tissue analysis. Total P was determined by the Vanadomolybdate method, K and Ca was determined by the flame photometry and Mg and Fe were determined by atomic absorption spectrophotometer (IITA, 1989). Total N was analyzed by the micro-Kjeldahl procedure as described by IITA (1989) and crude protein was obtained by multiplying the total N by a factor of 6.25. Data collected were subjected to Analysis of Variance (ANOVA) using SAS statistical package. Treatment means were separated using the least significant difference (LSD) at 5% probability level.

Plant height (cm)

Application of different mulch material had no significant ($P \geq 0.05$) effect on the plant heights of tomato plants at all the sampling periods (Table 1). The plant heights of tomato was significantly ($P \leq 0.05$) influenced by mulching rate at 2 WAT. The plants mulched with 15 t ha^{-1} materials was significantly taller than that of 20 t ha^{-1}, 5 t ha^{-1} and control plots but was not significantly different from the plant mulched with 10 t ha^{-1} (23.9 cm). At 4 WAT, plant height of tomato was significantly ($P \leq 0.05$) influenced by mulching rate. The plants mulched with 15 t ha^{-1} (39.9 cm) was significantly taller than other mulching rates while the least mean value (30.5 cm) was obtained from the control plot which was not significantly different from the plants mulched with 5 t ha^{-1} (31.3 cm). The plant heights of tomato was significantly ($P \leq 0.05$) increased by mulching rate at 6 WAT. The highest mean value (39.9 cm) was obtained from the plants mulched with 15 t ha^{-1} which was not significantly different from the plants mulched with 20 t ha^{-1} (38.5 cm). Also, the plants mulched with 10 t ha^{-1} (35.4 cm) and 5 t ha^{-1} (33.6 cm) were not significantly different from each other while the least mean value (29.3 cm) was observed from the un-mulched plants. The interaction effects between mulch material and mulching rate at 2, 4 and 6 WAT were not significant ($P \geq 0.05$).

Number of flowers per plant

The mean number of flowers of tomato is presented in (Table 2). The number of flowers increased as the mulching rate increased and declined thereafter. The mulch material had no significant ($P \geq 0.05$) influence on the number of flowers of tomato plants. The plants mulched with 15 t ha^{-1} (24.5) and 20 t ha^{-1} (24.4) significantly had similar number of flowers which were significantly different from the plants mulched with 10 t ha^{-1} (19.4) and 5 t ha^{-1} (16.9). The plants mulched with 10 t ha^{-1} was significantly higher than the plots left un-mulched (control) but significantly had similar number of flowers with the plants mulched with 5 t ha^{-1}, respectively. The interactive effects of mulch material and mulching rate was not significantly ($P \geq 0.05$) influenced.

Number of fruits per plant

The mean number of tomato fruits is presented in Table 3. The number of fruits increased as the mulching rate increased and declined thereafter. The mulch material had no significant ($P \geq 0.05$) effect on the number of tomato fruit. The mulching rate significantly ($P \leq 0.05$) affected the number of fruits. The plants mulched with 15 t ha^{-1} (21.2) significantly gave higher number of fruits than the control plot (12.2), 5 t ha^{-1} (14.0), and 10 t ha^{-1} (14.6) but was not significantly different from that of 20 t ha^{-1} (18.8). The interaction effects of mulch material and mulching rate was not significantly ($P \geq 0.05$) influenced

Total fruit yield

The total fruit yield of tomato increased as the mulching rate increased and declined thereafter as shown in Table 4. The total fruit yield of the tomato was no significantly ($P \geq 0.05$) increased by mulch material treatments. The total fruit yield of tomato was significantly ($P \leq 0.05$) influenced by mulching rate. The plants mulched with 15 t ha^{-1} (23.30 t ha^{-1}) was significantly higher than other values of mulching rates. Mulching rate of 20 t ha^{-1} (17.57 t ha^{-1}) was significantly higher than the plants mulched with 10 t ha^{-1} (11.90 t ha^{-1}), 5 t ha^{-1} (10.80 t ha^{-1}) and the least was obtained from un-mulched plot (8.13 t ha^{-1}). But there was no significant difference between the values of these treatments. The interactive effect of mulch material and mulching rate was not significant ($P \geq 0.05$).

Crude Protein, Carotene and Iron contents

The protein content of tomato fruit was significantly ($P \leq 0.05$) influenced by mulching rate (Table 5). Plants mulched with 5, 15 and 20 t ha^{-1} (1.0 mg/100 g) were significantly higher than that of 10 t ha^{-1} (0.9 mg/100 g) and the control plot (0.8 mg/100 g), respectively. The interaction effects of mulch material and mulching rate was not significant ($P \geq 0.05$) on protein content. Mulching rate had significant ($P \leq 0.05$) influence on carotene content of tomato fruit with the highest mean value (0.8 mg/100 g) obtained with 15 t ha^{-1} which was significantly higher than other mulching rates. The plants mulched with 20 t ha^{-1} (0.7 mg/100 g) was significantly higher than that of 5 t ha^{-1} and 10 t ha^{-1} (0.6 mg/100 g) which had no significant difference from each other while the least carotene content 0.4 mg/100 g was received from un-mulched plot. The interactive effect of mulch material and mulching rate was not significant ($P \geq 0.05$). The result showed that iron content of tomato fruit was significantly ($P \leq 0.05$) influenced by mulching rate. The highest mean value (3.0 mg/100 g) was obtained with 5 t ha^{-1} which was significantly higher than the plants mulched with 10 t ha^{-1} (2.6 mg/100 g) and the control plot (2.0 mg/100 g) but significantly recorded similar iron content with the plants mulched with 15 t ha^{-1} and 20 t ha^{-1} (2.8 mg/100 g). The interaction effects of mulch material and mulching rate on iron content of tomato fruit was not significant ($P \leq 0.05$).

Phosphorus, Potassium and Calcium contents

Mulch material had significant ($P \leq 0.05$) influence on phosphorus content of tomato fruit (Table 6). The dry guinea grass mulch recorded the highest mean value (6.6 mg/100 g) which was significantly higher than the mean value (5.0 mg/100 g) obtained from the groundnut shell mulch and the least mean value (4.4 mg/100 g) was received from rice husk mulch. Mulching rate had significant ($P \leq 0.05$) effect on phosphorus content of tomato fruit. The highest mean value (6.8 mg/100 g) was obtained from the plants mulched with 20 t ha^{-1}

which was significantly higher than the mulching rates of 5 t ha^{-1} and 10 t ha^{-1}. But had no significant difference from that of 15 t ha^{-1} (6.2 mg/100 g) while the least mean value (3.8 mg/100 g) was observed from un-mulched plot. The interaction of mulch material and mulching rate was significant ($P \leq 0.05$) on phosphorus content with the highest mean value (7.9 mg/100 g) obtained from dry guinea grass mulch at 15 t ha^{-1}.

The potassium content of tomato fruit was not significantly ($P \geq 0.05$) affected by mulch material. Mulching rate had significant ($P \leq 0.05$) influence on potassium content of tomato fruit. The plants mulched with 20 t ha^{-1} (4.9 mg/100 g) was significantly higher than that of 5 t ha^{-1} (3.1 mg/100 g) and 10 t ha^{-1} (3.6 mg/100 g) but was not significantly different from 15 t ha^{-1} (4.8 mg/100 g) while the least potassium content of 2.5 mg/100 g was obtained from the un-mulched plot. The interactive effect of mulch material and mulching rate on potassium content was not significant ($P \geq 0.05$). The calcium content of tomato fruit was significantly ($P \leq 0.05$) increased by mulch material. The highest mean value (2.4 mg/100 g) was obtained from rice husk mulch which was significantly higher than that of dry guinea grass mulch (2.2 mg/100 g) while the least mean value (2.1 mg/100 g) was received from groundnut shell mulch. Calcium content of tomato fruit was significantly ($P \leq 0.05$) increased by mulching rate. Plants mulched with 20 t ha^{-1} (2.8 mg/100 g) was significantly higher than that of 10 t ha^{-1} (2.2 mg/100 g) and the least calcium content (1.5 mg/100 g) was received from the control plot. The interaction effects of mulch material and mulching rate was significant ($P \leq 0.05$) and the highest calcium content (2.9 mg/100 g) were obtained from rice husk and dry guinea grass mulches with 15 t ha^{-1}, respectively.

Lycopene, Magnesium and Vitamin C contents

The mulch material had significant ($P \leq 0.05$) influence on lycopene content of tomato fruit (Table 7). The plants treated with rice husk mulch recorded the highest mean value (2.9 mg/100 g) which was significantly higher than the plants treated with groundnut shell mulch (2.3 mg/100 g) but was not significantly different from the plots applied with dry guinea grass mulch (2.8 mg/100g). The lycopene content of tomato fruit was significantly ($P \leq 0.05$) increased by mulching rate. The plants mulched with 20 t ha^{-1} (3.6 mg/100 g) were significantly higher than other mulching rates. Also, plants mulched with 15 t ha^{-1} (3.3 mg/100 g) was higher than that of 10 t ha^{-1} (2.6 mg/100 g) and 5 t ha^{-1} (2.3 mg/100 g) while the least mean value (1.6 mg/100 g) was obtained from un-mulched plot. The interactive effect of mulch material and mulching rate on lycopene content was not significant ($P \geq 0.05$).

Magnesium content of tomato fruit was not significantly ($P \geq 0.05$) influenced by mulch material, mulching rate and their interaction effects. The vitamin C content of tomato fruit was not significantly ($P \geq 0.05$) influenced by application of mulch material. The vitamin C content of tomato fruit was significantly ($P \leq 0.05$) influenced by mulching rate. Plants mulched with 20 t ha^{-1} (25.9 mg/100 g) was significantly higher than that of 10 t ha^{-1} (19.5 mg/100 g) and 5 t ha^{-1} (18.9 mg/100g), but was not significantly different from 15 t ha^{-1} (24.2 mg/100 g) while the least mean value (15.9 mg/100 g) was obtained from the control plot. The interaction of mulch material and mulching rate on vitamin C content had no significant ($P \geq 0.05$) effect.

DISCUSSION

Reports by Liasu and Abdul Kabir (2007) stated that mulching is a layer of material on the surface of the soil used to keep soil moist or to serve a wide variety of purposes. Organic mulches are those derived from the dead plant and animal tissues, which apart from soil protection also serve as nutrient sources when they decay. Findings from Kayum *et al.* (2008) revealed that mulching tomato plants with the use of water hyacinth, straw, am-ada leaf and banana leaf showed significant effect on growth and yield components and thus increase the yield. The significant plant height of 39.9 cm obtained with the mulching rate of 15 t ha^{-1} from the present study agrees with the report of Liasu and Abdul Kabir (2007) who stated that tomato plants subjected to mulching exhibited the highest plant height when compared with control. The above authors in their findings also stated that the tomato plants subjected to mulching exhibited the highest number of leaves per plant than the control plot. In the current study, mulching rate of 15 t ha^{-1} and 20 t ha^{-1} produced number of flowers of 25.4 and 24.4 that were significantly higher than the values of other mulching rates. This may be attributed to the fact that the mulching application rate was higher thereby retaining moisture in the soil which promoted flower formation.

This is in agreement with Anon. (2009) who reported that the thicker the mulch material the more water is retained in the soil to serve as a good medium for plant growth, development and efficient crop production. The results obtained from this study revealed that rice husk mulch gave higher number of fruits than other mulch materials. This agrees with the report of Akhtar *et al*. (2001) who reported that natural mulches such as leaf, rice straw, dead leaves and compost have been used for centuries to increase fruit per plant, fruit length, fruit size, average fruit weight and yield. Findings in this study also agrees with those of Kayum *et al*. (2008) who stated that mulching showed significant effect on growth, yield components and thus on the yield of tomato. The significant highest total fruit yield of 23.30 t ha^{-1} produced from the plants mulched with 15 t ha^{-1} in this study was at the upper value of 14.00 t ha^{-1} reported by Gudugi *et al*. (2012) and 21.47 t ha^{-1} reported by Elkner *et al*. (1991). The results of the current study is in conformity with Ertek *et al*. (2004) who revealed that mulching tomato plants at the rate of 10 to 20 t ha^{-1} will give better yield using mulch materials such as green leaves, dried leaves and coconut fronds.

The significant increase in the fruit nutritional qualities parameters which mulch materials and mulching rates treatments were imposed showed the potentials involved in tomato variety. The nutritional composition increased as the mulching rates increased. The result obtained from this present study is in agreement with the findings of Olaniyi *et al*. (2010). There was no consistency in the nutritional qualities obtained in this current study for the tomato variety used. The plants mulched with 15 t ha^{-1} closely followed by 20 t ha^{-1} significantly recorded higher nutritional qualities than the other mulching rates evaluated. The result of this study is in line with the findings of Olaniyi *et al*. **(**2010) who confirmed that there was inconsistence in the nutritional values obtained in their study for the tomato varieties used. Ara *et al*. (2007) supported the result obtained in this study that tomato is a dependable source of Vitamin A, B, C and D, minerals, Ca, P and Fe. Result of the nutritional qualities revealed that tomato fruits are rich in phosphorus, potassium, calcium and vitamin C. This might be the reason of their intensive use for stew in meals.

CONCLUSION

Based on the research findings, it can be concluded that Rice husk mulch gave better fruit yield and nutritional qualities than groundnut shell and dry guinea grass mulches. More so, the plants mulched with 15 t ha^{-1} gave the highest fruit yield and nutritional qualities than other treatments. It is therefore recommended for the tomato farmers within the study areas.

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Table 1: Effect of mulch material and mulching rate on plant height of tomato plants in 2014 cropping season

Mulching rate (t ha^{-1}) / Mulch Material	Plant height (cm)					
	0	5	10	15	20	MM Mean
			2WAT			
RH	18.9	20.4	25.7	23.3	23.6	22.4
GS	20.7	22.4	21.9	26.3	21.0	22.5
DG	24.4	20.1	24.0	26.7	20.8	23.2
MR Mean	21.3	21.0	23.9	25.4	21.8	
LSD (0.05) MM	ns					
MR	2.89					
MM x MR	ns					
4WAT						
RH	30.9	28.7	39.2	39.7	39.9	35.7
GS	29.2	34.9	31.7	40.9	31.0	33.5
DG	31.3	30.4	35.8	39.0	34.5	34.2

MR Mean	30.5	31.3	35.6	39.9	35.1	
LSD (0.05) MM	ns					
MR	3.65					
MM x MR	ns					
6WAT						
RH	28.6	32.4	34.6	41.1	36.3	34.6
GS	30.7	34.5	35.5	38.7	41.1	36.1
DG	28.6	34.0	36.1	39.8	38.0	35.3
MR Mean	29.3	33.6	35.4	39.9	38.5	
LSD (0.05) MM	ns					
MR	2.80					
MM x MR	ns					

RH= rice husk, GS= groundnut shell, DG= dry guinea grass, MM= mulch material, MR= mulching rate, NS= not significant, (P≤0.05), LSD= least significant difference

Table 2: Effect of mulch material and mulching rate on number of flowers of tomato plants in 2014 cropping season

	Number of flowers					
	Mulching rate (t ha^{-1})					
Mulch Material	0			15	20	MM Mean
RH	15.6	18.4	21.3	28.6	24.6	21.7
GS	14.2	15.7	17.2	25.1	22.4	18.9
DG	14.3	16.6	19.7	22.5	26.1	19.8
MR Mean	14.7	16.9	19.4	25.4	24.4	
LSD (0.05) MM	ns					
MR	4.47					
MM x MR	ns					

RH= rice husk, GS= groundnut shell, DG= dry guinea grass, MM= mulch material, MR= mulching rate, WAT= weeks after transplanting, NS= not significant, (P≤0.05), LSD= least significant difference

Table 3: Effect of mulch material and mulching rate on number of fruits per plant of tomato plants in 2014 cropping season

	Number of fruits					
	Mulching rate (t ha^{-1})					
Mulch Material	0	5			20	MM Mean
RH	13.1	14.5	15.1	20.7	18.8	16.4
GS	12.6	14.3	15.1	23.7	19.8	17.1
DG	10.9	13.2	13.6	19.3	17.8	15.0
MR Mean	12.2	14.0	14.6	21.2	18.8	
LSD (0.05) MM	ns					
MR	3.54					
MM x MR	ns					

RH= rice husk, GS= groundnut shell, DG= dry guinea grass, MM= mulch material, MR= mulching rate, WAT= weeks after transplanting, NS= not significant, (P≤0.05), LSD= least significant difference

Table 4: Effect of mulch material and mulching rate on total fruit yield of tomato plants in 2014 cropping season

	Total fruit yield (t ha^{-1})					
	Mulching rate (t ha^{-1})					
Mulch Material	0	5			20	MM Mean
RH	7.80	13.70	13.40	28.80	19.30	16.60
GS	9.30	9.20	13.40	23.20	18.60	14.70
DG	7.30	9.50	8.90	17.80	14.80	11.66

MR Mean	8.13	10.80	11.90	23.30	17.57
LSD (0.05) MM	ns				
MR	5.18				
MM x MR	ns				

RH= rice husk, GS= groundnut shell, DG= dry guinea grass, MM= mulch material, MR= mulching rate, WAT= weeks after transplanting, NS= not significant, (P≤0.05), LSD= least significant difference

Table 5: Effect of mulch material and mulching rate on protein, carotene and iron content of fruit nutritional qualities of tomato in 2014 cropping season

	Nutritional quality (mg/100 g)					
Mulching rate (t ha^{-1})						
Mulch Material	0	5	10	15	20	MM Mean
			Protein			
RH	0.8	1.0	0.9	1.0	1.0	0.9
GS	0.9	0.9	1.0	0.9	1.0	0.9
DG	0.8	1.0	0.9	1.0	1.0	0.9
MR Mean	0.8	1.0	0.9	1.0	1.0	
LSD (0.05) MM	ns					
MR	0.01					
MM x MR	ns					
Carotene						
RH	0.5	0.6	0.6	0.8	0.6	0.6
GS	0.4	0.6	0.6	0.8	0.7	0.6
DG	0.4	0.6	0.7	0.7	0.7	0.6
MR Mean	0.4	0.6	0.6	0.8	0.7	
LSD (0.05) MM	ns					
MR	0.07					
MM x MR	ns					
Iron						
RH	2.4	2.0	3.0	2.5	3.3	2.6
GS	1.6	2.3	2.2	3.6	2.6	2.5
DG	2.1	1.7	2.5	2.3	2.4	2.2
MR Mean	2.0	3.0	2.6	2.8	2.8	
LSD (0.05) MM	ns					
MR	0.22					
MM x MR	ns					

RH= rice husk, GS= groundnut shell, DG= dry guinea grass, MM= mulch material, MR= mulching rate, NS= not significant, (P≤0.05), LSD= least significant difference

Table 6: Effect of mulch material and mulching rate on phosphorus, potassium and calcium fruit nutritional qualities of tomato plants in 2014 cropping season

	Nutritional quality (mg/100 g)					
Mulching rate (t ha^{-1})						
Mulch Material	0	5	10	15	20	MM Mean
			Phosphorus			
RH	2.9	3.4	4.2	4.9	6.5	4.4
GS	3.5	4.1	5.3	5.8	6.3	5.0
DG	5.1	6.4	6.2	7.9	7.6	6.6
MR Mean	3.8	4.6	5.2	6.2	6.8	
LSD (0.05) MM	0.36					
MR	0.36					
MM x MR	0.13					
Potassium						

RH	2.4	3.8	4.0	4.6	4.5	3.9
GS	2.8	2.7	3.4	4.3	5.2	3.7
DG	2.4	2.9	3.3	5.5	5.1	3.8
MR Mean	2.5	3.1	3.6	4.8	4.9	
LSD (0.05) MM	ns					
MR	0.26					
MM x MR	ns					
Calcium						
RH	1.8	2.0	2.5	2.9	2.7	2.4
GS	1.3	1.5	2.2	2.4	3.0	2.1
DG	1.5	2.0	2.0	2.9	2.8	2.2
MR Mean	1.5	1.8	2.2	2.7	2.8	
LSD (0.05) MM	0.18					
MR	0.18					
MM x MR	0.03					

RH= rice husk, GS= groundnut shell, DG= dry guinea grass, MM= mulch material, MR= mulching rate, NS= not significant, ($P \leq 0.05$), LSD= least significant difference

Table 7: Effect of mulch material and mulching rate on lycopene, magnesium and vitamin C fruit nutritional qualities of tomato plants in 2014 cropping season

	Nutritional quality (mg/100 g)					
Mulching rate (t ha^{-1})						
Mulch Material	0	5	10	15	20	MM Mean
			Lycopene			
RH	1.9	2.7	2.9	3.5	3.7	2.9
GS	1.5	1.7	2.3	2.8	3.0	2.3
DG	1.5	2.5	2.6	3.5	4.1	2.8
MR Mean	1.6	2.3	2.6	3.3	3.6	
LSD (0.05) MM	0.16					
MR	0.16					
MM x MR	ns					
Magnesium						
RH	11.1	8.6	12.9	11.7	15.3	11.9
GS	7.1	12.5	9.4	16.2	9.5	10.9
DG	11.1	8.4	12.9	9.9	8.8	10.2
MR Mean	9.8	9.8	11.7	12.6	11.2	
LSD (0.05) MM	ns					
MR	ns					
MM x MR	ns					
Vitamin C						
RH	16.1	20.2	17.8	28.3	25.3	21.5
GS	16.5	16.7	23.8	21.3	28.7	21.4
DG	15.0	19.9	16.8	22.9	23.6	19.6
MR Mean	15.9	18.9	19.5	24.2	25.9	
LSD (0.05) MM	ns					
MR	2.22					
MM x MR	ns					

RH= rice husk, GS= groundnut shell, DG= dry guinea grass, MM= mulch material, MR= mulching rate, NS= not significant, ($P \leq 0.05$), LSD= least significant difference

RESPONSE OF TOMATO VARIETIES (Roma VF and UC82B) TO DIFFERENT SOURCE OF DIFFERENT ORGANIC MANURE AT SAMARU

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ABSTRACTS

The field experiment was conducted at the Institute for Agricultural Research (IAR) Farm, Samaru Zaria. Treatment consisted of two varieties of tomatoes (Roma VF and UC82B), and two sources of organic manure (poultry manure and cow dung). The treatments were factorially combined and laid out in a Randomized Complete Block Design (RCBD) with plot size of 3m by 3m (9m^2), replicated three times. The data collected were subjected to Analysis of Variance (ANOVA) using general linear model GLM of the Statistical Analysis System package (SAS, 2003) and the means were separated using the Duncan's Multiple Range Test (5% probability level) (Duncan, 1955). The study revealed that variety ROMA VF out-performed variety UC82B in terms of growth parameters (plant height and number of leaves). Similarly, growth and yield parameters of tomato significantly responded to poultry manure and cow dung.

Keywords: *Roma VF, Tomato, Varieties and Poultry Manure*

INTRODUCTION

Tomato *(Lycopersicon lycopersicon*) is an edible vegetable, often red fruit of the nightshade family known as solanaceae (Spooner *et al.,* 2005: Encyclopedia of life, 2014) Tomato species originated from the south American Andes and the use of tomato as a food originated in Mexico, and sprea**d** from there throughout the world following the Spanish colonization of the Americas (Encyclopedia of life, 2014).It is many varieties are now widely grown, sometime in green houses in cooler and warm climate of the tropics. It is one of the important vegetable crops grown throughout the world and ranks next to Irish potato in terms of the area of cultivation, but ranks first as a processing crop (Mehdizaden *et al.,* 2013) in Nigeria, tomatoes are grown during wet and dry seasons which attract higher profit during the dry seasons when demand is higher than supply (FAO, 2010) Tomato is one of most important vegetables in Nigeria as it is consumed by almost every household. Total tomato production in Nigeria was about 1.7 million tones (FAO2010). Importation of tomato into Nigeria becomes a necessity especially when the annual population growth rate about 2% (FAO, 2006) which exceed food production. Among the factors that contribute to low tomato yield in Nigeria were low soil fertility and improper selection of appropriate varieties adaptable to the agro-ecological zones (Adekiya and Ojenityi, 2010). Tomato is one of the most widely vegetables in the world. It is considered as the second significant vegetable crop in the world after potato (Mohammed *et al.,* 2010) the fruits are commonly eaten raw in salad served as a cooked vegetable, used as an ingredient of various prepared dishes, and picked.

Manure is the decomposed form of dead plant and animals which is applied to the soil to increase production. It is a natural form of fertilizer and is cost effective. The human and animals exist is also used as manure. The livestock manure is rich in nitrogen, phosphorus and potassium. Manure is highly rich in organic matter and humus and thus, improves the soil fertility. This is better in the long run and does not cause any pollution. It is a valuable and renewable resource. Poultry manure is derived from the piece of chickens used as an organic fertilizer, especially for soil with low nitrogen; it has the highest amount of nitrogen, phosphorus and potassium. Cow dung manure is also known as cow's pats, cow piece or cow manure, is the waste product (feaceas) of bovine animal's species, these species include domestic cattle (cow), bison (buffalo) and water buffalo. Cow dung is the undigested residue of plant matter which has passed through the animals' gut. Tomato is one of the most important and popularly vegetable crops in the world. The request

and demand of tomato is increasing day after day. Tomato production is increase but the space on land for its production is less, therefore this research need to find better manure among these two sample manure to test the best on two different varieties of tomato for farmers to have high yield product. Based on the aforementioned this research was conceived with the following objectives:
To determine the best variety among the two (Roma VF and UC82B)
To determine the best organic manure among the two sources (poultry and cow dung)

MATERIALS AND METHODS

The field experiment was conducted during 2021 dry season at Samaru College of Agriculture, Zaria. Home and Rural Vegetable Garden (Latitude 11º 11 N, Longitude of 38º E) and 686 meters above sea level. The site is falls in the Northern Guinea Savanna Ecological Zone of Nigeria. Treatment consisted of two varieties of tomatoes (Roma VF and UC82B), and two sources of organic manure (poultry manure and cow dung) rate. The treatments were laid out in a randomized complete block design with three replications. The soil sample was collected from 10 point from the experimental site with an auger prior to land preparation. The sample was sieved and analyzed for physiochemical properties using the standard procedure as describe by Black (1965). The gross plot was 2m × 2m (4 m^2). The following observations were recorded; plant height, Number of leaves and Number of fruit per plot. All data collected was subjected to Statistical Analysis of Variance (ANOVA) using F test as directed by Snedecor and Cochran (1967) and the treatment means were compare using Duncan Multiple Range Test (DMRT) Duncan, (1955).

RESULT AND DISCUSSION

Table 1 shows plant height of tomato at 3, 6 and 9 weeks after transplanting as affected by variety and organic manure at Samaru home and rural demonstration field during 2021 dry season. Result of the study showed that variety had statistically different plant height at 3 and 6 weeks after transplanting with Roma VF having presented statistically the tallest plant. However, at 9 weeks after transplanting variety had statistically shown the same plant height. Similarly, all the organic manure sources presented plant with statistically the same plant height at 6 and 9 weeks after transplanting. However, at 3 weeks after transplanting, poultry litter presented significantly the tallest plants, followed by cow dung and control. Interaction had no significant differences among the factors. This may be due to pear shaped fruit and determinate to semi-determinate growth habit (Quinn, 1998). It was reported that plant height of tomato was not significantly affected when 90 and 120kg N/ha were applied.
Result on number of leaves of tomato as affected by variety and organic manure sources presented in table 2. The two varieties differed significantly ($P \leq 0.05$) in terms of their number of leaves at all the stages of sampling except at 9 weeks after transplanting. Roma VF gave higher number of leaves. However, number of leaves responded significantly ($P \leq 0.05$) to organic manure at 3 and 6 weeks after transplanting with poultry litter having significantly the highest number of leaves per plant while cow dung and control presented the least number of leaves per plant at 3 and 6 weeks after transplanting. Interaction between the factors; variety and organic manure sources was highly significant at 3 weeks and significant at 6 weeks while there was no significant interaction between the factors at 9 weeks after transplanting. The reason for the variation in terms of plant height of tomato with Roma VF as the tallest may be due to short variety (50-60cm) in nature with semi-determinate growth habit and spreading branches and open pollinated with short maturity period of 80 days after transplanting (Anon, 2009). (Adeniran *et al*., 1999) reported that varying level of poultry manure alone have no significant effect on the number of leaves.
The result of number of fruits per plant of tomato as affected by variety and organic manure is presented in table 3. The two varieties had no significant differences in their number of fruit during the period of harvest. Number of fruits was significantly affected by organic manure sources and control. This was significant during the harvest in which poultry liter treatments presented the highest number of fruit. Interaction between the factors at 3 and 6 weeks after transplanting was significant and highly significant at 9 weeks. The overall variability of the measured variables and yield tomato recorded in this trial affirms the assentation of Adediran et al (2003) who reported crop yield response to organic means as largely dependent and varies with crop type, soil type and climate.

CONCLUSION

From the result obtained, it could be concluded that variety ROMA VF out-performed variety UC82B in terms of growth parameters (plant height and number of leaves). Similarly, growth and yield parameters of tomato significantly responded to poultry manure and cow dung.

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Table 1: Plant height of tomato (cm) as affected by variety and organic manure at Samaru during 2021 dry season.

Treatment	**Week After Transplanting**		
	3	**6**	**9**
Vatiety (V)			
Roma VF	19.74a	23.21a	27.11
Uc 82b	13.626b	19.22b	22.41
SE±	1.497	2.491	2.611
Organic Manure (O)			
Poultry litter	17.80ab	22.11	27.60
Cow ding	18.91ab	22.71	23.80
Control	13.33b	18.81	22.91
SE±	1.834	3.052	3.201
Interaction			
V x O	*	NS	NS

Means followed by the same letter (s) within Colum are not significantly different. At ($P \leq 0.05$).
NS: Not significant

Table 2: Number of leaves of tomato as affected by variety and organic manure at Samaru during 2021 dry season.

Treatment	**Week After Transplanting**		
	3	**6**	**9**
Vatiety (V)			
Roma VF	60.61a	152.00a	127.90
Uc 82b	39.62b	60.00b	94.81
SE±	5.251	22.114	15.322

Organic Manure (O)			
Poultry litter	59.81a	139.11a	116.44
Cow ding	44.22b	68.00b	99.71
Control	46.22b	111.00b	118.01
SE±	6.555	27.001	18.771
Interaction			
V x O	* *	*	NS

Means followed by the same letter (s) within Colum are not significantly different. At (P ≤ 0.05). NS: Not significant

Table 3: Number of tomato fruit per plot as affected by variety and organic manure at Samaru during 2021 dry season.

Treatment	NO OF FRUIT PER PLOT
Vatiety (V)	
Roma VF	19.44
Uc 82b	14.00
SE±	2.733
Organic Manure (O)	
Poultry litter	18.71ab
Cow ding	17.01ab
Control	14.51b
SE±	3.351
Interaction	
V x M	NS

Means followed by the same letter (s) within Colum are not significantly different. At (P ≤ 0.05). NS: Not significant

STUDIES ON PLANT PARASITIC NEMATODES ASSOCIATED WITH MANGO TREES IN GANYE AND GIREI LGA OF ADAMAWA STATE

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ABSTRACT
A survey of plant-parasitic nematode genera associated with rhizospheres of mango trees was conducted in Ganye and Girei LGA of Adamawa State. In this regard, a total of one hundred and twenty (120) soil samples each from the two (2) local government areas was collected at a depth of 10 - 15cm using auger. The soil samples were then transported to Crop Protection Department Laboratory, Modibbo Adama University Yola for extraction and identification at the generic level using the standard identification keys. Results showed a total of ten and eleven genera of PPNs were identified from the soil samples collected from around the root zone of mango trees in Ganye and Gire LGA respectively. Among the various genera of PPN encountered, Helicotylenchus spp. and Tylenchulus spp. were the most prominent species encountered. it is therefore recommended that management and control measures should implemented in order to curb the multiplication and spread of these nematode species to other regions.
Keywords: *Plant Parasitic Nematode, Mango trees, Soil samples, Population density*

INTRODUCTION

Mango (*Mangifera indica* L.) is one of the most popular fruits grown throughout the tropics and subtropics worldwide (Alemu *et al*., 2014). It belongs to the family of *Anacardiaceae*, and it is one of the most important species of the family and one of the most preferential fruit crops of the tropical and subtropical regions of the world (Vasugi *et al.,* 2012). Mango It is one of the most desirable fruits in the international market because of its delicious taste and high caloric value (Diedhiou *et al*., 2007). India is the world's largest producer; with shares around 56% of total global production. The other major mango producing countries are China, Mexico, Thailand, Indonesia, Pakistan, Nigeria, Philippines, Brazil, Egypt and Haiti (Swart, 2010).

According to Report Linker (2023), Nigeria was in twelfth place in 2021, producing 968,780 metric tons. However, the major producing states in the country include Benue, Jigawa, Plateau, Yobe, kebbi, Niger, Kaduna, Kano, Bauchi, Sokoto, Taraba, Adamawa, and FCT (Federal Capital Territory) (Yusuf and Salau, 2007). Mango has been acclimatized and adapted throughout the tropics and subtropics (Bally, 2006). Much of the spread and naturalization has occurred in conjunction with the spread of human populations, and as such, it plays an important part in the diet and cuisine of many diverse cultures. When ripe, mango fruit is particularly high in vitamin A (Bally, 2006). The fruit is also eaten green, processed into pickles, pulps, jams, and chutneys, and is frozen or dried.

Although grown widely, mangos prefer a warm, frost-free climate with a well-defined winter dry season. Rain and high humidity during flowering and fruit development reduces fruit yields (Bally, 2006). The tree generally flowers in mid- to late winter, with fruit maturing in the early to mid-summer month. Mangos are well adapted to cultivation and have been grown commercially for centuries (Bally, 2006). Mango is an important component of the diet in many countries in the subtropics and tropics (Alemu, 2014). In regions of the world that have experienced low living standards and serious nutritional deficiency, their attractiveness and flavor have also enhanced the quality of life (Mukherjee and Litz, 2009). However, mango production is limited by various pest and diseases at all stages of its development, right from the seedling in the nursery to the fruits in storage or transit (Alemu, 2014). Among the various pests limiting the successful production is plant parasitic nematode which are non-segmented microscopic, eel-like round worms, obligate parasite possesses stylets that live in soil causing damage to plants by feeding on roots or plant tissues. Zemtmyer *et al.* (2009). Ganye and Gire are among the 21 Local Government Areas of Adamawa State and are among the major production area of mango in the State. However, there is little or no study on plant parasitic nematode associated with mango. Therefore, this study was conducted to identify the different genera of plant parasitic nematode associated with Mango (*Mangifera indica* L.) and to determine the most prevalence nematode species in the study area.

MATERIALS AND METHODS

Survey Locations

The survey was conducted in two Local Government Areas of Adamawa State; Ganye and Girei. Ganye lies between latitude 8° 26' 5.89N and Longitude 12° 03' 3.85E. The mean annual temperature of the study area is between 32.3°C (maximum) and 19.6°C (minimum) while the average annual rainfall total is 1,231 mm (Kadams *et al*., 2020). While Girei lies between Latitude 9 0 11' -9 0 39'North and longitude 120 21' -120 49' East of the Greenwich Meridian. The area falls within the Northern Guinea Savannah Zone and has a tropical wet and dry climate (Adebayo, 2012).

Sampling Criteria

Mango farm was purposely selected from each location using Agricultural Development Project (ADP) structure as a guide to locate the representative of mango fields in the state and local government area. The criteria for selecting mango farms for sampling was based on the accessibility, availability of farmers and their willingness to allow the collection of soil sample (Ononuju, 2015).

Sampling Method and Collection of Samples

A total number of 120 soil samples were randomly collected for the survey (using random sampling method) from the rhizosphere of each tree showing symptoms of retarded growth and stunted growth by digging a hole with a radius of 3-5 cm from the base of the plant stand and at a depth of 0-30 cm. Two to 3 kg of soil samples were collected from each field, poured into polythene bags and labelled properly with details of the location of the farm, and transported to the laboratory of the Department of Crop Protection, Modibbo Adama University, Yola for nematode extraction and identification (Coyne *et al.,* 2007).

Nematode Extraction

Nematodes were extracted from 250 cm^3 of composite soil of each location using a modified Tray-technique as described by Bilgrami and Gaugler (2014). The extracted nematodes were identified and counted while viewing with a compound microscope at magnification of x10 in a Doncaster counting dish, and the mean nematode population was recorded. Identification of the plant parasitic nematode according to genera was done using a pictorial key as described by Mekete *et al*. (2012).

Data collection

Data were collected based on prevalence of plant parasitic nematodes, frequency of occurrence and nematode population density (Haougui *et al*., 2017). The data collected for frequency of occurrence was calculated in percentage frequency of occurrence formula described by (Haougui *et al*., 2017). The formula is indicated below:

FO=n/N×100

Where n= number of times an individual nematode occurred in the sample

N = sample size

S/N	Nematode Genera	(%) Frequency Of Occurrence	(%) Nematode Population (250cm^3)
1	*Helicotylenchus* spp.	35.54	25.5
2	*Tylenchulus* spp.	27.75	17.8
3	*Pratylenchus* spp.	18.12	12.1
4	*Rotylenchulus* spp.	16.82	10.8
5	*Trichodorus* spp.	11.66	8.7
6	*Meloidogyne* spp.	11.23	8.2
7	*Radopholus* spp.	8.06	6.1
8	*Longidorus* spp.	6.76	4.8
9	*Xiphinema* spp.	6.46	4.5
10	*Scutellonema* spp.	4.60	3.6

Table 2: Frequency of Occurrence and Nematode Population in Gboko LGA

S/N	**Nematode Genera**	**(%) Frequency Of Occurrence**	**(%) Nematode Population (250cm^3)**
1	*Tylenchulus* spp.	31.14	20.1
2	*Helicotylenchus* spp.	25.75	22.8
3	*Pratylenchus* spp.	22.57	13.8
4	*Meloidogyne* spp.	18.98	9.6
5	*Radopholus* spp.	17.18	9.2
6	*Trichodorus spp.*	14.98	7.8
7	*Longidorus spp.*	12.45	7.6
8	*Xiphinema* spp.	8.79	6.8
9	*Scutellonema spp.*	5.28	4.2
10	*Histotylenchus sp.*	5.3	3.6
11	*Rotylenchulus* spp.	3.59	3.0

DISCUSSION

Results from the microscopic examination of the soil samples collected from the study areas (Ganye and Girei LGA) within the rhizosphere of mango trees (at a depth of 0-30 cm) indicated the presence of eleven (11) different genera of plant parasitic nematodes associated with mango tree. The genera include; *Tylenchulus* spp., *Helicotylenchus* spp., *Rotylenchulus* spp., *Meloidogyne* spp., *Radopholus* spp., *Scutellonema* spp., *Xiphinema* spp., *Scutellonema* spp., *Histotylenchus* spp., *Trichodorus* spp. And *Pratylenchus* spp. These aforementioned genera pf PPN have previously been reported by various researchers to be among the major PPN associated with horticultural tree crops across the globe (Santos and Martinelli, 2016; Pranaya *et al*., 2020; Rawhat *et al.*, 2021).

Among nematodes genera encountered from 120 soil samples, collected from Ganye and Girei LGA, *Helicotylenchus* spp. and Tylenchulus spp. had the highest frequency of occurrence value (35.54 and 31.14% respectively) and also the most prominent genera in terms of population density (25.5 and 20.1% respectively). However, Pranaya *et al.* (2020) while surveying for nematodes associate with big fruit trees in Odisha, India found *Rotylenchulus* spp. as the most prominent species in soil samples collected within the rhizosphere of mango trees with 96% frequency of occurrence and 25.54% population density. The variation in diversity and abundance might be due to various edaphic factor within the study area. These findings agree with the assertion of Rawhat *et al.* (2021) that the diversity of nematodes and other micro-organisms depends upon the ecological and edaphic factors of their habitat. Altitude, temperature, and moisture like ecological factors play a vital role; soil pH and nutrients also greatly affect nematode populations and abundance (Rawhat *et al.* 2021).

CONCLUSION AND RECOMMENDATIONS

From the result of this study, it is inferred that ten and eleven genera of PPN were discovered to be associated with mango tress in Ganye and Girei respectively. However, among the various genera of PPN encountered, *Helicotylenchus* spp. and *Tylenchulus* spp. Were the most prominent species encountered. More these species of PPN have high tendency of parasitizing mango tress especially when they come in contact with roots by syphoning water and essential nutrient from the plant vascular system. In light of this, it is recommended that management and control measures should implemented in order to curb the multiplication and spread of these nematode species to other regions. More so further studies should be conducted to ascertain the magnitude of damage caused by these aforementioned PPN.

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DIVERSITY IN VITAMIN, MINERAL, PROXIMATE AND PHYTOCHEMICAL CONTENTS AMONG PULP, SEED AND RIND OF FOUR WATERMELON VARIETIES (*Citrallus lanatus*) IN SOUTH-WEST NIGERIA

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ABSTRACT
This study investigated the nutritional composition of watermelon seeds and rinds for possible uses as food and animal feed. Field experiment was conducted between August and November 2019 in Ogbomoso to determine the variability of vitamins and phytochemical contents among the pulp, seed and rind of four watermelon varieties (Sugar baby, Kaolack, Grey belle and Collos F1). At fruit maturity, six fruits per varieties, weighting 3 kg, were randomly selected for analyses. The results showed that Kaolack pulp has the highest concentration of vitamin C (8.16 mg/100g) while the seeds and rinds of Collos F1 have the highest concentration of vitamin E (0.130 mg/100g) and A (450.00 µg/100g), respectively. For all varieties, the highest value of lycopene was obtained from the pulp when compared with rinds and seeds. This implies that, although the rind and seed are often discarded, they have sufficient vitamins and minerals for human consumption. This is in addition to being useful as animal feed.
Keywords: *Mineral Content, Pulp, Rind, Seed, Watermelon, Varieties, Vitamin Content*

INTRODUCTION

Watermelon (*Citrallus lanatus* (Thunb) Matsum. and Nakai) belong to the family cucurbitacea, Genus: citrullus and species: lanatus (Paris, 2015). It is an economical important fruit crops known for its sweet and juicy pulp (Munisse *et al.,* 2011). Watermelon fruit has both nutritional and medicinal values (Gwana *et al*., 2014). It is a rich source of phytochemical compounds, which are beneficial for human health and well-being (Abu-Reidah *et al.,* 2013). Watermelon rind which is usually light green or white contains many hidden nutrients and it is edible, but most times it is avoided and discarded due to its unappealing flavor (Johnson *et al.*, 2012; Mohan *et al.*, 2016). Its rind and seed have high carotenes (Alpha, Beta and Gamma) which can be converted to vitamin in the body.

Despite the availability of fruits and other sources of vitamin A, World Health Organization (WHO, 2009) database on vitamin A deficiency (1995-2005) showed that approximately one third of children under the age of five around the world is suffering from vitamin A deficiency, which is estimated to claim the lives of 670,000 children under the age of five annually (Black *et al*., 2008). The highest prevalence is in developing countries of which Southeast Asia and Africa continents are not spared. The rind and seed also contain high potassium and magnesium which help to relax nerves and muscle and keeps blood circulating smoothly (Amin et al., 2014). Sometimes the rind is applied as feeds to animals or as fertilizer materials to crops (Erukainure *et al.*, 2010). In Africa, watermelon seeds may be ground into a coarse flour and oil may be extracted from them (Lim, 2012; McGuire, 2011).

Watermelon fruit contains a significant amount of citrulline for improvement of erectile dysfunction (Mandel *et al.*, 2005). It possesses high level of antioxidant which helps to fight harmful free radicals that can damage the body cell. It has diuretic and cleansing properties that make it beneficial for those with certain kidney and bladder diseases and also contains sufficient amino acid, beta-carotene which prevents ailment such as heart diseases (Naz *et al.*, 2014). The lycopene content which gives the fruit its colour play a role in the protection of prostrate and oral cancer (Gwana *et al.,* 2014). The mineral contents are good for preventing

conditions such as lowering high blood pressure, stroke and help to decrease the risk of kidney stone and bone loss due to old age (Sabo *et al.*, 2013).
Watermelon fruit is an important fruit crops that is underutilized. When it is used as fresh fruit or processed into juice, it generates much waste in the form of rind and seeds (Asghar *et al.,* 2012). Although the seeds are considered waste and have been shown to be highly nutritive and contain large amounts of proteins and many beneficial minerals (Sonawane et al., 2016). The knowledge of the nutritive content of various parts of the watermelon fruit will encourage their consumption in diverse ways and re-utilization of the vast amounts of seeds and rind discarded as waste. The nutrient value of many fruits, seeds and their rind has not received much attention and these are at times discarded, even with their hidden nutrients (Johnson *et al.,* 2012). Recently, more attention has been paid to the utilization of by-products and wastes, as well as underutilized agricultural products. Such utilization will contribute to maximizing available resources and can also result in the production of new foods (De Corato et al., 2018; Stevens et al., 2018). In Nigeria, there is dearth information about watermelon and its seeds and rind, but the indications are that it has versatile uses.
This study focusses on four distinct watermelon varieties, known for their unique attributes, and analyze the variations in nutrient content among the pulp, seed, and rind of each variety. By investigating these differences, we aim to shed light on the potential health benefits associated with consuming various parts of the watermelon and explore novel opportunities for value addition in the food industry.

MATERIALS AND METHOD

Experimental site

A Field experiment was conducted in 2018 at the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso, Nigeria Oyo State, Nigeria. Ogbomoso lies on latitude 18°10' N, longitude 4°16' E, and located in the Guinea savanna zone of Southwest Nigeria. The temperature of the area ranges from 28 to 33°C with relative humidity of about 75% all year except in January when the dry wind blows from the North. Rainfall distribution is bimodal and extends for eight to nine months of the year. On the average, the total annual rainfall is about 128 mm.

Treatment

The treatments consisted of four varieties of watermelon viz: Sugar baby, Kaolack, Grey belle and Collos F1. At fruit maturity, six fruits per varieties weighting 3kg were randomly selected to assess the nutritional contents. The selected fruits were cut vertically into two equal parts using a sharp kitchen knife, and the pulp, seeds and rind were extracted separately to determine their vitamin A, C and E, mineral, proximate and phytochemicals contents. Data collected were subjected to analysis of variance according to Statistical Analysis System (SAS Institute, 2021) and treatment means were compared using Duncan multiple range test at 5% probability level.

RESULTS

The results of vitamin contents of the pulp, seed and rind of fresh watermelon varieties is presented in (Table 1). Statistical assessment shows that the vitamin A was generally higher in the rind than the pulp and seed (Table 1). Vitamin A content of Collos F1 rind was the highest (450 µg /100g) while the lowest of 80 µg /100g was obtained from Grey belle pulp. Vitamin C content was the highest in pulp than the seed and rind (Table 1). The highest vitamin C content of 8.16 mg/100g was obtained from Kaolack pulp while the least of 1.14 mg/100g was obtained from Collos F1 seed. Vitamin E content was significantly($p>0.05$) higher in the seed than the pulp and rind. Kaolack seed had vitamin E content of 0.120 mg/100g which was significantly ($p>0.05$) higher than 0.034 mg/100g of Collos F1 pulp. Potassium content was highest in the seed and rind than the pulp, with Kaolack seed containing the highest concentration (1144.5 mg/100g) of potassium while Sugar baby pulp had the least (664.2 mg/100g) value. In terms of micro-minerals, the rind of all the four varieties had the highest iron. The highest iron content was obtained from Kaolack rind (11.3 mg/100g) while the least of 1.4 mg/100g was obtained from Sugar baby seed.

Table 1: Vitamin content of pulp, seed and rind of four varieties of watermelon

Treatment	Sugar baby	Kaolack	Grey belle	Collos F1

Vitamin A(µg/100g)				
Pulp	110.00b	130.00a	80.00d	100.00c
Seed	230.00d	290.00b	280.00c	350.00a
Rind	310.00c	430.00b	310.00c	450.00a
Vitamin C(mg/100g)				
Pulp	6.45d	8.16a	6.72b	6.51c
Seed	1.51b	1.65a	1.45c	1.41c
Rind	4.26d	4.88a	4.43c	4.78b
Vitamin E (mg/100g)				
Pulp	0.038b	0.043a	0.038b	0.034c
Seed	0.100c	0.130a	0.100c	0.120b
Rind	0.040b	0.040b	0.040a	0.060a
Potassium				
Pulp	664.2d	666.5c	686.9b	689.3a
Seed	1082.5c	1144.5	1126.3b	1044.4d
Rind	977.2c	972.1d	993.4b	1022.2a
Iron				
Pulp	0.61b	0.62a	0.55d	0.58c
Seed	0.14d	0.19b	0.17c	0.25a
Rind	1.44a	1.53b	1.35d	1.46c

Means along the row with the same letter(s) are not significantly different from each other using Duncan Multiple Range Test at 5% probability level

The result of phytochemicals content of pulp, seed and rind of four watermelon varieties are presented in Table 2. The result showed that highest lycopene content of 11.28 mg/100g was obtained from Kaolack pulp but significantly ($p>0.05$) different from what was obtained from Collos F1 pulp (11.25 mg/100) while the least of 2.49 mg/100g was obtained from Grey belle rind (Table 2). Highest Carotene content of 9.86 mg/100 g was obtained from Kaolack rind and significantly ($p>0.05$) similar to 9.84 mg/100g obtained from Grey belle rind while the least of 0.15mg/100 was obtained from the Sugar baby seed (Table 2). Generally, Phenol content was significantly($p>0.05$) higher in the rind than the pulp and seed of all the four watermelon varieties (Table 4). Phenol content of 0.114 mg/100g was obtained from Kaolack seed which was significantly ($p>0.05$) higher than 0.114 m/100g obtained from Grey belle seed that was the least phenol content but significantly ($p>0.05$) similar to 0.115 mg/100g obtained from Sugar baby seed (Table 2)

Table 2: Phytochemicals content of pulp, seed and rind of four varieties of watermelon

Treatment	Sugar baby	Kaolack	Grey belle	Collos F1
Lycopene (mg/100g)				
Pulp	11.03c	11.25a	11.21b	11.28a
Seed	6.69c	6.98a	6.65d	6.96b
Rind	3.05a	3.02b	2.49d	2.78c
Carotene C(mg/100g)				
Pulp	8.20c	8.69a	8.08d	8.27b
Seed	0.15d	0.18b	0.16c	0.28a
Rind	9.43d	9.86a	9.84b	9.81c
Phenol (mg/100g)				
Pulp	0.118b	0.119a	0.114d	0.116c
Seed	0.115c	0.121a	0.118b	0.124d
Rind	0.133c	0.144a	0.130d	0.141b

Means along the row with the same letter(s) are not significantly different from each other using Duncan Multiple Range Test at 5% probability level

DISCUSSIONS

The pulp, seed and rind of the four varieties of watermelon fruits were analyzed for vitamin and phytochemical contents. The value obtained for vitamin A content of Collos F1 watermelon rind (450

µg/100g) was higher than that of the findings of Johnson et al. (2013) for watermelon (15.73 µg/100g). The present result was also higher than the finding of Aremu and Nweze (2017) on watermelon (350.12 µg/100g). From the result, it was observed that all the watermelon fruits varieties studied are good sources of vitamin A. In general, this study showed that vitamin A content is higher in watermelon rind than the pulp and seed. This observation is in agreement with the findings of Setiawan et al. (2001), who reported that watermelon rind is an important source of vitamin A. Vitamin C was higher in the pulp than the seed and rind. Similar result was reported by Johnson et al. (2013) on watermelon. The highest vitamin C values obtained for pulp (8.16 mg/100g) in this study is close to the vitamin C content of watermelon (9.39 mg/100) reported by Johnson et al. (2013). The presence of Potassium helps to regulate high blood pressure (Daffodil *et al*., 2016). Iron is one of the important elements in the diet of infant, pregnant woman and nursing mother to prevent anemia (Oluyemi et al., 2006). This implies that watermelon seed and rind are good sources of minerals elements which play various physiological functions in the body.
This shows that the rind of watermelon which is often discarded can be used to provide feed supplement for livestock. Campbell, (2017) reported that fruit with low carbohydrate content are good for diabetic and hypertension patients.

CONCLUSION
The results of this study showed that watermelon fruits are good sources of vitamins, minerals, phytochemicals are in abundant in the rind and seed which are often discarded are good sources of vitamin and minerals elements which play various physiological functions in the human body. The vitamin A can help combating Vitamin A deficiency which has been a major public health problem in many developing countries including Nigeria. Also the presencce of potassium in abundant which is one of the important minerals in the body which helps to regulate fluid balance, muscle contractions, reduced blood pressure and osteoporosis. Also, the rind and seed can also be used in animal feed.

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IMPLEMENTATION OF GREEN TECHNOLOGY IN HORTICULTURE FOR REDUCING POSTHARVEST LOSS IN NIGERIA

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ABSTRACT

Horticultural crop production plays a significant role in the economic and health sectors of a country. The tremendous food loss despite increased production is a cause for concern to meet the no poverty and zero hunger target in developing countries by 2030. Green technology has brought tremendous change in revolutionizing agriculture in all its facets, ranging from planting to post-planting operations. The main concern of this paper is to present some applications of green technology in horticulture such as the application of edible coatings and films and light emitting diode (LED). Edible coatings enhance shelf life by reducing percentage weight loss, retarding physicochemical changes, and delaying fruit ripening, while edible films function as an effective carrier for antimicrobials, and led emitting diode (LED) with red light enhances the total phenolics, anthocyanins, lycopene, α-tocopherol, and other compounds in several fruits and vegetables. These technologies save produce from loss through microbial infection, respiration rate and improved antioxidant quality general management, which leads to eradicating hunger, increasing productivity and profits and improving nutrition. This overview is about the current novel technologies to be adopted for reducing postharvest loss and waste.

***Keywords**: Horticultural crops, No poverty, Zero hunger, Green technology*

INTRODUCTION

The Food and Agriculture Organization (FAO) has projected over the years that Nigeria, on average losses \$9 billion (about ₦3.5 trillion) annually to postharvest waste. Fruits and vegetable production is globally challenged by food loss and waste, economy, and climate change among others. Strokes have been passed on poor infrastructure, inefficient logistics, low technology know-how, insufficient skills, inadequate knowledge, poor managerial ability of supply/value chain actors, and lack of markets for the increasing rate of food loss during production, postharvest and processing stages of fruits and vegetables (Ncama et al., 2019). The acceptability and quality of fruits and vegetables accessed by consumers are based on the physico-chemical attributes. The properties range from produce maturity stage, physical appearance (shape, size and colour), attractiveness of the colour (vibrancy), absence of dirt, pest infestation and disease signs. Other quality attributes could be attributed to the sugar content of produce, both fresh or processed form Gholamipour et al., 2010; Mandal et al., 2018). There are a few innovative green postharvest technologies adopted to improve the shelf life, nutritional quality and physical attributes of fruits and vegetables.

Edible Coating

Edible coatings are regarded as green technology because it is safe, sustainable, and environmentally safe. A perfect coating material must be odourless, tasteless, safe for consumption and flexible (Prasad and Batra, 2005). Edible coatings act as a bar of exchange of gases and moisture between produce and its immediate environment. It is a thin layer of about 0.3 mm made from degradable materials either encased or covered around the surface of fruits. The essence of coating is to delay respiration process, slow down ethylene production and microbial growth as recorded by Kahramanoğlu et al., (2020); Wan et al., (2021). As shown in Table 1, edible coatings are categorized into three; Lipid-based material, protein-based material, and polysaccharide-based materials. A combination of different types can also be adopted to achieve optimum results (Pascall and Lin, 2013). Edible coatings have been widely accepted and observed to reduce weight loss by a range of fruits and vegetables sweet cherries, peaches, and plums (Hazrati et al 2017; Kumar et al 2018). Applying edible coatings also reduces loss of quality during storage of fruits and vegetables by forming a semipermeable gas barrier around the produce to obstruct transpiration process, regulate O_2 and CO_2 gases exchange between the in-situ atmospheric condition of the fruits and the ambient environment. Therefore, edible coatings can enhance shelf life by decreasing weight loss, retarding physicochemical changes, and delaying fruit ripening.

Edible Films

Edible film solutions are prepared by dissolving (plasticizer) in solvents (water, alcohol or a mixture of both). The essence of adding plasticizer to the solvent is to improve the flexibility and elasticity of the film. To improve the functionality, other additives (colors, flavours and antimicrobial agents) can be added to the solution (Janjarasskul and Krochta, 2010). According to Hambleton et al., (2009), edible films functions as effective carrier for antimicrobials, they vary from Polysaccharide-based edible films (carrageenan and chitosan), Hydrocolloid-based edible films (alginate and carboxymethylcellulose; CMC) which can be used as an effective barrier to non-polar aroma compounds thereby reducing aroma loss and oxidation and prevent moisture losses Dragich and Krochta, (2009) respectively. Edible chitosan film combined with bioactive compounds and essential oils reduces *Escherichia coli* and *Listeria monocytogenes* and quality enhancement of broccoli (Alvarez et al., 2013).

Light emitting diode (LED) Technology

This technology embraces the significance of light in plant growth and sustenance. Light is a significant factor that influences energy availability for photosynthesis and the leadway to a wide range of physiological and biochemical processes in plants. The led emitting diode (LED) technology produces monochromatic light (blue, red, blue and white light) within 400 nm and 700 nm wavelengths. According to Massa et al., (2008), the wavelength specificity, long lifespan, low thermal energy, and non-toxicity of LED lights are recently been observed for their postharvest techniques to increase the life span and sustain the quality of fresh produce. The quality of light has been proven to affect the quantity and rates of phytonutrients in plants (Yeow, 2020). Surrounding light with red enhanced the total phenolics, anthocyanins, lycopene, α-tocopherol, and other compounds in several fruits and vegetables.

CONCLUSION

Adopting the appropriate postharvest technologies can drastically reduce the economic loss caused by postharvest losses of produce. Reducing these losses has the potential to improve food availability and minimize waste to the lowest percentage. Over the years, green postharvest technology practices (use of edible coating and ultraviolet) have been adopted to enhance nutritional quality and sustain the postharvest properties of produce. Furthermore, to reduce food waste and loss due to postharvest diseases, antimicrobial application of LED technology could be applied. Edible coatings and films are regarded as alternative packaging and not a replacement for synthetic packaging methods. Edible films double as a method of reducing postharvest losses and environmental pollution in the long term. Nonetheless, to maintain the quality and extend the shelf life of horticultural produce, various technical hitches and economic challenges must be subdued to increase the chances of developing countries in modern trade. The various green technology methods have limitations, therefore integrated methods should be adopted for the desired result. The implementation of the combined treatments may be of future research focus especially for industrial use.

Increased effort on efficiency and cost-effectiveness is essential to provide efficiency and cost-effectiveness for the industry.

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Table 1: The effectiveness of the edible coatings on selected produce

Edible Coating	Tested crop	Mechanism of operation	References
1.5% guar gum	Tomatoes	Reducing respiration rate	Ruella-Chacon (2017)
2% chitosan	Guava, mango	Reduce weight loss, delay changes in TSS, TA and maintains firmness within the first 12 days	Gholamipour et al., 2010
1% peach gum polysaccharide; 5% alginate	Cherry tomatoes	Decreases respiration and weight loss, maintains firmness, and extends shelf-life	Hossain and Iqbal 2016; Ruelas-Chacon et al., 2017
50% aloe vera gel	Banana	Reduce weight loss and delays ripening	Díaz-Mula et al., 2011; Ratra et al., 2016

Table 2: Effect of LEDs technology in inducing different levels of phytonutrients on selected tested crops

LED light	Tested crop	Phytonutrients	References
Blue	Strawberry, purple pepper, table grapes	Total phenolic, chlorophyl, anthocyanin, flavonoids, and vitamin C	Nassarawa et al., 2021; Liu et al.,2022
Red	Basil, parsley	Total phenolic, vitamin C and α-tacopherol	Samuolienė et al., 2016
Green	Cabbage, lettuce, cabbage	A-carotene and antocyanin	Lee et al., 2016
Blue red	Eggplant, carrot sprout	Carotenoids	Jarerat et al., 2022

HIGH RESISTANCE OF *Vernonia amygdalina* TO *CUCUMBER MOSAIC VIRUS* INFECTION

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ABSTRACT
This research was designed to study the pathological effect of Cucumber mosaic virus (CMV) on Vernonia amygdalina plants. This was with the aim to determine the susceptibility status of the plant to CMV infection. Thirty five apparently healthy V. amygdalina plants were raised in the screen house for two weeks before mechanical inoculation with a virulent CMV strain. Enzyme linked immunosorbent assay (ELISA) and reverse transcription polymerase chain reaction (RT-PCR) methods conducted for viral detection in leaf samples, four weeks after inoculation both recorded zero CMV incidence. Symptoms severity/development evaluation after four weeks revealed 34 of 35 test plants with zero symptom severity scores. An extremely low percentage mean symptoms severity score of 0.571 % (1/175) was obtained with percentage disease resistance score of 99.429 %. The data obtained from this research were indicative of the tendency of V. amygdalina to present absolute resistance to the CMV.
Keywords*: Cucumber mosaic virus (CMV), Vernonia amygdalina, Disease resistance.*

INTRODUCTION

Vernonia amygdalina that many people call bitter leaf is a popular shrub that grows to a height between two and five metres. It is a commonly cultivated plant in Nigeria and other countries located in the African tropics (Igile *et al*., 1994). *Vernonia amygdalina* is a perennial, multipurpose, rapid, regenerating, soft-wooded plant with a bitter taste. Anti-nutritional phytochemicals within the plants are responsible for its bitter taste (Bonsi *et al*., 1995). The leaves are consumed as green leafy vegetable. Its richness in minerals and vitamins has made it an important human diet (Sobukola *et al*., 2007). It has a wide folkloric uses against diverse tropical diseases. More importantly it has gained wide application in the treatment of amoebic dysentery (Moundipa *et al*., 2000), gastrointestinal disorders (Akah and Ekekwe, 1995), blood sugar regulation, blood tonic, antimicrobial and antiparasitic activities (Akinpelu, 1999; Hladik *et al*., 2005). Some of the identified bioactive compounds of *V. amygdalina* responsible for its ethnobotanical uses include alkaloids, saponins, terpenes, flavonoids, phenolic acids, steroids, anthraquinone, coumarins, sesquiterpenes, xanthones and edotides (Izevbigie, 2003; Cimanga *et al*., 2004; Muraina *et al*., 2010). It is cultivated widely because of its nutritive, medicinal and economic values.

Cucumber mosaic virus (CMV) was first described in detail in 1916 on cucumber and other cucurbits simultaneously by Doolittle and Jagger (Zitter and Murphy, 2009). CMV is a plant pathogenic virus in the family Bromoviridae and a type member of the plant virus genus, *Cucumovirus*. CMV has a worldwide distribution (both in tropical and temperate climates) and noted to have the widest host range for any plant virus (Palukaitis & García-Arenal, 2003), including more than 1200 species in over 100 families of dicotyledonous and monocotyledonous angiosperms. It is transmitted by more than 75 species of aphids in a non-persistent manner and through the seed in some plant hosts. Experimentally, it is easily transmitted by mechanical inoculation of plant sap. It is an economically important disease in a large variety of crop plants. CMV causes a systemic infection in most host plants. Symptoms of CMV can vary greatly depending on the crop infected and the age of the plant when infection occurs. CMV causes mosaic in cucumber, melon and other cucurbits; blight (withering) in spinach; mosaic, string-like leaf and systemic necrosis in tomato; mosaic and ringspot in pepper; mosaic and stunting in clover, lupins and Lucerne. They also cause stunting in soybean; mosaic and infectious chlorosis in banana; and mosaic and dwarfing in many other species of dicotyledonous and monocotyledonous plants (Palukaitis, 2003). Subgroup I strains have been shown to be more virulent in crops than the subgroup II strains (Wahyuni *et al*., 1992; Zhang *et al*., 1994).

Annually, one of the major challenges of crop cultivation in Nigeria leading to very low crop yield and poor market value of harvested produce is the high perennial incidence of viral-like diseases on farms (Mohammed *et al*., 2017) with CMV among the predominant viruses. However, there is no report of any research work conducted to study the impact of CMV in *Vernonia amygdalina* production in Nigeria. In view of the potential devastating impact of CMV on many crop productions leading to severe economic losses, this research was designed to study the pathological effect of a virulent isolated Nigerian CMV strains on *Vernonia amygdalina* plants. The outcome of this research work will assist in the placement of the bitter leaf as either a part of host-range crops of CMV or otherwise. It may also be useful in the creation of biological agent(s) from the studied crop that may be helpful in the control of CMV on farms.

MATERIALS AND METHODS

Thirty five (35) *Vernonia amygdalina* plants were raised in the screen house from stems cut from apparently healthy plants. The stems were potted in 10 litre size perforated plastic buckets filled with sterilized manured loamy soil. The newly emerging shoot from the *Vernonia amygdalina* stems were mechanically inoculated after two weeks with the virulent CMV Group I strain with NCBI GenBank Accession KM091952 that was previously isolated from tomato and preserved in cowpea within the screen house.

Preparation of inoculation buffer (pH 7.2): To 1 litre of water, 14.2g sodium phosphate dibasic (0.1M), 13.61g potassium phosphate monobasic (0.1M), 3.722g EDTA (0.01M) and 0.121g L-Cysteine (0.001M) were added. Few drops of 2-Mecarpto-ethanol were added to the inoculation buffer just before use.

Protocol for inoculation of tomato seedlings: Inoculation of potted test plants was carried out 4 weeks after potting of plants. The inoculum was prepared by grinding the leaves obtained from CMV positive reservoir plants and homogenization with the inoculation buffer. Carborundum was sprayed on selected leaves of potted test plants and inoculum gently rubbed on leaves. The plants were rinsed with distilled water to enable clear observation of viral symptoms.

Evaluation of CMV symptoms development and severity rating in inoculated plants: The symptom severity evaluation was conducted for a period of 4 weeks after inoculation. Symptom severity in plants was evaluated according to the symptom severity scale described by Friedmann *et al*. (1998) as follows: 0 = no visible symptoms, inoculated plants showed same growth and development as uninoculated plants (control); 1 = very slight yellowing of leaflet margins on apical leaf; 2 = some yellowing and minor curling of leaflet ends; 3 = a wide range of leaf yellowing, curling and cupping, with some reduction in size, yet plants continue to develop; 4 = very severe plant stunting and yellowing, pronounced leaf cupping and curling, and plant growth stops and 5 = wilting, dryness or death of plant.

Serological indexing for CMV detection in inoculated plants: Leaf samples were collected from inoculated plants after 4 weeks and tested for the presence of CMV using the enzyme linked immunosorbent assay (ELISA) technique. ELISA antiserum set and the control were obtained from Plant virus collection centre of Leibniz-Institut Deutsche Sammlung Von Mikroorganism und ZellkulturenBraunschweig (DSMZ) Germany. Antigen coated plate enzyme-linked immunosorbent assay (ACP-ELISA) method was used for the detection of CMV as described by the manufacturer's manual available on: https://www.dsmz.de/fileadmin/_migrated/content_uploads/ACP-ELISA.pdf . Assessment of results were carried out by spectrophotometric measurement by placing the plate in the ELx 800 universal multiscan ELISA microplate reader provided with 405 nm filter and the reading was taken after 1 hour and overnight. Samples with values exceeding twice the reading of the healthy control were considered positive.

Nucleic acid Extraction: The cetyltrimethyl ammonium bromide (CTAB) method was used for nucleic acid extraction from the leaf samples as described by Abarshi *et al*. (2010) and Dellaporta *et al*. (1983). CTAB RNA extraction buffer pH 8.0 was made by mixing 2% molecular biology grade cetyltrimethyl ammonium bromide powder (Sigma H6269) (w/v), 100 mM Tris-HCl, 20 mM EDTA, 1.4 M NaCl, and 0.2% β-mercaptoethanol (v/v) (was added just before use). From each leaf sample, 100 mg was grinded in 1000 µl of nucleic acid extraction buffer in a sterile mortar and pestle. The sap was poured into new sterile tube and vortex briefly before incubating in water bath at 60 ºC for 10 mins. The plant sap was brought to room temperature and equal volume of the mixture containing phenol, chloroform and iso-amyl alcohol in the ratio 25:24:1 was added. Sap was vortexed, centrifuged at 12000 rpm for 10 mins and 450 µl of the supernatant were pipetted into new sterile tube**.** Cold isopropanol 300 µl was added, mixed and sap incubated for 1 hr at -20 ºC. The mixture was centrifuged at 12000 rpm for 10 mins to sediment the DNA. The supernatant was gently decanted to ensure the pellets were not disturbed. 500 µl of 70% ethanol was added to the pellets and centrifuge at 12000 rpm for 5 mins. The ethanol was decanted and the RNA was air dried at room temperature. RNA pellets were suspended in 50 µl TE buffer for further use and storage at -80 ºC.

Reverse Transcription Polymerase Chain Reaction (RT-PCR) : With the aim of amplifying the 3' end of the CP (Coat protein) gene and C-terminal noncoding region of RNA3 of CMV, RT-PCR was carried out using the CMV specific primers, 5' GCC GTA AGC TGG ATG GAC AA 3' and 5' TAT GAT AAG AAG CTT GTT TCG CG 3' as described by Wylie *et al*. (1993). The PCR mix used for cDNA synthesis and amplification in a one step reaction contains 2 µL of the template RNA, 1 µL of 10 pm reverse primer, 1 µL of 10 pm forward primer, 3 µL of 25 mM $MgCl_2$, 10 µL of PCR buffer, 1 µL of 10 mM dNTP, 0.24 µL of reverse transcriptase (1 U/µL) and 0.24 µL of Taq polymerase (1 U/µL) (Promega USA). RT-PCR was accomplished with the amplification programmed for one cycle cDNA synthesis of 44 ºC for 30 min and 95 ºC for 5 min and 35 cycles of amplification with 45 sec of denaturation at 95 ºC, 45 sec of annealing at 54 ºC and 45 sec of extension at 72 ºC followed by one cycle of final extension for 7 min at 72 ºC. The RT-PCR products were analyzed by 1.5% agarose gel electrophoresis.

RESULTS

CMV symptoms development/severity evaluation in mechanically inoculated *Vernonia amygdalina*: Out of the 35 mechanically inoculated test plants, only 1 plant presented very mild leaf mosaic symptom of a score of 1 as shown in Table 1. There were no symptoms of leaf mottling, distortion, filiformity, stunted growth, wilting and plant death in test plants. Thirty four test plants (34/35) recorded zero symptom severity scores with no observable defect. An extremely low percentage mean symptoms severity score of 0.571 % (1/175) was obtained. The percentage disease resistance score of 99.429 % was also recorded.

ELISA Test: The result of the ELISA (Table 2) for 35 tested leaf samples presented values between the range of 0.092 and 0.147 which are well below the reference value of 0.42 for the positive (twice the value of the healthy sample). The buffer sample recorded an ELISA value of 0.2 while the disease control produced a value of 3.102. This outcome revealed all tested samples as sero-negatives and disease control as sero-positive. Hence, all test plant samples were clean with zero CMV incidence (0/35) of CMV.

RT-PCR test: As shown on the agarose gel (Plate 1) and Table 3, the expected PCR amplicons of 500 base pairs were observed in only the disease control samples and not in any of the 35 test plants and buffer samples. This finding correlates with the ELISA results and further confirmed the absence of CMV in all tested samples.

DISCUSSION

The data obtained from the symptoms severity and development evaluation in test plants (Table 1) were indicative of the absolute or high degree resistance possess by the *V. amygdalina* to CMV and perhaps many other related viruses. The results of the ELISA (Table 2) and RT-PCR test (Plate 1 and Table 3) which revealed zero CMV incidence in inoculated samples (0/35) were also glaring pointers to the tendency of the plants to present absolute resistance to the CMV. The presence of numerous peculiar bioactive compounds in bitter leaf have been reported by Igile *et al*. (1995) and many other researchers (Farombi and Owoeye, 2011). More than thirty compounds belonging to several classes of compounds with different biological activities have been isolated and characterized from *V. amagdalina (*Oyeyemi *et al*., 2018). The list includes sesquiterpene lactones like vernolide, vernodalol, vernodalin, hydroxyvernolide, vernodalinol, vernomygdin, epivernodalol, 11,13-dihydrovernodalin and 3′deoxyvernodalol; flavonoids like luteolin, luteolin 7-O-β-glucuronoside and luteolin 7-O-β-glucoside; steriod glycosides like vernonioside B_1 and steriod saponins like vernoamyosides A, B, C and D (Quasie *et al*., 2016). The sesquiterpene lactones are unique to *V. amygdalina* (Abay *et al*., 2015) and have been shown to be the main active compounds responsible for most of the plant's activities ranging from antibiotics, antischistosomal, antiplasmodial, antioxidant, anti-inflammatory and anticancer activities (Luo et al., 2011). Oyeyemi *et al*. (2018) also reported that the activities shown by the plant were likely due to synergistic reactions of the individual components.

The biologically active compounds of *Vernonia amygdalina* are saponins and alkaloids (Muraina *et al*., 2010), terpenes, steroids, coumarins, flavonoids, phenolic acids, lignans, xanthones and anthraquinone (Cimanga *et al*., 2004), edotides (Izevbigie *et al*., 2003) and sesquiterpenes (Ohigashi *et al*.,1994). These compounds are likely to possess antiviral properties preventing viral replication and migration from the point of infection to other parts. Sudhanshu *et al*. (2023) reported the inhibition of virus by luteolin, luteolin-7-o-βglucoside, vernodalol, vernolepin, vernodalin. Although not yet to be proven, it is not out of place to presume that resistance to CMV is achieved through the inhibition of activities of CMV replicase enzyme and movement protein which are responsible for the replication of viral nucleic acid and cell-to-cell spread of the virus respectively, by bioactive compounds present in bitter leaf.

RECOMMENDATIONS

The findings of this research work are expected to educate farmers and stake holders on the resistance of *V. amygdalina* to CMV. This may also be an eye-opener to the use of bitter leaf as a natural, affordable biological agent in the sustainable control of the notorious CMV on susceptible crops. Hence, more researches along this line will be needed.

Table 1: CMV symptoms severity evaluation test in *Vernonia amygdalina*

Sample ID	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Score	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Sample ID	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	H
Score	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total symptoms severity score												1/175						
Mean symptoms score												0.00571						
Percentage symptoms severity score												0.571 %						
Percentage Disease resistance score												99.429 %						

H = Healthy control sample

Total symptoms severity score = Sum of observable severity scores of all test plants / (Maximum obtainable symptom score of 5 x Number of samples).
Mean symptoms score = Total symptoms severity score ÷ (Maximum obtainable symptom score of 5 x Number of replicates).
Percentage symptoms severity score = Mean score × 100 %.
Percentage disease resistance score = 100 – Percentage symptoms severity score.

Table 2: CMV ELISA TEST RESULT

SAMPLE ID	One Hour Reading	Overnight Reading	Inference
SAMPLE 1	0.113	0.121	C
SAMPLE 2	0.119	0.105	C
SAMPLE 3	0.119	0.108	C
SAMPLE 4	0.111	0.129	C
SAMPLE 5	0.12	0.108	C
SAMPLE 6	0.113	0.115	C
SAMPLE 7	0.125	0.115	C
SAMPLE 8	0.121	0.105	C
SAMPLE 9	0.117	0.111	C
SAMPLE 10	0.118	0.112	C
SAMPLE 11	0.112	0.14	C
SAMPLE 12	0.126	0.138	C
SAMPLE 13	0.099	0.115	C
SAMPLE 14	0.098	0.147	C
SAMPLE 15	0.099	0.128	C
SAMPLE 16	0.089	0.094	C
SAMPLE 17	0.093	0.103	C
SAMPLE 18	0.094	0.105	C
SAMPLE 19	0.097	0.11	C
SAMPLE 20	0.096	0.114	C
SAMPLE 21	0.096	0.119	C
SAMPLE 22	0.092	0.097	C
SAMPLE 23	0.089	0.092	C
SAMPLE 24	0.1	0.113	C
SAMPLE 25	0.101	0.122	C
SAMPLE 26	0.093	0.106	C
SAMPLE 27	0.095	0.117	C
SAMPLE 28	0.093	0.102	C
SAMPLE 29	0.094	0.102	C
SAMPLE 30	0.091	0.104	C
SAMPLE 31	0.092	0.1	C
SAMPLE 32	0.097	0.132	C
SAMPLE 33	0.095	0.103	C
SAMPLE 34	0.097	0.122	C
SAMPLE 35	0.092	0.099	C
DISEASE	1.199	3.102	I
HEALTHY	0.088	0.213	C
HEALTHY	0.09	0.215	C
BUFFER	0.094	0.2	C

C = Clean **I** = Infected

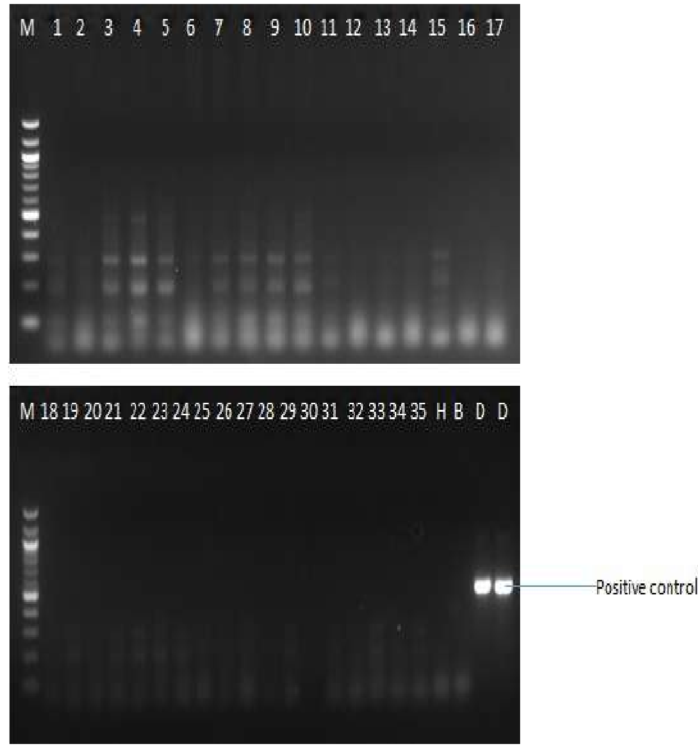

Plate 1: RT-PCR agarose gel. Well M, H, B, D contain 100-1000 base pair ladder, healthy control and disease control samples respectively. Well 1-35 contain tested samples. All tested samples presented no amplicons while both disease samples revealed the expected 500 base pair CMV amplicons.

Table 3: RT-PCR Diagnosis result table

Sample ID	RESULTS
1	-
2	-
3	-
4	-
5	-
6	-
7	-
8	-
9	-
10	-
11	-
12	-
13	-
14	-
15	-
16	-
17	-
18	-
19	-
20	-
21	-
22	-
23	-
24	-
25	-
26	-
27	-
28	-
29	-
30	-
31	-
32	-
33	-
34	-
35	-
Healthy	-
Buffer	-
Disease	+++
Disease	+++

- sign indicate CMV negative samples while +++ **sign** indicate CMV positive samples

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SOCIO-ECONOMIC CHARACTERISTICS OF TURMERIC (*Curcuma Longa* L.) FARMERS IN OTUKPA, OGBADIGBO LOCAL GOVERNMENT AREA, BENUE STATE

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ABSTRACT
The study was conducted to determine the socio-economic characteristics of turmeric farmers in Otukpa, Ogbadibo LGA of Benue State. Purposive sampling was used to collect data from forty-one (41) farmers across Otukpa and analyzed using descriptive statistics such as frequency and percentages. Results obtained indicated that 40.8% of the farmers are female and 59.20% are male. The mean age of the farmers was 45.5 years and 71.23% of the farmers are in their active ages (36 – 55). 58.5% of the farmers are married, 36.6% of the farmers are illiterate, 85.37% had farm size of >1 ha and the farmers earned an average annual income of ₦6,403.28. The constraints identified are inadequate finance (97.6%), lack of technical skill (95.1%), lack of improved varieties (95.1%), pest and disease (92.7%), bad road network (85.4%), high cost of transportation (73.2%). The study recommended that enlightenment programs be used to encourage more farmers to engage in the production of turmeric due to its numerous health benefits, the economic benefit derivable from its production and also the should mobilize themselves into viable cooperatives so that they can gain from the use of pooled resources and finances in cooperatives. This will go a long way in ensuring food security, increasing the earnings and improving the livelihood of the smallholder farmers.
***Keywords**: Socio-economic, Turmeric (Curcuma Longa L.), descriptive statistics, percentages*

INTRODUCTION

Turmeric (Curcuma longa L.) is a monocotyledonous, herbaceous, rhizomatous spice belonging to the ginger family Zingiberaceae. The genus name curcuma is probably derived from the Persian word 'kurkum' a name also applied to saffron. Turmeric is called as 'Yellow gold', 'Indian saffron', and 'The golden spice of life'. It is considered the “Queen of Spices” and one of the top most used spices in the world. It has diversified uses such as turmeric powder, dried rhizomes and as curry flavor preparation for meat, fish, vegetables, pulses etc. Besides, it is used in medicine and cosmetics and as dye in textile industries. In addition to its role in the colourants of curries, these compounds have been reported to have anti-inflammatory Lukita-Atmadja et al., (2002), anti-arthritic, anti-oxidant, anti-allergic, anti-bacterial (Chattopadhyay et al., 2004; Fagbemi et al., 2009), anti-cancer (Duvoix et al., 2005), and anti-viral (HIV) properties (Ammon and Wahl, 1991).
Literature revealed that India is the world’s largest producer of turmeric supplying 94% of the world’s demand and spread from India to Southeast Asia, China, Northern Australia, the West Indies, and South and Central America (Nwaekpe, *et al.,* 2015 and Gopalan , *et al.,*2000).
Nigeria can play a leading role in turmeric production considering the prevailing favorable soil and climatic conditions in the country. With increased awareness on the benefits of turmeric among the users and its use in a number of processed products, the demand for turmeric is increasing. Turmeric is a good cash crop for Nigerian and other African countries as its production requires low technology, less capital investment, and it can be grown with comparatively less use of fertilizer.
However, it is worthy of note that demands for agricultural produce (Tumeric inclusive) had for a long time out-strip supply especially in developing countries like Nigeria. Similarly, Tomato yields in smallholder cropping systems in Africa have generally been found to be far below potential (Maliwichi et

al., 2014). Hence, it may be said that domestic production of tumeric does not meet its high demand especially in developing countries probably because tumeric is not sustainably produced due to certain constraints. To ensure that smallholder farmers are consistent in their production, several issues need to be analysed and addressed. Action must therefore be taken to help small scale farmers in identifying and overcoming constraints that reduce the production of tumeric. It is therefore imperative to determine the socio-economic characteristics of turmeric farmers in the study area and also the constraints facing the farmers.

MATERIALS AND METHODS

The study was carried out in Otukpa, Ogbadibo LGA, of Benue state, Nigeria. Benue State is delineated into three agricultural zones, namely; Northern zone (A), Eastern zone (B) and Central zone (C). The state comprises (23) local government areas with Makurdi as the state capital. It is located between longitude 7° 47' and 10° 0' East and latitude 6° 25' and 8° 8' North. It shares boundaries with five other states namely; Nasarawa state to the north, Taraba state to the east, Cross-River state to the south, Enugu state to the south-west and Kogi state to the west. The state also shares a common boundary with the Republic of Cameroon on the south-east. Benue state occupies a landmass of 34,059 square kilometers. Benue State has an estimated population of 5,741,815 million persons (NBS, 2006).

The state enjoys a tropical climate which manifests into two distinct seasons. The rainy season is from April to October with total annual amount ranging between 1120 – 1500mm, while the dry season is from November to March. Temperatures are constantly high averaging between 28^{o} – 32^{o}c. Physiographically, the land is level and made up mainly of undulating plains at elevations ranging from 150m to 300m above sea level. The major crops grown here include, rice, yam, cassava, groundnut, millet, soybeans, maize, citrus, mango, sorghum, sweet potatoes, cocoyam, guava, oil palm, tomatoes, cowpea, cashew and okra. Small ruminants such as goat, sheep, and non-ruminants such as swine, rabbits and poultry are also reared in the state. Purposive sampling technique was adopted in selecting the farmers in the various districts in Otukpa. A total of forty-one (41) farmers were selected and data was collected through a structured interview guide which cover all aspect of the objective was used to elicit information from the farmers in the study area. Descriptive statistics such as frequency and percentage was used for data analysis.

RESULTS AND DISCUSSION

The Socio-economic characteristics of turmeric farmers such as gender, age, education, family size, occupation level, land holding and average on-farm income are presented in (Table 1). The result shows that 40.8% of the farmers are female and 59.20% are male indicating that there more female farmers engaged in the production of turmeric. The mean age of the farmers was 45.5 years. 71.23% of the farmers are in their active ages (36 – 55). This implies that most of the farmers in the study areas are in their active and productive age. Also, 58.5% of the farmers were married, 29.3% were single and 12.2% were separated / divorced. The predominance of married persons implies that these are responsible individuals who are ready to improve their livelihood and that of their families, since; marriage is often associated with occupational stability and responsibility Olojede, *et al*., (2011)**.**

A greater percentage of the farmers are illiterate 36.6%, followed by Diploma holders (22.0%) and primary education holders (17.1%). This implies that more respondents were illiterate with low possibility to utilize information on agriculture for enhanced food production. Kadte *et al*., (2018) also observed low level of education among turmeric growers in his study. A greater percentage (85.37%) had farm size of >1 ha, which implies that the respondents are small scale farmers. Commercialization of the sector is still an issue in Nigeria. Thus, farmers who have the monetary resources and ability to increase their farm size have the tendency to increase their farm outputs. The constraints to turmeric production are numerous and are shown in Table 2, it reveals that the major constraint as shown in the table 2 are inadequate finance (97.6%), lack of technical skill (95.1%), lack of improved varieties (95.1%), pest and disease (92.7%),bad road network (85.4%), high cost of transportation (73.2%).

CONCLUSION

Tumeric production is dominated by 30.8% of the farmers are female and 44.2% are male. The mean age of the farmers was 45.5 years and 77.23% of the farmers are in their active ages (36 – 55). 58% of the farmers are married, 35.50% of the farmers are illiterate, 82.0% had farm size of 1-2 ha and 75.0% of the farmers earned an average annual income of ₦6,403.28. The constraints witness by the farmers are inadequate finance (97.6%), lack of technical skill (95.1%), lack of improved varieties (95.1%) pest and disease (92.7%), bad road network (85.4%), high cost of transportation (73.2%). The study recommended that enlightenment programs be used to encourage more farmers to engage in the production of turmeric due to its numerous health benefits and also the economic benefit derivable from its production and also the should mobilize themselves into viable cooperatives so that they can gain from the use of pooled resources and finances in cooperatives. Turmeric is profitable to the growers especially when grown in a large scale with improved varieties. This will go a long way in ensuring food security, increasing the earnings and improving the livelihood of the smallholder farmers.

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Table 1. Socio-economic farmers in Otukpa

S/N	Framers categories	Frequency	Percentage means (%)
1	**Gender**		
2	Female	17	40.83
3	Male	24	59.20
4	**Age**		
5	18-35	8	19.51
6	36 – 55	29	71.23
7	56 – 75	4	9.76
8	**Marital Status**		
9	Single	12	30.20
10	Married	24	58.00
11	Separated	5	11.80
12	**Education level**		
13	Illiterate	35.5	
14	Primary education	17.1	
15	Secondary education	13.8	
16	Diploma	22.6	
17	HND/BSc	9.0	
20	**Farm Size (1-2ha)**	85.03	
21	**Occupation level**		
22	Agriculture only	82.80	
23	Agriculture and Business	17.10	
24	**Average income on-farm**	6,403.28	

Source: Field survey, 2021.

Table 2: Factors Constrainting turmeric production

Factors	Frequency	Percentages (%)
Inadequate finance	40	97.6
Lack of technical Skill	39	95.1
Lack of improved varieties	39	95.1
Pest and disease	38	92.7
Bad road netwok	35	85.4
High cost of transportation	30	73.2

Multiple answers, 2021

PROPER RECORD KEEPING FOR ENHANCEMENT OF INFORMATION LITERACY IN NIGERIAN HORTICULTURE

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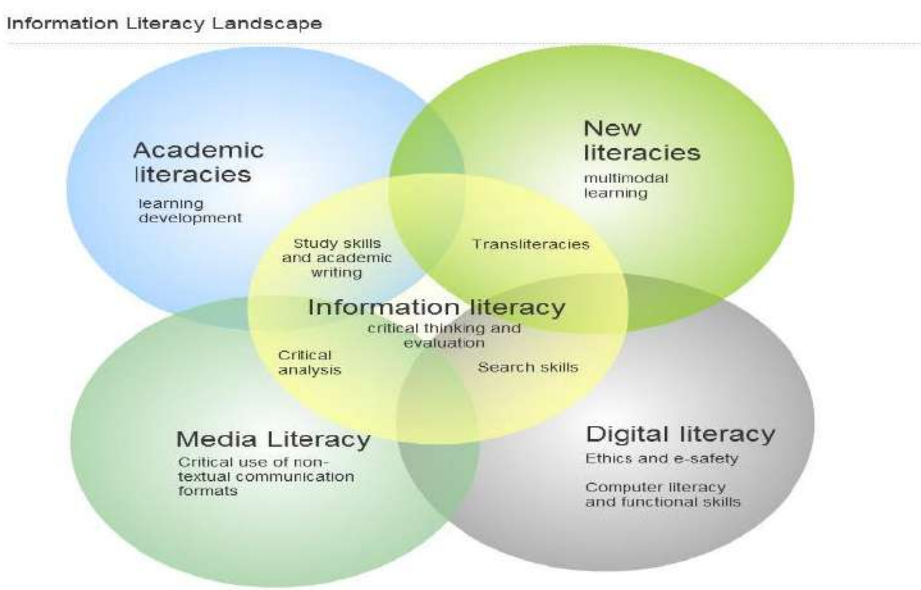
ABSTRACT
Horticulture plays an important role in every area of human endeavor. Availability of information from research output contributes to increase in production and utilization of horticultural crops. Information literacy remains an issue to be given proper attention as low information literacy among farmers and other stakeholders can affect productivity due to low utilization of information. Proper record keeping of research output and information is vital in ensuring that farmers, policy makers and other stakeholders are abreast of latest technologies and breakthrough in horticultural crops production. On the other hand, there is need to increase visibility of research information from research institutes, Universities and private sectors in the areas of horticultural crops research. This will enhance visibility and information literacy among farmers, policy makers and other actors along the value chain.
Keywords: *Horticulture, information literacy, record keeping*

INTRODUCTION

Horticultural information availability and accessibility are important in ensuring food security and safety in Nigeria. Information is product of research and other human activities. Uptake of research information contributes significantly to food production, security, economic empowerment and improved livelihood. Information literacy is important in utilization horticultural information. Information literacy involves abilities to recognize, locate, evaluate and effective use of available information to meet various needs. Other requirement for information literacy include awareness and engagement with the digital world, usefulness of acquired information, articulation of acquired information, information use ethics, how to communicate info ration to other users and how to evaluate information for credibility and authority. (ALA, 2016) Information literacy is enhanced by knowledge acquisition. Sources of information and its landscape as shown in figure 1 play vital roles in information availability and utilization.



Source: Coonan and Jane (2014)

In enhancing information literacy, the role of record keeping cannot be over emphasized. Credibility of records goes a long way in supporting its relevance and trust by information users. The need for accurate records keeping and how records that are vital are managed in organization like research institute should be given adequate attention. Records keeping involve supervision and administration of digital or paper records to ensure availability and easy retrieval when needed (Kirvan, 2023). Records are materials which contain information which are created, executed or received, and further maintained as evidence and information by an organizations or persons. It can be used in pursuance of legal obligations or in the transaction of business. Horticultural research outputs can be termed as records covering agronomy, crop protection and utilization of products. Such records serve as basic tools for planning; monitoring and decision making that bring out efficiency and effectiveness in farmers, institutions and cooperate farming organizations. Horticultural Farming operations and decisions can be based on the available information carried out, processed, stored and retrieved when needed for daily decision making in research environment. Research institutions create records to support and provide evidence of their transaction in various formats either through paper based or electronic format.

Management and keeping of records in research institutions includes utilizations of information stored as records which serve as important resources to record keeping. Records management helps an organization get the costs and risks that can come with poorly managed records. This can improve crop yield and farmers productivity as they are abreast of latest information and technological breakthroughs n the areas of horticultural crops production. Proper record keeping has positive effect on workers' productivity and promotes proper agribusiness management Gomathy *et al*.,2022; Manteaw *et al.,* 2021). Therefore, research institutions must keep and manage vital records well; so that they can be used for day-to-day running of farming activities. Due to the importance of records in farming operations, there is need for proper management as tools for literacy among seekers of information in horticulture.

Research institutes must establish and cautiously manage and keep vital records by some levels of confidentiality, proper maintenance, security and preservation of such documents must be well managed for retrieval (Uwaifo, 2004., Akporhonor *et al.,* 2004). Retrieval of available information can be of great benefit to horticultural crop farmers. According to Igwokwe *et al.,* 2012, reading is an essential tool for lifelong learning and improvement. However, paper-based documentation in organizations such as Research institutes, polytechnics, colleges of educations and universities' hardcopies continue to be viewed as a factor affecting information availability, utilization and information literacy levels among users.

PROBLEMS OF RECORD KEEPING IN NIGERIA

According to (Afolabi 1999) record management practice in Nigeria has a number of problems. These include insufficient skilled and experienced record management personnel and possibly, low priority of record management in the scheme of things. Trained and qualified records managers should be in charge and handle records properly so as to end the loss and misplacement of vital records are not absorbed into the system. Lots of problems encountered in records keeping in research institutions which are mentioned above and others are lack of record manuals, and filling guidelines, difficulty in retrieval and lack of appreciation to staff and the management.

IMPROVING VISIBILITY TO ENHANCE HORTICULTURAL INFORMATION LITERACY

Research institute should see electronic records as means of organizing and keeping vital records. Staff should be adequately trained in the area of records and archival management. Records management policy should be set in place in all research institution so as to eradicate inefficiency of records keeping management. High premium should be placed on records that have enduring and evidential value. Poor management of records causes loss of correspondences and other useful information. Misplacement of vital documents useful for populating institutes data base and which are beneficial to farmers affects literacy level of horticultural information seekers. In a research carried out in NIHORT, over 60% of respondents were of the opinion that there is need to computerize the institute library as a means to enhance visibility and horticultural information literacy among stakeholders while >80% were not sure of the availability of useful horticultural materials in the library (Table 2) This may have affected the frequency of visit to the library as most library users visit the library Cooneman and Jane (2014), identified digital literacy as one of the factors affecting information literacy.

Table 1: Frequency and percentage views of respondents on effect of computerization on information literacy

Item	SD	D	NS	A	SA	U
Computerization of information will increase reliability	4 (3.3)	-	-	30 (25)	78 (65)	4.3
Awareness of valuable horticultural information in research library	2 (1.7)	1 (0.8)	100 (83.3)	-	17 (14.2)	3.2

Source: Field survey, 2017

Note SD: strongly disagree; D = Disagree; NS = not sure; A = Agree; SA= Strongly agree and U=undecided.

CONCLUSION

Due to the importance of information and its utilization for human development, there is need for proper horticultural crops record keeping as it is necessary in improving farmers efficiency in order to increase food security and environmental conservation.

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AGRO-MORPHOLOGICAL VARIATIONS, EARLINESS AND FRUIT YIELD OF SELECTED TOMATO ACCESSIONS EVALUATED IN IBADAN, SOUTHWESTERN NIGERIA

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ABSTRACT

Agro-morphological variations, earliness and fruit yield were evaluated in 20 tomato accessions at the National Horticultural Research Institute (NIHORT), Ibadan, Nigeria. Eleven elite tomato accessions (obtained from the World Vegetable Centre) and nine accessions (obtained from NIHORT) were evaluated. The study was conducted in a randomized complete block design with three replications. The tomato lines were transplanted to the field at 50cm x 50cm spacing. Plot size for each cultivar was 2m x 2.5m. The descriptors for tomato (IPGRI, 1996) was used to characterize the accessions. Data were collected on days to 50% flowering and fruiting, fruit set (%), and fruit yield. The result indicated high agro-morphological diversity among the cultivars. Three plant growth types were observed among the tomato accessions. Semi-determinate dominated with 60.87 % while determinate and indeterminate growth types were 17.39 % and 21.74 % respectively. Foliage density ranged from sparse to dense with most of the cultivars exhibiting intermediate foliage density (65.22 %). Fruit blossom end were flat (81%), indented (13.64%) and pointed (4.55%). Days to 50% flowering ranged between 27 in Ibadan Local to 40 in AVTO 0301while 50% fruiting ranged from 34 days in Ibadan Local to 45 days in AVTO 1219. Number of fruits and fruit weight per plant was significantly highest in Cherry 19 (261 fruits) and Ker-Ojik 22 (141 t/ha) respectively. The variations exhibited by these tomato accessions can be harnessed for selection and hybridization in tomato breeding programs.

Keywords: *Agro-morphology, diversity, growth types, fruit yield, Tomato*

INTRODUCTION

Tomato is an important component of the daily diet in Nigeria which is either consumed fresh or in processed form as tomato paste. The demand for tomato in Nigeria is very high and supply is hardly adequate due to low yield caused by inadequate improved cultivars, poor production and management system, pests and diseases among others. The huge demand for tomato is a pointer to the need for breeding programs in order to enhance production efficiency, yield and quality of tomato fruits (Ibitoye *et al.,* 2020). Therefore, the evaluation of tomato germplasm is of great importance for crop agronomic and genetic enhancement in the current and future time (Ramzan *et al.,* 2014). Diversity in plant genetic resources (PGR) provides opportunity for plant breeders to develop new and improved cultivars with desirable characteristics (Govindaraj *et al.,* 2015). Marefatzadeh-Khameneh *et al*, (2021) studied genetic variability in 589 tomato accessions and advocated that germplasm could be used to develop improved genotypes. The lack of genetic variability and unavailability of high-yielding cultivars has been reported to be among the main reasons for low seed production; hence, it is imperative to increase genetic variability to develop high-yielding tomato cultivars by evaluating available germplasm (Brake *et al.,* 2021; Kulus, 2022).

Morphological description and classification is a traditional approach used to quantify genetic differences, and is often used for genetic diversity analysis (Khadivi-Khub *et al.,* 2008; Terzopoulos and Bebeli, 2008; Nikoumanesh *et al.,* 2011). Musa *et al,* (2023) concluded in their study that the application of morphological techniques could be considered to provide suitable parameters for studying the evolution of the genetic divergence among tomato lines. Reports from authors above clearly indicate that genetic diversity is necessary to develop high-yielding genotypes. Also, the evaluation of improved cultivars or breeding lines along side with local materials may enhance selection and hybridization for improved yield and quality as required by Nigerian tomato farmers. Beside breeding, tomato yield can also be enhanced by adopting improved management techniques and good agronomic practices if researchers/farmers understand the agro-morphological traits of available cultivars. The objectives of this study was to evaluate agro-morphological variations among elite and local tomato cultivars for further breeding and use by farmers.

MATERIALS AND METHODS

The study was carried out at the vegetable research field of the National Horticultural Research Institute (NIHORT), Ibadan, Oyo state, Southwestern Nigeria. Twenty tomato accessions comprising of eleven elite lines (obtained from the World Vegetable Centre, Taiwan), three improved commercial varieties (Roma VF, UC 82B and Early spring) and six breeding and local lines (obtained from the Seed Technology Unit, NIHORT) were used for the study. The seeds were raised in the nursery for three weeks and thereafter transplanted to the field at a spacing of 50cm x 50cm. Plot size for each accession was 2m x 2.5m translating to 30 plants per plot. The study was conducted in randomized complete block design with three replications. Hoe weeding, fertilizer application and other necessary crop management and field maintenance were carried out as at when required. In order determine the level of variations among the tomato cultivars, plant characterization based on descriptors for tomato (IPGRI, 1996) was used. Data were also collected on days to 50% flowering and fruiting, fruit set (%) and fruit yield. Quantitative data collected were subjected to analysis of variance and significant means were separated using least significant difference at 5% level of probability.

RESULTS

The result of the plant characterization (Table 1.) based on descriptors for tomato (IPGRI, 1996) revealed high variations based on physico-morphological characters. Three plant growth types were observed among the 20 genotypes of tomato. Semi-determinate/determinate growth type dominated the tomato accessions (78.26 %) while other accessions had indeterminate growth types (21.74 %). Stem internode length ranged from sparse to long with highest number of accessions exhibiting long internode length (43.48 %). The foliage density ranged from sparse to dense with majority of the accessions exhibiting intermediate foliage density (65.22 %) while 8.70 % of the accessions displayed sparse density and others (26.09 %).

A close look at the accessions showed that, 16 exhibited many numbers of leaves under first inflorescence while 3 exhibited few number of leaves. The leaf attitude ranged from semi-erect to drooping with majority of the accessions (39.13 %) displaying drooping leaf attitude. Standard leaf type dominated the accessions with 82.61 % while 17.39 % of the accessions exhibited other leaf types. However, none of the accessions exhibited dwarf and potato leaf type. Style position ranged from inserted to highly exerted (Table 1). The blossom end fruit shape for 81.82% of the accessions is flat, 13.64 % is indented and for 4.55 % is pointed while the blossom end scar 77.27 % of the accessions is closed as the remaining 22.77 % is open.

In table 2, days to 50% flowering ranged between 26 (in Ibadan L17) and 40 (in AVTO 1219). Ibadan L17 was also observed to have reached 50% fruiting earliest with 34 days. There were six other accessions with early fruiting (cherry 19, AVTO 1920, Alausa 20, AVTO 1429, AVTO 1906 and Ker-Ojik). The accessions with late flowering and fruiting were five. The result further revealed that five accessions had more than 70% fruit set (Ker-Ojik 22, Alausa 20, Cherry 19, Kercash 23 and K/Wali). Intermediate fruit set was observed in 10 accessions while two accessions had slightly less than 50% (Ibadan L17 and AVTO 1219) fruit set. The remaining three accessions had between 50 and 59% fruit set (Table 2). A cursory look at table 3 revealed that number of fruits ranged significantly from 261 in Cherry

19 to 14 in AVTO 1424. Number of fruit was also found to be high in Ker-ojik 22 with 147 fruits. With regards to fruit yield per plant, fruit weight per plot and total marketable weight (t/ha), the highest number of fruit recorded in Cherry 19 did not ultimately translate to highest fruit yield per plant, fruit weight per plot and total marketable weight (t/ha), as Ker-ojik gave the highest with 3.54 kg, 73.8kg and 141.7 tons respectively. Other accessions with high fruit yield per plant, fruit weight per plot and total marketable weight (t/ha) were Ibadan L17 and Kercash 23. Cherry 19, Alausa 20, AVTO 1429, AVTO 1920 were in the third categories in terms of yield. Accessions with low fruit yield per plant, fruit weight per plot and total marketable weight (t/ha) were UC 82B, Roma VF, AVTO 1909. The data on non- marketable yield revealed that three accessions (Early spr 18, Ibadan L17, K/Wali) top the list with more than 4/tha. There were seven accessions with very low non-marketable fruits of 1.0 - 1.5 tons/ha. The results also showed that Ibadan L17 though with high yield also had high very high non-marketable yield (4.38 t/ha).

DISCUSSION

Morphological parameters, molecular techniques, and genotype origins are essential tools that can be used to improve cultivars (Luo *et al.,* 2010). The results from this study has shown some distinct traits and similarities among the tomato accessions evaluated and their performance in Ibadan which falls in the derived savanna agro-ecological zone. In terms of earliness, Ibadan L17, Cherry 19, Alausa 20, AVTO 1920 AVTO 1429, AVTO 1906 and Ker-Ojik were identified while Ker-ojik, Ibadan L17 and Kercash exhibited high yield potential. Gumasta *et al,* (2023) evaluated 17 tomato ecotypes and identified maximum morphological parameters for the tomato ecotype VNR(THT)9/2020 and further recommend it as suitable for cultivation in Bhopal region farming community (India). The high non marketable fruit in Ibadan L17 accession among others will require further improvement and major causes will further need to be evaluated. The low non-marketable fruits in AVTO 1706, AVTO 0301, AVTO 1219, AVTO 1906, AVTO 1907, Roma VF and Cherry 19 may be further evaluated for consideration in breeding and use. Further evaluation of these tomato accessions for pests and diseases will be required as this information can aid in making informed decisions regarding tomato selection, breeding including cultivation practices, and crop management strategies for sustainable production.

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Table 1: Variations in qualitative characters of the 20 accessions of tomato evaluated.

S/No	Plant characters	Frequency
1	Foliage	Sparse (8.70%), intermediate (65.22%), others (26.09%)
2	Leaf attitude	Semi erect, erect and drooping
3	Style position	Inserted and exerted
4	Leaf type	Standard (82.61%), others (17.39%)

Table 2: Sources, earliness and fruit set (%) in the selected tomato accessions.

S/No	Accession	Source	Days to 50% flowering	Days to 50% fruiting	Fruit set (%)
1	AVTO1706	World Veg	33.33	38.33	63.50
2	AVTO0301	World Veg	34.33	42.33	63.30
3	AVTO1219	World Veg	40.00	44.67	49.70
4	AVTO1429	World Veg	32.67	36.33	55.50
5	AVTO1424	World Veg	38.33	44.00	68.30
6	AVTO1906	World Veg	30.33	38.67	57.30
7	AVTO1907	World Veg	33.00	40.00	66.20

8	AVTO1915	World Veg	38.33	42.00	59.30
9	AVTO1909	World Veg	31.33	42.33	66.40
10	AVTO1920	World Veg	31.00	38.00	67.20
11	AVTO1914	World Veg	33.67	42.33	66.50
12	Kercash 23	NIHORT	33.00	40.00	87.70
13	UC 82B	NIHORT	33.00	42.33	66.50
14	Roma VF	NIHORT	38.33	41.00	61.00
15	K/ Wali	Farmers field	37.00	45.00	70.50
16	Ibadan L 17	NIHORT	26.67	34.33	48.90
17	Early Spr 18	NIHORT	36.00	40.33	61.50
18	Cherry 19	NIHORT	29.67	35.33	85.70
19	Alausa 20	NIHORT	28.00	35.33	93.70
20	Ker-Ojik 22	NIHORT	34.00	37.67	90.70
	LSD (5%)		4.43	4.07	22.52

Table 3: Fruit yield, marketable and non-marketable fruit weight in the selected tomato accessions evaluated

S/No	Accession	Number of fruits plant^{-1}	Fruit weight plant^{-1} (kg)	Fruit yield plot^{-1} (kg)	Mkt Fruit (t/ha)	Non-Mkt Fruit (t/ha)
1	AVTO1706	16	1.26	26.96	48.20	1.47
2	AVTO0301	18	1.18	21.74	48.70	1.49
3	AVTO1219	17	0.94	17.13	37.70	1.30
4	AVTO1429	18	2.04	41.11	81.70	3.02
5	AVTO1424	14	0.95	18.39	38.10	1.65
6	AVTO1906	18	1.25	21.64	50.00	1.10
7	AVTO1907	19	1.29	24.41	51.60	1.07
8	AVTO1915	21	0.97	18.93	37.40	3.80
9	AVTO1909	22	1.19	22.58	30.30	3.97
10	AVTO1920	18	2.19	41.96	87.60	3.53
11	AVTO1914	23	1.09	19.48	60.10	1.94
12	Kercash 23	55	2.77	57.54	113.3	3.08
13	UC 82B	27	0.78	15.17	31.20	2.25
14	Roma VF	22	0.75	12.84	19.10	1.48
15	K/ Wali	19	1.19	23.97	47.70	4.05
16	Ibadan L 17	21	2.95	56.64	117.9	4.38
17	Early Spr 18	29	1.01	20.24	37.30	4.84
18	Cherry 19	261	1.77	36.57	80.50	1.19
19	Alausa 20	59	1.95	38.63	78.10	3.27
20	Ker-Ojik 22	147	3.54	73.83	141.7	3.43
	LSD (5%)	15.9	0.55	10.66	21.20	2.48

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COMPARATIVE STUDY OF CASHEW JUICE EXTRACTION METHODS FOR EFFECTIVE PROCESSING AND UTILIZATION OF CASHEW APPLES

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ABSTRACT
Cashew apple utilization is very low considering its production capacity of Nigeria. Motorized juice extractor, manual mechanical juice extractor and hand-squeezed juice method were studied to compare their effects on selected performance parameters and quality parameters of cashew apple juice. Mechanical juice extractors showed low extraction efficiency and rate with high extraction losses. But mechanical manual extractor indicated similar quality values with manual-hand squeezed method. The motorized juice extractor requires improvement to produce juice that will meet quality standard. Further study to determine optimal performance conditions of the mechanical extractors may yield better results.
Keywords*: Cashew apple, Juice extractors, Performance parameters, Quality parameters*

INTRODUCTION

Many fruits provide helpful benefits because of their vitamins and mineral composition including detoxifying properties. Unfortunately, many people find ease access to these fruits difficult due to unavailability in readily forms. Cashew apple is nutritious and very rich in Vitamin C (270 – 300mg/100ml) which is reportedly to be 5 and 10 times that of oranges and pineapples respectively (Ugwu and Okonkwo, 2022).The juice is also possesses therapeutic properties in forms of minerals and antioxidants which are believed to be effective for treating some ailments, such as dysentery, stomach ulcers and gastritis (Diana et al 2021).The high juice content of about 85% of cashew apple (Ogunwolu, 2017 and Olalusi et al, 2020) and its by-products such as pulp which can be processed into other useful products makes it very suitable to proffer solution to active hunger.For instance, high fibre content of 15 - 18% of cashew apple (Dagadkhair *et al*. (2018) can be used as dietary fibre in foods or as base in animal feeds. Africa Cashew Alliance estimated that 18% of the population's Vitamin C requirement will be met by processing just 15% of cashew apple. Farmers' income would also increase averagely by 15.5%with about 0.9 billion US dollar increase in G.P.D of producing countries in Africa. Akinnibiosun and Oyetayo (2018) stated that World market for cashew will remain strong in the future due to the considerable potentials of high valued by-products. Ibirogba (2019) claimed cashew has higher production capacity and lower production cost than those of its competitors like cocoa which make it well suitable for economic recovery and industrialization. Utililzation of cashew apples is an additional income since it is an integral part of the fruit that produces the nut, which is a significant economic commodity, and does not require extra investment or labour input for production. Extraction of the juice through appropriate indigenous sustainable technologies will encourage storability and prolong the shelf life.

Nigeria is one of the world leading cashew producers, producing about 960,000 M.T. nuts per annum (Ibirogba, 2019). It was reported as second major crop after cocoa (Akinnibiosun and Oyetayo, 2018 and Ibirogba, 2019). Cashew apple is an integral part of the fruit which consists of the nut and the apple reported to be about 9 – 12 times the weight of the nut (Dimoso, 2020); every one tonne of cashew nut produces estimated 8 – 10 tonnes of cashew apples claimed Dagadkhair *et al*. (2018). The use of cashew apples and by-products is an opportunity to diversify farm activities and economy. Surprisingly, cashew apples are currently left to rot on the farms despite its enormous potentials and opportunities for commercial exploitation. Only 6 – 10% of the Nigeria's cashew apple production is utilized (Ugwu and Okonkwo, 2022 and Olalusi *et al*. 2020). According to Africa Cashew Alliance, cashew apple usage across all raw cashew nut (RCN) producing countries in Africa is insignificant as no country is processing greater than 1% of its total cashew apple production. The very small percentage utilized is mostly consumed raw by squeezing fresh through the mouth. The overall juice market in Sub-Saharan Africa was also growing at an average of 12-15% as further stated. Cashew apples are seasonal and highly perishable, due to high sugar content, resulting in low utilization. The astringency of the apples due to high content of tannins causing harsh taste has also been identified as a major factor for low consumption of the juice. This must be appropriately removed to a reasonable level through blanching/boiling before extraction (Bolarinwa et al. 2020). The most practicable way of prolonging the storage life of fruits is the extraction of the juice content according to Martins *et al*. (2018). They added that fruit juices can be stored for months or years depending on preservation and packaging methods. Development of juice extractors using local materials at minimal cost with required effectiveness and efficiency will improve availability of juices at affordable prices, increase their consumption and reduce postharvest losses Zhenchen *et al*. (2020) had studied the performance of some selected mechanical apple juicers and stated considerable differences in terms of extraction factors and juice quality. Information on such study for cashew apple juice extraction is very scarce. Nigeria produces enormous quantity of cashew apples, but very little portion of this production is consumed as raw apples. Proper extraction of juice from these apples through sustainable technologies resulting in quality and acceptable products will promote utilization of nutritious benefits of cashew apples, reduce apple losses and increase farmers' income. It is therefore worthwhile to investigate proper ways of extracting cashew apple juice which will promote consumption of its high Vitamin C and mineral contents, increase farmers' income and apple reduce losses.

Therefore, this study aimed to determine the suitability of mechanical method of extracting juice from cashew apples using machines of different operational principles with a view to encourage improved juice extraction and quality for better consumption and utilization of the juice.

MATERIALS AND METHOD

Materials used for this experiment were a motorized juice extractor, a manual mechanical extractor, muslin cloth, gas cooker, cooking pots, digital stop watch, digital weighing scales, plastic bottles, plastic bowls and fresh cashew apples.

Description of the mechanical juice extractors

The motorized juice extractor comprised of the extraction chamber made of a perforated cylindrical barrel, housing a worm shaft driven by a pulley and belt system. A conical piston is located at one end of a screw shaft which was supported by two ball-bearings. The barrel was lagged by a screen mesh with smaller holes than those of the barrel, meant for juice filtration. A trapezoidal hopper was located at one end on the top of the barrel while two outlets for discharging the juice and the pulp respectively were located below the discharge tray connected to the barrel. The manual juice extractor comprises of the extraction chamber made of a perforated cylindrical barrel, housing a screw conveyor driven by hand through a handle welded to the screw shaft. A conical piston was welded to one end of the screw shaft supported by a ball-bearing. A bevel gear attached to the conveyor shaft was driven by a bigger bevel gear attached to the end of the handle. A trapezoidal hopper was located at one end the barrel. The juice discharge tray positioned below the barrel had two different openings for discharging the juice and the pulp respectively. By comparison, the motorized extractor consisted of a warm shaft while the manual extractor was made of a screw conveyor. A screen was also present in the extraction chamber of the motorized extractor while it was not in the manual. A petrol engine is the power source of the motorized extractor while that of the manual type was by human effort aided by a gear system.

Preparation of Experimental Materials

Cashew apples used for this experiment were plucked directly from trees from the plantation of Cocoa Research Institute of Nigeria, Ibadan headquarters, located within Latitude 70^0 30'N and $30^0$54'E at an altitude of 200m above sea level. The apples were processed immediately as recommended by Ogunwolu(2017) that they should be juiced within 3 hours of harvesting. The apples were first sorted to select those that were of quality, their nuts were removed as they were washed. Blanching of the apples was carried out in boiling water for 10 minutes as reported by Bolarinwa *et al*. (2020).

Experimental Procedure

About 1.5 kg each cashew apple picked randomly from the blanched bulk was measured through the digital weighing scale (model ZE 11 and 1g sensitivity). Each of the apple samples was fed into each of the motorized juice extractor (MJE) and manual juice extractor (MME) respectively and replicated 3 times. Juice of 3 samples of the same weight as used for the mechanical extractors was squeezed by hand using muslin cloth (MHE). Quantity of the juice extracted juice left and extracted manually by hands (measured by weighing balance KERRO BL5002 of sensitivity 0.01) and the pulp were weighed and recorded. The time taken for extracting juice from each sample was measured using stopwatch (model Timeless, and accuracy 0.001secs). Pasteurization is an intrinsic part of fruit juice processing to ensure microbial safety and to inactivate enzymes such as polyphenol oxidase (PPO), and peroxidase (POD) that could lead to undesirable sensory and nutritive changes (Petruzzi et al., 2017) to ensure the juice is fit for consumption. Extracted juice samples were also pasteurized in plastic bottles before storage. Physical parameters, which include pH, specific gravity, degrees brix, colour and sedimentation test was checked on the extracted cashew juice after 24 hours of extraction. The hand expelled; fresh unpasteurized cashew juice was used as control. Also, heavy metals present were quantified in the cashew juice.

Performance Evaluation and Data analysis

The data obtained from the experiment was processed manually using scientific digital CASIO calculator and analyzed through SAS software (version 9.1)to determine the following parameters according to Adeleke *et al*. (2017) and Unuigbe *et al*. (2018):

Extraction efficiency, EF (%): $\frac{Je}{Je+Jhs} \; x \; 100$

1

Extraction losses, EL (%): $\frac{[(Fs-(Je+Rw)]}{Fs} \; x \; 100$

2

Extraction rate/capacity, ER(kg/hr): $\frac{Je}{T}$

3

Where:

Je – Juice extracted by machine, Jhs - Juice hand squeezed, Rw – Residue waste, Fs – Feed sample, T – Time taken for juice extraction

RESULTS AND DISCUSSION

Effects of extraction methods on machine extraction parameters

It was indicated that different methods of cashew apple juice extraction had effects on the extraction parameters (Table 1). The mean extraction efficiency of the manually operated extractor was lower but comparable to that of motorized type. Both mechanical extractors had very low efficiency compared to the hand squeezing method. This might be due to machine design, including the operating factors such as feed rate and machine speed. However, low extraction efficiency had been reported by Adeleke *et al*. (2017). Motorized extractor had the lowest extraction rate compared to considerably equal values for the other two methods. This might be caused by juice losses or poor extraction due to speed of the motorized extractor. Zhenchen *et al*. (2020) had reported low juice extraction rate of 29.4 – 47.0kg/hr for manual apple juicer while Martins *et al*. (2018) stated 38.9 kg/hr for a motorized citrus extractor. The extraction losses of motorized and manual extractors were much higher than the hand squeezed method. This could be due to poor extraction or machine leakages. This can have a negative implication on the purpose for designing the machine as it determines the economic value. High extraction losses of a motorized cashew apple extractor reported by Adeleke *et al*. (2017) were attributed to possible high speed and poor machine assembling. Optimizing the extractor performance operation of the two juice mechanical extractors may improve results.

Table 1: Effects extraction methods on juice extraction parameters

Methods/Treatments	Dependent Variable	Mean	Std Dev	Minimum	Maximum
MJE	EF	56.54	9.940092	48.4	67.62
	ER	19.92	1.920451	18.23	22.01
	EL	52.42	12.66768	41.32	66.22
MME	EF	54.546	9.647032	44.51	63.75
	ER	26.58	4.456422	22.46	31.31
	EL	42.51	2.560703	40.33	45.33
MHE	EF	100	0	100	100
	ER	25.05	0.74	24.31	25.79
	EL	8.94	0.625806	8.33	9.58

MHE- Manual-hand expelled, MME- Manual mechanical extractor, MJE- Motorized juice extractor

Table 2 indicated that the efficiency of both mechanical extractors, which were not significantly different, was different from that of the hand squeezing. Both the extraction rate and extraction losses were not different significantly for the three juice extraction methods investigated.

Table 2: Comparison of significance of the extraction methods

Methods/Treatments	EF	ER	EL
MJE	56.543b	19.923a	52.420a
MME	54.547b	26.580a	42.510a
MHE	100.000a	25.050a	8.937a

*Means with the same letter along the column are not significantly different at 0.05 sig. level

Effects of extraction methods on juice quality parameters

The pH of cashew juice obtained from manual hand expelled (MHE), manual mechanical extractor (MME) and motorized juice extractor (MJE) methods were 3.8 and 3.9(Table 3). The control, unpasteurized hand expelled juice, had a pH value of 3.7 bearing close similarity with others. From these results, all the cashew juice obtained were acidic, and falls within the allowed limits by the Standard Organization of Nigeria, that is; 1.4-4.0 (SON, 1997). It was therefore evident that material makeup of the equipment does not significantly alter the acidity of the juice. The specific gravity of all the juices ranged between 1.046 - 1.062, although observed specific gravity for fresh unpasteurized sample was lower, an indication that less solute were extracted. Specific gravity as observed with these different methods showed more pulps were dissolved into the body of the juice as noted with manual mechanical extractor and motorized juice extractor. Brix indicated that the dissolved solids that are being measured consist entirely of sucrose. The soluble sugars; as observed in fresh unpasteurized cashew juice, was 9.7 compared with those found in pasteurized samples. Increased brix level in cashew juices obtained from the MHE, MME and MJE, was a response to pasteurization activity involved. Total sugars (Brix), found in MHE and MME agreed with the Standard Organization of Nigeria's prescription except the sample obtained from MJE which exceeded stipulated limit (7-14%). Colour as measured by spectrophotometric method, with fresh unpasteurized cashew juice showed marked difference when compared with cashew juice expelled using the listed methods. Juice extracted by MJE showed lowest colour (absorbance-1.114) as a result of shorter extraction time. Heat treatment effect on the sugar content, caramelisation, imparts colour build-up on all the juice. The sediment content (measured by centrifugation method in gramme) in cashew juice extracted increased with extraction methods as fresh unpasteurized juice had least (1.02) sediment while it increased in MHE, MME and MJE (10.63- 13.48).

Table 3: Physical parameters of cashew juice extracted using different methods

Parameters	MHE	MME	MJE	Control
pH	3.8	3.9	3.9	3.7
SG	1.046	1.048	1.062	1.038
Brix (%)	11.3	12.1	15.3	9.7
Colour 380/420 (nm)	1.309	1.696	1.114	0.989
Sediment (g)	10.63	12.50	13.48	1.02

SG- specific gravity.

Table 4 showed the trace metal in the extracted cashew juice obtained from the different methods. Chromium, Cadmium and Lead were absent (nil) in the extract. Copper in cashew juice extracted using motorized juice extractor was higher (2.763 mg/l) than in manual-hand expelled sample and manual mechanical extractor. No significant difference in amount of copper in cashew juice obtained from both MHE and MME. Obtained results falls within the maximum allowable limit of 5 mg/l, specified by FAO/WHO (SON, 1997). Zinc, another metal of importance was present in the cashew juice extract. Cashew juice produced using manual hand expeller and manual mechanical extractor compares abundantly with permissible limit of SON. Therefore, it is considerably safe to employ these methods in cashew juice processing. On the other hand, excess zinc (13.04 mg/l) was quantified in cashew juice expelled using motorized juice extractor, MJE. The iron content (21.33 mg/l) in the cashew juice extracted with motorized juice extractor was beyond stipulated norm (15 mg/l). This was an indication of iron deposits from the material make up in the equipment. A likelihood of wear in component parts of the extractor was suspected. Iron contents of cashew juice obtained from manual-hand expeller (2.42 mg/l) and manual mechanical extractor (10.41 mg/l) were within limits. Arsenic was not determined.

Table 4: Trace metals in cashew juice extracted using different methods

Heavy metals (mg/l)	MHE	MME	MJE
Copper	0.397±0.08	0.423±0.03	2.763±0.10
Iron	2.420±0.11	10.410±0.18	21.330±0.22
Chromium	Nil	Nil	Nil
Cadmium	Nil	Nil	Nil
Zinc	1.249±0.07	1.703±0.15	13.035±0.21
Lead	Nil	Nil	Nil
Arsenic	ND	ND	ND

ND- Not determined.

CONCLUSION

Juice extracted by mechanical methods indicated low values for selected machine performance parameters. Manual-hand expeller and manual mechanical extractor produced better juice quality. The motorized juice extractor needs to be improved to meet required quality standard. Further study of the performance of the mechanical extractors that may give better results is recommended.

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IMMEDIATE AND RESIDUAL EFFECTS OF TITHONIA BIOCHAR (TITHOCHAR) PRETREATMENTS ON FRESH BIOMASS WEIGHT OF AMARANTHUS IN CHEMICAL FERTILIZER TREATED SANDY SOIL

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ABSTRACT
Optimal crop production in sandy soils is limited by their poor water and nutrient holding capacities. The immediate and residual effects of Tithonia diversifolia (TD) biochar types on soil properties and fresh biomass wight (FBW) of Amaranthus hybridus in chemical fertilizer treated soil under leaching condition was evaluated. The experiment was a factorial combination of three tithonia biochar types: sole TD tagged (B1), TD co-pyrolyzed with poultry manure (PM) (tagged B2) and TD co-pyrolyzed with PM and bone meal (tagged B3) and two chemical fertilizers: NPK 15:15:15 (tagged NPK) and urea. Checks that received neither biochar (tagged NB) and chemical fertilizer (NCF) were compared. Each biochar type was applied at 5 t/ha (equivalent to 0.75 g/300 g soil) and each chemical fertilizer applied at 120 kg N/ha (equivalent to 0.12 and 0.04 g NPK and urea per 300 g soil respectively). The treatments were arranged in completely randomized design with three replications. The test crop A. hybridus was nurtured for 4 weeks each in amended soil during two consecutive cropping. Results indicated that biochar pretreatment significantly increased FBW of A. hybridus with higher performance during the residual cropping with higher positive residual effects in chemical fertilizer soils pretreated with B1 and B3. The FBW increased by 276.4, 59.8, 130.2 and 199.1% in sole biochar, biochar pretreated NPK, biochar pretreated urea and sole chemical fertilizer soils respectively during the residual compared to immediate cropping. The study highlighted the importance of biochar characteristics and nutrient composition in influencing its effectiveness in enhancing soil chemical characteristics and crop yield.
Keywords*: Tithonia biochar, Residual cropping, NPK 15:15:15, Urea, Amaranthus hybridus, Calcareous soil, Sandy soil.*

INTRODUCTION
Chemical fertilizers are important recurring farm inputs for efficient crop production (Khan et al. 2022). They have contributed immensely to enhanced crop production in the world. Their continued use among farmers as major soil fertility management tool is linked to their fast nutrient dissolution potential in soil, ease of application, transportation and subside given on it by most African governments. Africa's chemical fertilizer usage is reported to be much lower than in other countries, with an average of less than 25 kg per hectare of farmland. This is significantly lower than countries like China, where usage is around 400 kg per hectare (FAO, 2019). The reality of increasing loss of fertile farmland in Africa especially from farms intensively managed by chemical fertilizers is not in tandem with the low fertilizer usage data in Africa. Poor documentation of farming activities and input usage by local farmers in Africa could be attributed to inability to properly ascertain current chemical fertilizer usage in most African countries.
Indiscriminate sole use of chemical fertilizers especially on light textured soils characterized by low water and nutrient holding capacities is without adverse environmental implications (Zhang et al., 2023; Li et

al., 2023; Fidel et al 2018). For example, manufacturing and field application of nitrogenous fertilizers such as urea, ammonium sulphate and NPK fertilizer variants have been implicated as major drivers for enhanced global greenhouse gas emissions, soil acidification, surface and underground water eutrophication and organic matter depletion in soils (Wu et al., 2023). The need therefore to develop resilient system in light textured soils yearly receiving increasing chemical fertilizer treatments is essential for future food and environmental security in Africa. One of the approaches that has been well reported is the use of biochar (Hou et al., 2023; Wu et al., 2023)

Biochar is a carbon-rich solid product from the thermal decomposition of biomass in the absence of oxygen. Its porous surface, large surface area and well distributed functional groups have made it an efficient soil amendment for improved water and nutrient holding in soil and as a mitigation tool for greenhouse gas emissions from soils (Zhang et al., 2023; Li et al., 2023). Research outputs on effects of co-application of biochar with chemical fertilizers is increasing annually but little of such have been documented for sandy soils in Africa. This work hypothesized that biochar pretreatment in chemical fertilizer treated soil would improve soil characteristics for eventual increased biomass yield of crop over two consecutive cropping. The work therefore assessed immediate and residual effects of one-time application of biochar produced from *Tithonia diversifolia* modified with or without poultry manure and bone meal on biomass yield of *Amaranthus hybridus* in sandy soil managed by common chemical fertilizers during two consecutive cropping.

MATERIALS AND METHODS

Soil sampling and routine analysis

The soil studied was from the fallowed section of the Greenhouse site of the department of Horticulture, Cape Peninsula University of Technology, Cape Town, South Africa (33°55'45.53" S, 18°38'31.16" E). The soil is formed under Mediterranean climate characterized by cold and wet winter and hot and dry summer. Top soil of 0-15 cm depth was sampled using hand trowel. The soil was air dried and sieved with 2 mm mesh sieve followed by laboratory routine analysis. The soil pH was extracted by 1.0 M KCl and distilled water in soil to extractant ratio of 1:2 read using pH meter earlier standardized in buffer 4, 7 and 9 solutions. The electrical conductivity of the soil extracted by distilled water above was read using an EC meter. Soil available phosphorus (P) was extracted by Olsen procedure using 0.5 M sodium bicarbonate solution. Exchangeable cations and soil cation exchange capacity (CEC) were extracted by 0.2 M ammonium acetate at pH 7. For the CEC determination, the soil was pre-leached with 0.2 M K_2SO_4 followed by total NH_4 extraction with 1 N KCl and colorimetric determination on the SEAL Auto Analyzer 3 with 15 mm flow cell and 520 nm filter. The particle size was by chemical dispersion of the soil in sodium hexametaphosphate followed by sedimentation at 20℃ using ASTM E100 (152H-TP) hydrometer. The total carbon (TC) was by combustion method in the TOC analyzer (elementar Model) at 950 ℃. Initial acidification of the soil sample with 10% HCl acid to liberate the carbonate components in the soil which represents the total inorganic carbon (TIC) in the soil was carried out. The combustion of the resultant oven dried acidified samples at 950 ℃ gave the total organic carbon (TOC). The difference between TC and TOC was thereafter taken as the total inorganic carbon (TIC) of the soil.

Biochar production and their nutrient composition determination.

The shoot biomass of *Tithonia diversifolia* (TD) was used as the basal feedstock for the production of the biochar studied. Sole TD biochar was by pyrolysis of 30 g of TD in the laboratory furnace at 400 ℃. Pyrolysis of 15 g of TD mixed with 15 g of air-dried poultry manure (PM) at 500 ℃ gave the TD+PM biochar while further spiking with 10 g each of TD, PM and bone meal at 400 ℃ all at 20 mins residence time gave the TD+PM+BM biochar. The C and N in the biochar was determined in the C and N elemental analyzer. The energy dispersive spectroscopy (EDX spectroscopy) was used for the determination of P, Ca, Mg and K in the biochar samples after been sputtered with gold. The ash content was estimated from combustion of biochar samples in the furnace at 550℃.

Treatments and experimental set up

The experiment was a factorial combination of three biochar types: sole TD (tagged B1), TD+PM (tagged B2) and TD+PM+BM (tagged B3) and two chemical fertilizer types: NPK 15:15:15 (tagged NPK) and urea. Each biochar was applied into 300 g soil in a leaching column at 5 t/ha (equivalent to 0.75 g/300 g soil). Each of the chemical fertilizer was applied at 120 kg N/ha (equivalent to 0.12 and 0.04 g NPK and urea per 300 g soil respectively. The treatments with no biochar (NB) and no chemical fertilizer (NCF) were included for comparison. This gave twelve treatments laid in completely randomized design with three replications.

During the immediate cropping, each biochar type was applied two weeks before the chemical fertilizer application for proper equilibration after been moistened to field capacity. Two weeks old *A. hybridus* vegetable seedlings of equal height were transplanted at one plant per column into each biochar amended soil with or without appropriate chemical fertilizers. The seedlings were thereafter nurtured for four weeks. All the aforementioned were repeated during the residual cropping without fresh application of each of the biochar types.

Data collection and analysis

The harvested vegetable from each column was weighed on the measuring scale after all the adhering soils unto the roots were washed under running water and wiped with soft towel. The soil sampled from each treated soil after harvesting during the residual trial was subjected to pH, electrical conductivity, TOC and TIC determination following procedures earlier described. The two-way analysis of variance was utilized for the statistical analysis of the data collected and means were separated by LSD at $p<0.05$. Simple linear regression was conducted to assess the contributions of selected soil parameters from the chemical fertilizer soil pretreated with biochar to fresh biomass yield of *A. hybridus*.

RESULTS

Characteristics of the soil studied

The soil is a light textured calcareous soil characterized by very high concentration of exchangeable Ca with alkaline pH of 8.01. The soil has moderate phosphorus, TOC and TIC contents. The soil was dominantly sandy (Table 1).

Nutrient characteristics of the biochar tested

The biochar made from sole *T. diversifolia* (sole TD) has the lowest ash content and highest total carbon and nitrogen contents resulting in biochar with highest C/N ratio. Fortification of *T. diversifolia* with poultry manure with or without bone meal as found with TD+PM and TD+PM+BM respectively, modified the nutrient composition of the resultant biochar types. These modified biochar types had higher ash contents, lower carbon and nitrogen contents to achieve lower C/N ratios compared to what was obtained from sole TD biochar.

Immediate and residual effects of tithonia biochar pretreatments on fresh biomass weight of *A. hybridus* in soil treated with common chemical fertilizers

Chemical fertilizer (CF) types significantly influenced fresh biomass weight (FBW) of *A. hybridus* during the immediate cropping. (Fig. 1). The NPK based treatments gave highest FBW. Biochar pretreatment prior chemical fertilizer application significantly improved FBW in both NPK and urea-based treatments relative to sole chemical fertilizer application. For instance, pretreating soil with B2 and B3 prior to NPK fertilizer application significantly increased FBW by 122 and 39.6% respectively compared to sole NPK application. All the three BC types significantly enhanced FBW in urea-based fertilizer treatments. Soil pretreatment with B1, B2 and B3 prior to urea application increased FBW by 48.9, 45.6 and 73.4 % respectively compared to sole urea treatment.

Table 1: Characteristics of the soil studied

Parameters	Values
pH (KCl)	8.01
pH (water)	7.95
EC (µS/cm)	26.6
Olsen P (mg/kg)	26.1
Total organic C (%)	5.02
Total inorganic C (%)	2.63
Exchangeable bases and CEC (cmol/kg)	
Ca	12.7
Mg	0.53
K	0.08
Na	0.07
CEC	2.79
Particle size distribution (%)	
Clay	4.00
Silt	4.00
Sand	92.00
Textural class	Fine sand

Table 2: Nutrient characteristics of the biochar tested

	Biochar Types		
Parameters	B1	B2	B3
C (%)	58.71	9.85	14.41
N (%)	1.07	0.41	0.84
P (%)	0.02	0.02	0.01
Ca (%)	0.16	0.20	0.17
Mg (%)	0.07	0.04	0.07
K (%)	0.45	0.57	0.28
Ash (%)	20.04	75.34	84.70
C/N	48.16	21.03	15.00

B1= biochar from sole *T. diversifolia* at 400°C, B2= biochar from *T. diversifolia* plus poultry manure at 500°C and B3= biochar from *T. diversifolia* plus poultry manure and bone meal at 400°C.

With reference to sole CF types, FBW produced was in the order of NPK > urea > NCF while the order B1 > B2 > B3 > NB was followed for FBW produced for sole biochar treatments during the immediate cropping. Biochar application prior to NPK and urea usage consistently increased FBW by mean values of 50.8 and 56.0% respectively compared to their individual sole chemical fertilizer application across all the biochar types. The NPK fertilizer was most responsive to B2 for increased FBW production while urea had superior response with B3. During the residual cropping, the biochar types, chemical fertilizer types and their interaction did not significantly affect the FBW of *A. hybridus*. Although, the FBW produced here were drastically higher than what were achieved from their corresponding treatments during the immediate cropping. Soil that received neither biochar nor chemical fertilizer was responsible for the least FBW produced which was similar to the observation from the immediate cropping. The NPK-based treatments consistently produced higher FBW. The potential of the biochar types to enhance FBW of *A. hybridus* seems to shift during the residual trial. Only B1 and B3 pretreatment improved FBW over sole chemical fertilizer application in NPK and urea -based treatments respectively.

During residual cropping, FBW in earlier sole B1, B2 and B3 treated soil increased by 285.4, 290 and 242.3% respectively compared to immediate cropping. The FBW of Amaranthus in NPK treated soil pretreated by B1 and B3 increased by 224 and 60.2% respectively while FBW in B2 pretreated soil reduced by 11.1% during the residual cropping. Sole NPK treated soil also increased FBW by 138.7% during the residual cropping compared to the immediate cropping.

Immediate and residual effects of tithonia biochar pretreatments on fresh biomass weight of *A. hybridus* in soil treated with common chemical fertilizers

Chemical fertilizer (CF) types significantly influenced fresh biomass weight (FBW) of *A. hybridus* during the immediate cropping. (Fig. 1). The NPK based treatments gave highest FBW. Biochar pretreatment prior chemical fertilizer application significantly improved FBW in both NPK and urea-based treatments relative to sole chemical fertilizer application. For instance, pretreating soil with B2 and B3 prior to NPK fertilizer application significantly increased FBW by 122 and 39.6% respectively compared to sole NPK application. All the three BC types significantly enhanced FBW in urea-based fertilizer treatments. Soil pretreatment with B1, B2 and B3 prior to urea application increased FBW by 48.9, 45.6 and 73.4 % respectively compared to sole urea treatment.

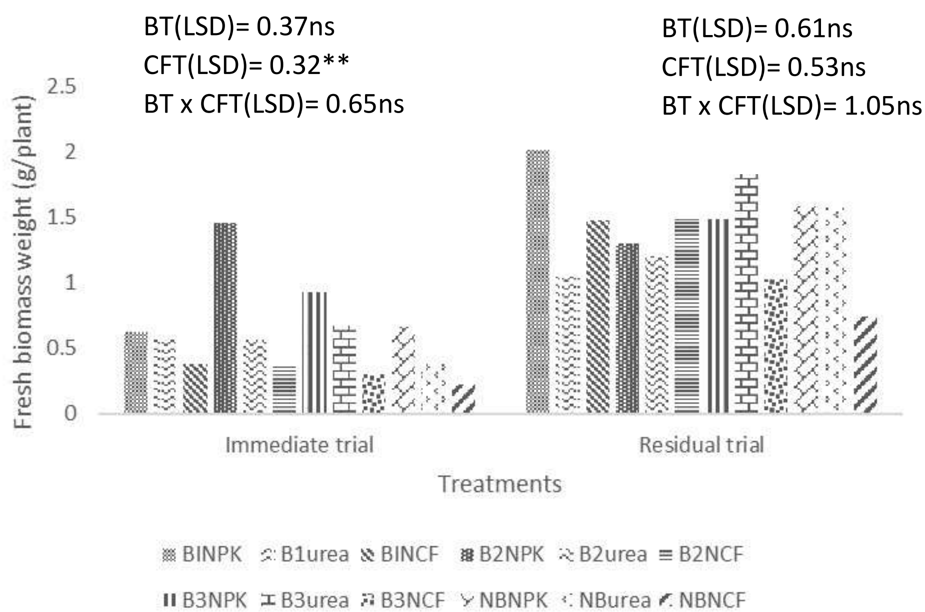

Fig. 1: Immediate and residual effects of tithonia biochar pretreatments on fresh biomass weight of *A. hybridus* in soil treated with NPK 15:15:15 and urea fertilizers.

BT= biochar types, CFT= chemical fertilizer types, B1= sole TD biochar, B2= TD+PM biochar, B3= TD+PM+BM biochar, NB= no biochar, NCF= no chemical fertilizer, NPK= NPK 15:15:15 fertilizer, ns= not significant, **=significant at p<0.01

Effects of biochar pretreatments on electrical conductivity (EC) and pH of soil treated with common chemical fertilizers after the residual cropping

Soil EC after residual cropping was significantly affected by biochar type, chemical fertilizer type and their interaction (Table 3). All the treatments significantly increased EC contents of the soil at the end of the trial. The final soil EC was in the order of NPK > urea > NCF and B3 > NB > B1 > B2 for the sole chemical fertilizer and biochar treatments respectively. Pretreating NPK treated soil with B2 and urea treated soil with B3 significantly increased soil EC above other biochar types. Consistent least EC values were recorded from urea -based treatments with values below what were observed from soil with neither chemical fertilizer nor biochar pretreatment and sole biochar treatments. (indicating least labile nutrient concentrations in the urea -based treatments at the end of the trial).

Soil pH at the end of the residual cropping was significantly affected by biochar and chemical fertilizer types (Table 3). The pH values were higher in sole biochar treated soils followed by urea and NPK based treatments (indicating increasing soil acidification potential of NPK > urea > sole BC treatments). The B1 was responsible for highest pH values in both the NPK and urea-based treatments representing 1.2 and 1.1

% increases compared to sole NPK and urea treated soils respectively. The NPK-based treatment consistently produced the least pH values across all treatment factors.

Table 3: Effects of biochar pretreatments on electrical conductivity (EC) and pH of soil treated with NPK 15:15:15 and urea fertilizers after the residual cropping

	Soil EC (µS/cm)				Soil pH			
	Chemical fertilizer types				Chemical fertilizer types			
Biochar types	NCF	NPK	Urea	Mean	NCF	NPK	Urea	Mean
B1	130.62	137.23	116.73	128.2	8.18	8.12	8.16	8.16
B2	125.52	156.23	111.61	131.12	8.12	8.04	8.08	8.08
B3	132.43	125.68	118.12	125.41	8.12	8.02	8.09	8.08
NB	131.33	153.14	113.13	132.53	8.07	8.02	8.07	8.05
Mean	129.98	143.07	114.9		8.12	8.05	8.10	
BT (LSD)	2.32***				0.025***			
CFT (LSD)	2.01***				0.022***			
BT x CF (LSD)	4.01***				0.044 ns			

BT= biochar types, CFT= chemical fertilizer types, B1= sole TD biochar, B2= TD+PM biochar, B3= TD+PM+BM biochar, NB= no biochar, NCF= no chemical fertilizer, NPK= NPK 15:15:15 fertilizer, ns= not significant, **=significant at p<0.01

The total inorganic carbon (TIC) and total organic carbon (TOC) were significantly affected by biochar type, chemical fertilizer type and their interaction (Table 4). The TIC and TOC values observed in all the treatments were below the initial 2.63 and 5.02% respectively prior to commencement of the work. The NCF treatments that received no chemical fertilizers were generally highest in TIC and TOC followed by urea and NPK based treatments (indicating intense TIC decomposition in the NPK fertilizers). Sole B3 and sole NPK treated soils had highest (2.85%) and lowest (1.93%) TIC contents respectively. Biochar pretreatment of urea treated soil with B1, B2 and B3 increased TIC by 23.3, 8.7 and 5% respectively while only B2 and B3 pretreatments increased TIC by 11.9 and 15 % respectively in NPK treated soil relative to their individual sole chemical fertilizers. The NCF treatments again produced higher TOC followed by NPK and urea-based treatments. The TOC content was interestingly highest (1.78%) in unamended soil which received neither biochar nor chemical fertilizer and least value (1.10%) from urea soil pretreated by B2. The B1 and B3 were responsible for higher TOC and TIC contents respectively in the soil studied.

Table 4: Effects of biochar pretreatments on total inorganic carbon (TIC) and total organic carbon (TOC) of soil treated with NPK 15:15:15 and urea fertilizers after the residual cropping

	TIC (%)				TOC (%)			
	Chemical fertilizer types				Chemical fertilizer types			
Biochar types	NCF	NPK	Urea	Mean	NCF	NPK	Urea	Mean
B1	2.13	1.69	2.70	2.17	1.65	1.20	1.32	1.39
B2	2.43	2.16	2.38	2.33	1.29	1.23	1.10	1.21
B3	2.85	2.22	2.30	2.46	1.37	1.25	1.18	1.27
NB	2.33	1.93	2.19	2.15	1.78	1.65	1.66	1.70
Mean	2.43	2.00	2.39		1.52	1.33	1.32	
BT (LSD)	0.002***				0.002***			
CF (LSD)	0.002***				0.002***			
BT x CF (LSD)	0.003***				0.004***			

BT= biochar types, CFT= chemical fertilizer types, B1= sole TD biochar, B2= TD+PM biochar, B3= TD+PM+BM biochar, NB= no biochar, NCF= no chemical fertilizer, NPK= NPK 15:15:15 fertilizer, ns= not significant, ***=significant at p<0.001

Contributions of selected soil parameters to fresh biomass weight or *A. hybridus* in chemical fertilizer treated soil pretreated with different tithonia biochar types.

The contributions of the soil parameters considered to the FBW of *A. hybridus* is in the order of TIC > EC > pH > TOC (Fig. 2). This represented about 55, 53, 24 and 0.7% variations accounted for changes in FBW of A. hybridus by TIC, EC, pH and TOC of the soil studied respectively. All the selected soil parameters except soil EC had negative relationship with FBW of the test crop. Although, all the contributions of the soil parameters considered to the FBW were not significantly influenced.

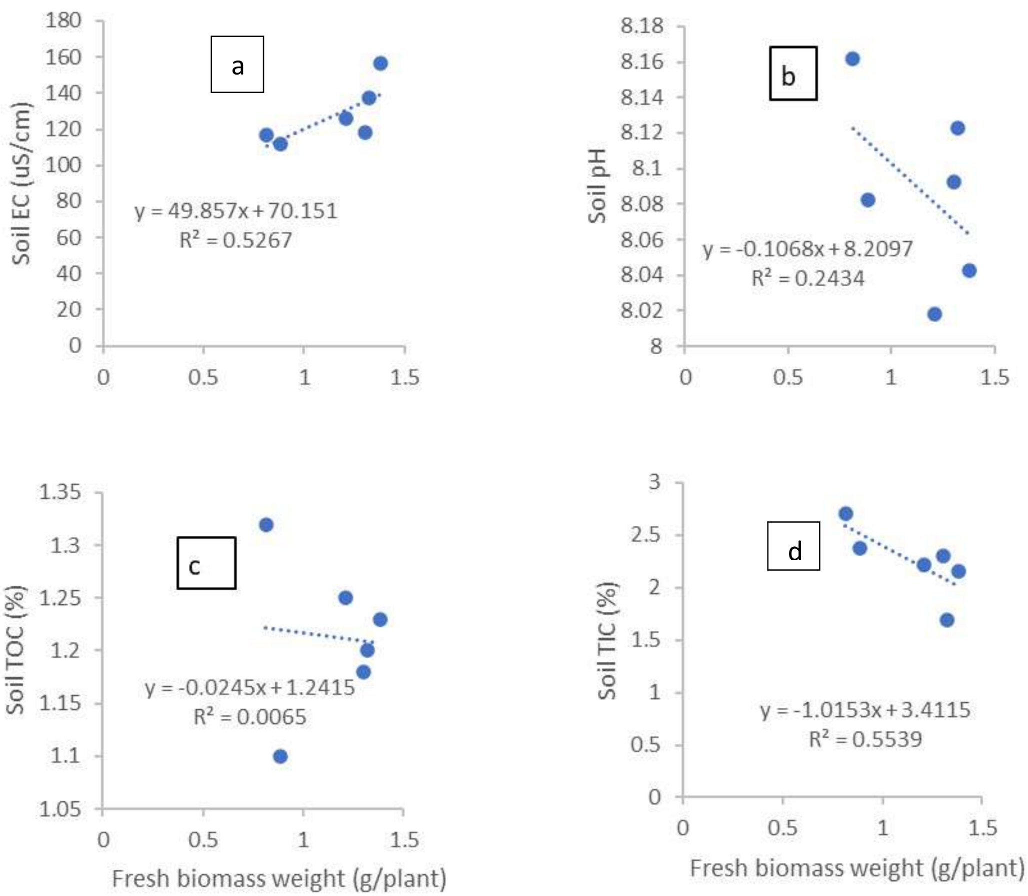

Fig. 2: Contributions of selected soil EC (a), pH (b), TOC (c) and TIC (d) to fresh biomass weight of *A. hybridus* in chemical fertilizer treated soil pretreated with different tithonia biochar types.

DISCUSSION

The sandy calcareous soils are widely spread in the arid and coastal regions of the world (Taalab et al., 2019; Aboukila et al., 2016). Their use for crop production is limited by their poor water and nutrient holding capacity (Alghamdi et al., 2023). This condition makes these soils susceptible to faster nutrient leaching especially under increasing rainfall influxes leading to reduced fertilizer use efficiency and environmental pollution (Khan et al., 2022). This present work hypothesized that the pretreatment of sandy soil before chemical fertilizer application with biochar produced from *T. diversifolia* and modified with or without poultry manure and bone meal, will improve soil characteristics and lead to increased fresh biomass yield for *A. hybridus* over two consecutive cropping seasons.

Biochar pretreatment significantly increased FBW of A. hybridus during both cropping trials. The work underscores the positive residual potentials of the biochar tested as indicated by their multiple fold increases in the FBW of A. hybridus during the residual cropping compared to the immediate cropping. Similar increased biomass yield of Amaranthus was reported by Islam et al., 2020; Punnoose and Anitha, 2017) following biochar application. The ability of B1 and B3 to support higher biomass yield during the immediate cropping compared to BI could be linked to their lower carbon contents and C/N ratios and higher ash contents. These characteristics supported increased nutrient mineralization rate compared to the sole TD biochar. The sole TD biochar (BI) however required longer period for its optimal nutrient dissolution as indicated by its higher proportionate contribution to biomass production of the test crop especially under the sole biochar and co-application with NPK. Nutrient composition including ash, carbon and macronutrient contents as well as C/N ratios are therefore important parameters to consider for biochar in biochar that will guarantee nutrient availability under immediate or residual application conditions. In this trial, B1 guaranteed higher positive residual effects on soil characteristics and eventual fresh yield of the test crop compared to B2 and B3. However, the higher ash composition of the B3 and B2 contributed to their potentials to enhance TIC over TOC. The BI on the other hand supported higher TOC as a result of its high innate carbon content over B2 and B3. This corroborates the submission of Zhang et al. (2023) and Wang et al. (2022).

The FBW depression observed during the residual cropping in NPK soil pretreated with B2 could be linked to reactions between the high nutrient mineralizing potentials of the B2 and the NPK fertilizer characterized by high nutrient solubility. These innate characteristics of the B2 and NPK fertilizer predispose the soil to higher nutrient losses and dissolved organic carbon during the leaching simulation that was done weekly in each amended soil. This also explained the generally lower TOC and TIC in all the amended soils as well as the untreated soil that received neither biochar nor chemical fertilizers. The weekly leaching process which mimicked rainfall impacts on the soil was sufficient to encourage faster organic and inorganic carbon dissolution in the soils. Although, the impact of the weekly simulation was more severe in chemical fertilizer soils that were not pretreated with biochar. In fact, TOC and TIC where generally significantly higher in absolute control soil compared to sole chemical fertilizer treated soils.

The large surface area and porous nature of biochar have been reported to be instrumental in modifying the soil structure for improved water and nutrient holding capacities (Hou et al., 2023; Wu et al., 2023; Fidel et al., 2018). This eventually leads to reduced nutrient leaching, volatilization and enhanced uptake by plant for improved biomass production (Gu et al., 2022). The generally higher FBW in biochar pretreated soils from the current work rightly affirm this report. The regression model revealed the significant contribution of nutrient mineralization and buffering from the two carbon pools of the soil. This is consistent with the submissions of Khalil et al. (2023). The negative correlation in the TOC and TIC indicated supply of nutrients from this nutrient bank into the soil solution. This effect was confirmed by the generally increases in the electrical conductivity readings from each of the amended soil. The EC has been reported as an indicator of nutrient ion concentration in the soil (). The increasing EC in the soil as a result of nutrient concentration increases during the residual cropping therefore explains the positive relationship between EC and the FBW of A. hybridus.

CONCLUSIONS

The study highlighted the importance of balancing the use of chemical fertilizers with sustainable soil management practices to ensure food and environmental security in Africa. The use of tithonia biochar was evaluated for potential solution to enhance soil quality and crop productivity while mitigating the negative environmental impacts of chemical fertilizers. The study emphasized the importance of considering nutrient composition, including ash, carbon, macronutrient contents, and C/N ratios when selecting biochar as pretreatment for chemical fertilizer treated soils. These parameters play significant role in ensuring nutrient availability under immediate and residual application conditions. The different biochar types (B1, B2 and B3) studied had varying effects on crop yield. Biochar types with lower carbon contents and C/N ratios and higher ash contents (such as B1 and B3) supported higher biomass yield during the immediate cropping compared to BI (sole Tithonia diversifolia biochar) and vice versa.

The study indicated that certain biochar types such as B2 had high nutrient mineralizing potential, and when used in combination with NPK fertilizer, which has high nutrient solubility, could lead to soil conditions that encouraged higher nutrient losses and dissolved organic carbon during leaching simulations. This could result in decreased total organic carbon and total inorganic carbon in the soil. Summarily, the study demonstrated the potential of biochar as a soil amendment to improve the productivity of sandy calcareous soils, especially when used in conjunction with chemical fertilizers. It highlighted the importance of biochar characteristics and nutrient composition in influencing its effectiveness in enhancing crop yield and reducing nutrient leaching.

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EFFECT OF SILVER NANOPARTICLES SYNTHESIZED *PETIVERIA ALLIACEA* EXTRACTS ON INSECT PESTS OF COWPEA (Vigna unquiculata l. Walp)

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ABSTRACT
This study was conducted to examine the insecticidal potential of nano-synthesized Petiveria alliacea Leaf and Root applied at three different concentration (5, 10, and 20%) against the observed insects (Riptortus dentipes and Mylabris pustulata) of cowpea at Ladoke Akintola University of Technology, Teaching and Research Farm Ogbomoso during the planting season of cowpea, 2021. Synthetic insecticides (chlorpyrifos) and negative control were included in the treatments for comparison. The experimental land was demarcated and arranged in a Randomized Complete Block Design and each treatment was replicated three times. Data were collected on insects' infestation density, pod damage (%), number of root noodles, and the number of yields (t/ha). Significant means were separated using Duncan Multiple Range test at 5% probability level. All the tested Nano insecticides were effective against the observed insects but none of the tested insecticides was as effective as chlorpyrifos. Also, the effectiveness of Nano. P. alliacea leaf and root depended on the observed insects. Nano P. alliacea root and leaf at 20 % v/v compete effectively with Chlorpyrifos with respect to pod damage meanwhile the plants treated with Nano P. alliacea leaf at 20% v/v had the highest significant yield (0.51 t/ha). However, all the treatments had the same significant effect on the number of root noodles. Therefore, nano-insecticides from P. alliacea leaf and root can be used in the management of field insect pests of cowpea.
Keywords: *Riptortus dentipes, Nano formulations, Petiveria alliacea, Mylabris pustulata Chlorpyrifos, Cowpea*

INTRODUCTION
Cowpea (*Vigna unquiculata* L. walp) belongs to the family Fabaceae (Ibrahim, 2017). This crop was reported to have originated from West and Central Africa, and is a major source of protein in many parts of Africa (Enyiukwu *et al.*, 2018). The major constraint in the cultivation of cowpea is insect pest infestations which cause up to 70% grain yield loss Alao and Adebayo (2011). Among the insect pests of cowpea, post-flowering insects such as *Meglurothrips sjostedti* Tryborn, *Maruca vitrata*, Fabricious *Clavigralla tomentoscollis* and *Riptortus dentipes* (Jackai and Adala, 1997; Alao *et al*., 2011) have been implicated to have caused major economic lost. To protect this crop from pest attack, farmers usually rely on quick pest management options, mainly synthetic chemicals (Alao and Adebayo, 2011). However, the use of synthetic insecticides has several challenges such as development of pesticide resistant pests, and harmful effects on humans and the environment (Shabana *et al.*, 2017). Due to the aforementioned problems, botanical insecticides have been explored and discovered to successfully control insect pests. The importance of botanical pesticides is attributed to their efficacy, biodegradability, varied modes of action, low toxicity as well as availability of source materials (Riyaz *et al.,* 2022).
Extracts of *Petiveria alliacea* have demonstrated acaricidal (Rosado-Aguilar *et al.,* 2010), antinociceptive (Gomes *et al.,* 2005), insecticidal (Akanbi *et al*., 2007), analgesic and antioxidant effects. Nanoparticles can be defined as materials and systems whose structures and components exhibit novel and significantly improved physical, chemical and biological properties, phenomena and processes due to their nano scale

size i.e. in a range of 1-100 mm (Agbaje *et al.,* 2016). There is a tremendous scope for the development of novel bio oriented natural pesticides from a combination of nano particles and plant-based chemicals which is highly environmentally safe, biodegradable and effective. Therefore, this study was conducted to examine the insecticidal potential of nanosynthesized *P. alliacea* leaf and root against *R. dentipes* and *M. pustulata* infestations on cowpea plants.

MATERIALS AND METHODS

Study Site

The study was carried out at Ladoke Akintola University of Technology (LAUTECH) Teaching and Research Farm (longitude 40 301E and latitude 10051N). The region climate could be described as hot humid tropical falls in Southern Guinea Savana Nigeria with a mean temperature of 27ºC and annual rainfall of 1400 mm. It is marked with dry and wet seasons, characterized by a bi-modal rainfall pattern with peaks in July and September.

Experimental Design and Management

The experimental land was ploughed and harrowed once and 24 plots were demarcated and arranged in a Randomized Complete Block Design, and each treatment was replicated three times. The plot dimension was 4 m by 4 m, with a planting distance of 1 m between each plant stand. The total number of plants stand per plot was 25 stands. Cowpea variety (Ife Brown) was planted and three seeds were dropped per planting hole, and thinning was done two weeks after planting to one plant per stand. Weeding was done manually at two weeks interval.

Nano Formulation

P. alliacea roots were chopped into pieces manually. *P. alliacea* roots and leaves were air dried at room temperature for three weeks. Grinding of the leaves and roots were done separately with mortal and pestles. Powdered root and leaves of *P. alliacea* were measured separately with electronic sensitive-scale and they were later taking to the Nano-technology laboratory at the Microbiology Department, LAUTECH, for further processing.

Nano formulation of *P. alliacea* was done following the already established procedures by (Agbaje *et al*., 2018). One gram of *P. alliacea* leaf and root powders were measured out separately which was then dissolved in 100 ml of distilled water, and allowed to stay in water bath at 60^0 C for an hour. The solution was filtered with a filter paper, then centrifuged the filtrate at 4000RPM (Revolutions per minute) for 20 mins. The clear supernatant was used for the synthesis. The supernatant was reacted with 40 ml of 1 mm Silver Nitrate solution, and it was later placed under sunlight for photo-activation. Afterwards, the colour change was observed till a stable colour was obtained.

Treatment Application

Application of the treatments commenced three weeks after planting. Nano-formulated *P. alliacea* root and leaf extracts were applied at three different concentrations (5, 10, and 20% v/v) while synthetic insecticide (Chlorpyrifos) was applied at manufacturer's recommended rate. Untreated plots were included in the treatments for comparison. Each of the extracts was diluted with 1000 ml of water to achieve the same spraying volume. Application was done with hand sprayer of 2 L capacity and this was done early in the morning.

Chlorpyrifos	1 m/ 1 L
Control	-
Nano *Petiveria alliacea* leaf	5 %, 10 %, and 20 % v/v
Nano *Petiveria alliacea* root	5 %, 10 %, and 20 % v/v

Data Collection and Analysis

Data were collected on insects' population density and this was done by visual observation from the two middle plant rows. However, counting of the insects on the field was done a day after the application of the treatments for four consecutive weeks. Data were also collected on the followings; number of damage pods/plot, root noodles, and weight of the grain was taken with the sensitive scale and converted to yield (t/ha), Data collected on insects were transformed using square root transformation while data on percentage were transformed with log transformation before subjecting them to analysis of variance (ANOVA) and means were separated using Duncan Multiple Range Test (DMRT) at 5% probability level using Statistical Analysis Software (SAS), v2.0 (2005).

RESULTS

Table 1 shows the effect of insecticide on yield, pod damages, and number of noodles. At 20 % concentration, Nano *P. alliacea* root and *P. alliacea* leaf competed effectively with Chlorpyrifos, as the nano formulation had the most significant effect on preventing pod-sucking insects. Meanwhile, Nano *P. alliacea* leaf had the highest significant effect on the yield parameters of the tested plants. With respect to number of noodles, no significant difference was detected between the treated plants and untreated plants.

Table 1: Effect of Insecticide on Yield, Pod Damages, and Number of Noodles

Treatment	Rate	% Pod damages	Noodles	Yield (t/ha)
Nano *P. alliacea* root	5	28.67^{d}	3.33^{a}	0.31^{e}
	10	52.00^{bc}	3.33^{a}	0.25^{d}
	20	75.00^{a}	4.00^{a}	0.44^{b}
Nano *P. alliacea* leaf	5	38.33^{cd}	3.33^{a}	0.11^{e}
	10	62.33^{ab}	3.00^{a}	0.37^{c}
	20	81.00^{a}	3.33^{a}	0.51^{a}
Chlorpyrifos	-	71.33^{a}	3.33^{a}	0.37^{bc}
Control	-	43.33^{c}	4.33^{a}	0.09^{e}

Means with the same superscript(s) are not significantly different

Figure 1 demonstrated the efficacy of insecticides on *R. dentipes* infestations on cowpea plant. Nano *P. alliacea* root 20% had the highest insecticidal effect on *R. dentipes* infestations compared to other insecticides. The above mentioned nano formulation performed better than the synthetic insecticides.

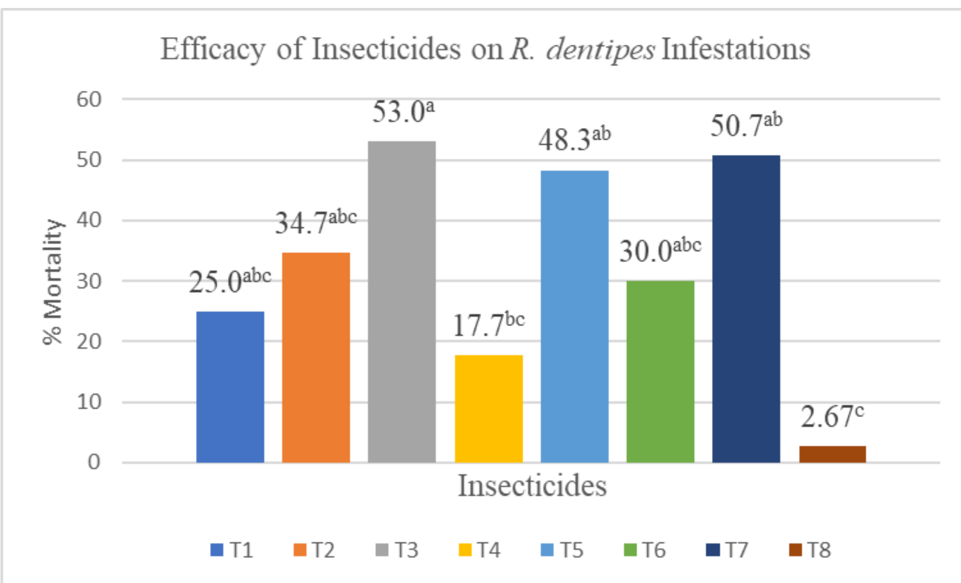

Figure 1: Efficacy of Insecticides on *R. dentipes* Infestation

Key: T1 = Nano *P. alliacea* root 5%; T2 = Nano *P. alliacea* root 10%; T3 = Nano *P. alliacea* root 20%; T4 = Nano *P. alliacea* leaf 5%; T5 = Nano *P. alliacea* leaf 10%; T6 = Nano *P. alliacea* leaf 20%; T7 = Chlorpyrifos; T8 = Control

According to Figure 2, all the tested nano-insecticdes had significant effect on flower beetle infestations. However, both nano *P. alliacea* root and leaf at 20 % concentration, competed effectively with Chlorpyrifos

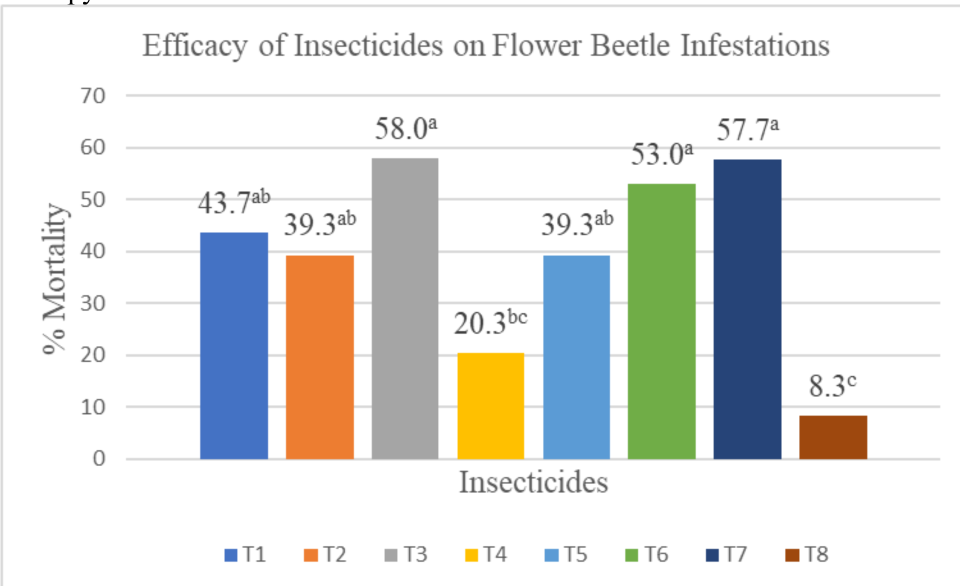

Figure 2: Efficacy of Insecticides on Flower Beetle Infestations

Key: T1 = Nano *P. alliacea* root 5%; T2 = Nano *P. alliacea* root 10%; T3 = Nano *P. alliacea* root 20%; T4 = Nano *P. alliacea* leaf 5%; T5 = Nano *P. alliacea* leaf 10%; T6 = Nano *P. alliacea* leaf 20%; T7 = Chlorpyrifos; T8 = Control

DISCUSSION

Management of field insect pests is necessary in order to have a reasonable yield of crops. However, these have negative effects on humans and the environment, apart from being costly for resource-poor farmers (Kusi *et al.,* 2019). Use of biopesticides is gaining more attention as alternative to synthetic insecticides in the control of field insect pests both in the developed and underdeveloped countries (Akutse *et al*., 2020). Many of these countries are banning the use of synthetic chemicals because of the reported poisonous residual (Ileke and Ogungbite, 2014). In the recent years, nanoparticles have been receiving much attention in the field of agriculture (Guan *et al*., 2008). Rouhani *et al*. (2011) reported that ZnO-TiO2-Ag nanoparticles have insecticidal activity on *Frankliniella occidentalis* Pergande and showed the most mortality effect pertained to 28%ZnO-70%TiO22%Ag (LD50 = 195.27 mg L-1).

All the tested nano insecticides significantly controlled the observed insect pets when compared with the untreated plants which had highest population density of the observed insects. This is in line with Dialoke *et al*., (2017) who reported that the application of all rates of formulated neem seed oil controlled *Riptortus dentipes* infestation. The nano *P. alliacea* insecticide formulated from leaf and root at 20% concentration competed effectively with Chlorpyrifos against flower beetle infestations. This agrees with Alao and Adebayo (2011), who stated that the application of *Tephrosia vogelii* and *P. alliacea* crude extracts at 20% concentration proved to be more effective against the three observed insects – *Maruca vitrata*, *Megalurothrips sjostedti*, and *Riptortus dentipes* when compared with other tested concentrations. However, nano *P. alliacea* root at 20% concentration had higher insecticidal efficacy than Chlorpyrifos when tested against *R. dentipes* infestations, while Nano *P. alliacea* leaf at 10 % concentration had the same insecticidal potential as Chlorpyrifos.

The data suggest that nano *P. alliacea* root had more insecticidal ability than the leaf. This suggests that the root might have had higher insecticidal active chemical compounds than the leaf, this observation is in line with Akintan *et al*., (2021) who reported that *P. alliacea* root possessed higher insecticidal compound than the leaf. Nano *P. alliaceae* root at 20 % concentration had the highest insecticidal potential against *R. dentipes*. This agrees with Alao and Adebayo (2011), who reported that the single application of the *T. vogelii* and *P. alliacea* extracts at 20% concentrations were the most effective against *M. vitrata*, *M. sjostedti*, and *R. dentipes* field insect pests of cowpea. However, during this research study, no dead insects were found on the experimental plot. This indicates that the mode of action of the formulated nano-insecticides can be repellent or anti-feedant which is the nature characteristic of botanical insecticides because they are not true insecticides (Isman, 2008; Dubey *et al*., 2010). The results revealed that cowpea plants treated with nano-formulated *P. alliacea* leaf applied at 20 % concentration had the highest yield. This is in line with Ghidan *et al*., (2020) who reported that Zinc 50 and sulfur 200 nano-particles concentrations significantly increase the plant yield of broad bean.

CONCLUSION

Based on the results of this research, nano insecticides successfully prevented field insects' infestations of cowpea plant. Also, nano-insecticides should be applied at highest concentration in order to have higher yield. Therefore, nano-insecticides can be incorporated into insect pest management program of cowpea especially in the organic farming system. However, further field studies should be conducted on the use of nano insecticides against other field insect pest of crops.

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A REVIEW ON THE POTENCY OF BOTANICALS IN THE MANAGEMENT OF COFFEE MAJOR INSECT PESTS

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ABSTRACT
Coffee is a perennial beverage crop grown in Nigeria and other countries of the world, serving as a good source of livelihood and income for many. However, insect pests such as coffee leaf miners, Leucoptera spp. (Lepidoptera: Gracillariidae), coffee berry borer, Hypothenemus hampei (Ferrari) (Coleoptera: Curculionidae: Scolytinae), coffee white stem borer, Xylotrechus quadripes (Coleoptera: Cerambycidae); Coffee mealybugs, Coccoidea, (Hemiptera: Pseudococcidae); Antestia bug, Antestiopsis spp (Hemiptera:Pentatomidae) and the coffee green scale, Coccus spp. (Hemiptera: Coccidae) causes significant damage to the crop. Several measures have been adopted by farmers, particularly, the use of synthetic insecticides which have destructive effects on both man and the environment. Globally, some researches have been conducted to check the potency of extracts and essential oils of some botanicals against these pests. The results obtained revealed that the plant samples tested were found effective against the insect pests. Therefore, any of the botanicals evaluated here can be explored as biopesticides against the insect pests. Future research should concentrate on isolation and characterization of active components in these plants samples.
Keywords*: Coffee, Botanicals, Insect pests, Synthetic insecticides*

INTRODUCTION

Coffee is a perennial crop belonging to the family Rubiaceae in the genus *Coffea* which are mostly evergreen trees and shrubs. They are said to have originated from Africa comprising of more than a hundred species. The two main cultivated and commercially utilized species are the *Coffea arabica* L. and *C. canephora* var. *robusta* Pierre ex A. Froehner. (Mendesil, 2019; Waller et al., 2007). The most widely cultivated species globally is *C. Arabica* as it is considered to produce beans of good quality, hence has a higher market value. On the other hand, *C. canephora* is better adapted to warmer and more humid tropical environments than *C. arabica* and able to withstand more adverse conditions. *Coffea arabica* is cultivated on the highlands, while *C. canephora* is grown in the lowlands. More so, *C. canephora* is usually more resistant to coffee pests than C. Arabica (Mendesil, 2019; Rutherford *et al.,* 2006)

Coffee is one of the world's most economically important agricultural produce in many developing countries. It is the main source of income for a good number of people, predominantly the low income farmers in rural areas (Barera, 2017). Coffee is high value low volume cash crop and more profitable than cereal crops as a result of its high demand in International market (Sharma *et al*., 2015). It is been taken as beverage globally due to its health benefits, taste and aroma. Coffee beans and leaves possess some phytochemicals which have both ant-inflammatory effect and antioxidant potency in man (Alli *et al.,* 2021, Eva *et al.,* 2016).

The successful cultivation and production of Coffee is threatened by a host of factors, insect pest attack is significantly top the list. Various insect pests attack different parts of coffee from seedling stage all through to the maturity stage of the plant. It was reported that over 3000 species of insects attacks coffee globally and being a perennial crop, it provides a very conducive environment for these insect pests to thrive (Mendesil, 2019; Waller *et al.,* 2007). However, it is only a few of these insect pests that are significant in the effective production of coffee as they cause a reduction in yield and lower the qualities of coffee bean. The major insect pests of coffee are; coffee leaf miners, *Leucoptera* spp. (Lepidoptera: Gracillariidae), coffee berry borer, *Hypothenemus hampei* (Ferrari) (Coleoptera: Curculionidae: Scolytinae), coffee white stem borer, *Xylotrechus quadripes* (Coleoptera: Cerambycidae); Coffee mealybugs, Coccoidea, (Hemiptera: Pseudococcidae); Antestia bug, *Antestiopsis* spp (Hemiptera:Pentatomidae) and the coffee green scale, *Coccus* spp. (Hemiptera: Coccidae) (Mendesil, 2019; Rutherford *et al.,* 2006). Table 1 below shows the major insect pests of coffee.

The objective of this paper is to evaluate the efficacy of botanicals in the management of the major insect pests of coffee around the world. This was achieved with the aid of published articles by various researchers on coffee and the management of several insect pests.

Management of coffee insect pests with chemical insecticides

Several chemical insecticides such endosulfan which is used against the coffee berry borer, aldrin, lindane among others are being used by coffee stakeholders in managing this crop. Though they've been reported to be effective, they pose a lot of threats to the environment as they are highly poisonous. Also, dependence on synthetic/chemical insecticides is having serious detrimental effect on natural enemies and has resulted in to the development of resistance to various organophosphates. The indiscriminate use of chemical insecticides equally makes coffee bean not acceptable in the international market due to high chemical residues (Merhi *et al*., 2022; Vega *et al*., 2006; Noel and Fontana, 2018).

Botanical insecticide which has been documented to be non- persistence in the environment, selective towards beneficial and non-target organisms, low toxicity to humans and mostly affordable has been found as a good alternative to the use of chemical insecticides (Chengala *et al.,* 2017). Various plant extracts, essential oils and isolated compounds have been discovered to have insecticidal activity against many stored product pests (Alabi *et al*., 2023; Noudegbessi *et al*., 2021; Aikpokpodion *et al*., 2013). Table 2 below summarizes studies that have been conducted in the laboratory on some plant species (with insecticidal activities) from different families used in the management of the insect pests of coffee. All the plant species listed have been reported to cause high mortality and/or repellence against the tested organisms (Mendesil, 2019; Barrera *et al*., 2017; Zorzetti *et al*., 2012).

Table 1: Major insect pests of coffee

S/N	Common name	Insect species	Order and family	Host coffee plant	References
1	Coffee berry borer	*Hypothenemus hampei* (Ferrari)	Coleoptera: Curculionidae: Scolytinae	Arabica and robusta	Mendesil, 2019
2	Coffee leaf miners	*Leucoptera* spp	Lepidoptera: Gracillariidae	Arabica	Mendesil, 2019
3	Coffee green scale	*Coccus* spp.	Hemiptera: Coccidae	Arabica and robusta	Mendesil, 2019
4	Coffee white stem borer	*Xylotrechus quadripes*	Coleoptera: Cerambycidae	Arabica	Manikandan *et al*., 2019
5	Coffee mealybugs	Coccoidea	Hemiptera: Pseudococcidae	Arabica and robusta	Rutherford *et al*., 2006
6	Antestia bug	*Antestiopsis* spp.	Hemiptera: Pentatomidae	Arabica	Mendesil, 2019

Table 2: Botanicals with insecticidal activities used experimentally for the control of some of the insect pests of coffee

Insect pest	Plant species tested	Common name	Form used	References
Hypothenemus hampei (Ferrari) (Coffee berry borer)	Thymus vulgaris, Aloysia sp., Ruta chalepensis, Chenopodium ambrosioides Cymbopogon nardus (L.)	Thyme Beebrushes Garden rue Mexican tea Citronella grass	Essential oil	Mendesil *et al.,* 2012; Mendesil *et al.,* 2019
	Tephrosia purpurea (Linn.) Pers.	Wild indigo/fish poison	Extract	Barrera et al., 2017; Zorzetti *et al*., 2012
	Moringa oleifera Lam.	Drumstick tree	Extract	Barrera et al., 2017; Zorzetti *et al*., 2012
	Piper alatabaccum	Pepper	Extracts	Santos *et al*., 2013
	Aeollanthus pubescens Benth. (*Lamiaceae*)	Purple flowered plant	Extract	Mawussi *et al*., 2009
	Ocimum canum Sims (*Lamiaceae*)	Wild basil	Extract	Mawussi *et al*., 2012
	Schinus terebinthifolius (*Anacardiaceae*) Raddi	Rose pepper	Extract	Santos *et al*., 2013b
	Ricinus communis L. (*Euphorbiaceae*)	Castor bean	Extract	Celestino *et al*., 2016
	Azadirachta indica A. Juss (*Meliaceae*)	Neem	Extract	Zorzetti *et al*., 2012
Leucoptera spp (Coffee leaf miners)	*Citrus limon* *Musa sapientum* *Ocimum basiculum* *Petiveria alliaceae* *Psidium guajava*	Lemon Banana Basil Guinea hen weed Guava	Extracts	Alves *et al*., 2012
Xylotrechus quadripes (Chevrolat) White coffee stem borer)	*Allium sativum* L., *Allium cepa* L., *Zingiber officinale* *Melia azedarach* L, *Artemesia indica* Willd	Garlic Onion Ginger Chinaberry India wormwood	Extracts	Manikandan *et al*., 2019
Antestiopsis spp. Antestia bug	*Millettia ferruginea* (Hochst.) Baker, *Chrysanthemum Cinerariifolium* L. *Dysphania* (*Chenopodium*) *ambrosioides* (L.)	Berebera Pyrethrum Mexican tea	Extracts	Mendesil and Abdeta 2007
	Ruta chalepensis L.	Garden rue	Essential oils	Mendesil, 2019; Mendesil *et al*., 2012

Table 3: Phytochemical Constituents of some Plants Materials Used Experimentally for the management of insect pests of coffee

Plant species	Flavonoids	Alkaloids	Saponins	Phenolics	Glycosides	References
Moringa oleifera	+	+	+	+	+	Saini *et al.,* 2016, Okah *et al*., 2019
Tephrosia purpurea	+	+	-	+	+	Kumkhale *et al.,* 2020
Azadirachta indica	+	+	+	+	+	Ujah *et al.,* 2021; Alka *et al*., 2018
Ricinus communis L	+	+	+	-	+	Manoj Kumar, 2017
Ruta chalepensis L	+	+	+	+	-	Madhu *et al.,* 2014
Dysphania ambrosioides (L.)	+	+	+	+	-	Hewis *et al*., 2020
Allium sativum	+	+	+	+	+	Singh and Kumar., 2017
Thymus vulgaris	+	+	+	-	+	Nema *et al.,* 2015
Cymbopogon nardus (L.)	+	+	+	+	+	Muttalib*, et al.,*2018
Zingiber officinale	+	+	+	+	+	*Osabor et al.; 2015*

Relationship between insecticidal properties of botanicals and their phytochemical compositions

Plant synthesizes a host of phytochemicals such as flavonoids, tannins, phenol, cardiac glycosides, saponins, alkaloids and others. These secondary metabolites have been documented to exhibit various biological activities, insecticidal activities inclusive. From Table 3 above, all the botanical species used against the insect pests of coffee have the major phytochemicals such as saponins, alkaloids, flavonoids, and phenols. These are known to have activity against pathogens and therefore aid the insecticidal activities of botanicals. The mode of action of these phytochemicals seems to be their ability to tamper with the physiology and behavior of the insect pest which consequently result into death (Maazoun *et al*., 2019; Pavela *et al.*, 2017).

Flavonoids have been found to have insecticidal potency and report has it that these compounds can regulate the feeding and oviposition behavior of insects (Simmonds, 2003). In a study conducted by Salunke *et al.,* (2005), flavonoids were found to be toxic to adults and eggs of *Callosobruchus chinensis* (L.) at a dose dependent rate. Maazoun *et al*. (2019) tested quercetin dehydrate, rutin hydrate and naringin and discovered that all the three flavonoids were active as aphicides against the woolly apple aphid. More so, alkaloids have been reported to play a pivotal role in mortality and antifeedant deterrent against several insect pests. Khani *et al. (2011)* tested the extracts of *Piper nigrum* which has as much as 99% alkaloids against *Sitophilus oryzae* and the results showed that mortality rates of adults increased with increasing concentration of the extract. Yang Ge *et al.* (2015) reported that alkaloids derived from C*ynanchum mongolicum* are potential insect inhibitors as they appear to disrupt insect hormone balances. They were equally found to have contact toxicity against the aphid *Lipaphis erysimi.* tannins are toxins Tannins are toxic substances that significantly minimize the growth and survival of many herbivores and also serve as feeding repellent to a great number of insects leading to their eventual death (Sarma *et al*., 2019).

CONCLUSION

The successful production of the economically important beverage plant, coffee is threatened by the insect pests infestation.The use of synthetic insecticides has been discouraged due to their adverse effects on humans and the environment. This brought about the discovery of the botanical pesticides which serves as a great alternative. It is very germane to preserve coffee tree from the infestation by its various pests using any of the botanicals listed in this review as they have been proven to have insecticidal potentials against the insect pests. Further works have to be done on identification and characterization of the active ingredients present in these botanicals.

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EFFECTS OF BLANCHING AND PACKAGING MATERIALS ON SOME CHEMICAL COMPOSITION OF OKRA (*Abelmoschus esculentus L. Moench*) STORED IN EVAPORATIVE COOLANT STRUCTURE

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ABSTRACT
Okra (Abelmoschus esculentus L. Moench) is a highly perishable vegetable prone to quality and nutritional losses during storage. The study carried out in the laboratory of the Department of Crop and Horticultural Sciences, Faculty of Agriculture, University of Ibadan investigated the impact of blanching and different packaging materials on some chemical compositions of stored okra fruits in Evaporative Coolant Structure (ECS). Blanched and unblanched okra fruits packaged in sealed and perforated plastic were stored, and the crude protein, ascorbic acid, and mucilage contents were measured at 4-day intervals. Data were subjected to analysis of variance. Results showed that unblanched okra and okra packaged in sealed plastic had better preservation of mucilage content, ascorbic acid levels, and crude protein compared to blanched okra and okra packaged in perforated plastic. The chemical composition of unblanched okra was preserved for 8 days but declined at 12 and 16 days after storage (DAS).
Keywords: *Evaporating Coolant Structure (ECS), Days After Storage (DAS)*

INTRODUCTION

Okra [*Abelmoschus esculentus (L.) Moench*] is an economically important vegetable crop grown in tropical, sub-tropical, and warm temperate parts of the world (Camcius, *et al*., 1998; Kang *et al*., 2010). Okra is an annual dicotyledonous herb that belongs to the Malvaceae or mallow family and is a relative of cotton (*Gossypium hirsutum L.*). It is grown for its leaves, fruits, seeds, floral parts, and stems. Okra is prominent because of its high nutritive and medicinal value, ease of cultivation, wide adaptability, and pleasant flavor (Lamont, 1999). However, the post-harvest management of okra stands out as one of the most important parts of okra farming. Due to their high-water content (90%) and strong metabolism, which is characterized by a fast respiratory rate, vegetables become extremely perishable after harvest (Mota *et al*., 2010). Okra has a limited shelf life and may deteriorate quickly if not maintained properly, despite its value. Blanching is a process that involves briefly subjecting vegetables to heat (often boiling water or steam), followed by quick cooling. This can help to remove dirt, lower the microbial load, and inactivate enzymes that could otherwise lead to spoiling (Kaur and Singh, 2015). Okra can benefit from proper packing by being shielded from physical harm, exposed to less air and moisture, and protected from microbial contamination (Müller *et al*., 2018).

The effectiveness of the preservation process depends on the appropriate use of packaging materials. The quality of the food product can be impacted by the diverse features of the packaging materials (such as plastic films, paper, and metal cans). In light of the unique requirements of the food product, it is crucial to choose an appropriate packaging material (Oliveira *et al*., 2017). In addition to blanching and packaging, storage conditions can also be used to extend the shelf life of okra. These conditions involve storing the vegetables in a cool, dark, and dry environment with minimal air circulation. This can help slow down the metabolic processes that lead to spoilage and maintain the quality of the vegetables for a longer period (Sharma *et al*., 2017).

The Food Safety and Inspection Service (FSIS) of the United States Department of Agriculture (USDA) recommends keeping blanched vegetables, including okra, in a sealed container in the refrigerator at a temperature of 4°C or lower (USDA FSIS, n.d.). Okra cannot be stored in a refrigerator, which is the conventional method of storing it after blanching in Nigeria because the power supply is frequently interrupted. There is a need to investigate alternative, non-electric methods of storage such as evaporative coolant structures. Packaging materials play an important role in extending shelf life and maintaining the chemical composition of okra. The study was set up to evaluate the effects of blanching and packaging materials on the ascorbic acids, protein, and mucilage content of okra stored in ECS.

MATERIALS AND METHODS

Experimental site and source of sample

The experiment was conducted between November 2, 2022, and November 18, 2022, in the laboratory of the Department of Crop and Horticultural Sciences at the University of Ibadan. Okra fruits (Kirikou F1 variety) were sourced from a vegetable farm in Alabata, Moniya, Ibadan, Oyo state.

Preparation of okra for storage

The okra fruits were sorted and cleaned to remove any debris or unwanted materials. The okra fruits were then divided into two portions. The first portion was blanched with water at the temperature of 100°C for 5 minutes and cooled in ice water for 5 minutes. The second portion was left unblanched. Each portion was then divided into 250 g batches and packaged into different packaging materials (sealed plastic and perforated plastic) before storage.

Experimental design and data collection

The 2 x 2 factorial experiment was laid out in a completely randomized design with four treatments replicated 3 times. The ascorbic acid, crude protein, and mucilage content of the okra fruits were determined at four-day intervals throughout the storage period using procedures outlined by AOAC (Association of Official Analytical Chemists) methods (2005). Data collected were subjected to analysis of variance (ANOVA) using GenStat software. Means were separated using the Least Significance Difference (LSD) at a 5% probability level.

RESULT

The Mean Temperature (^{0}C) and Relative Humidity (%) of The Storage Conditions

Evaporative coolant structure (ECS), had a relative humidity of 89%, and the mean temperature in the morning, afternoon, and evening was 20.5°C, 22.0°C, and 20.4°C, respectively. On the other hand, the open shelf storage had a relative humidity of 75%, and the mean temperature in the morning, afternoon, and evening was 27.8°C, 32.2°C, and 28.1°C, respectively as shown in (table 1).

Effect of Blanching on Crude Protein, Mucilage Content, and Ascorbic Acid of Okra

The effect of blanching on some chemical composition of okra fruits was investigated as shown in (table 2). Results showed that there was a significant difference between blanched and unblanched okra fruits from 4 to 8 days after storage (DAS) except at 4 DAS for mucilage content where there is no significant difference. Unblanched okra fruits had the highest crude protein content, mucilage content, and ascorbic acid from 4 to 8 DAS, indicating higher protein retention compared to blanched okra. Due to spoilage, records were not taken from 12 to 16 DAS for blanched okra, whereas records were taken for unblanched okra until 16 days.

Effect of Packaging on Crude Protein, Mucilage Content, and Ascorbic Acid of Okra

Table 2. shows the effect of packaging on some chemical composition of okra. There was a significant difference between the sealed and perforated plastic used in packaging okra fruits. Okra fruits packaged in sealed plastic recorded the highest crude protein, mucilage content, and ascorbic acid content across the days of storage, except at 12 DAS where perforated plastic recorded the highest ascorbic acid content.

Effect of Blanching and Packaging Interaction on Crude Protein, Mucilage Content, and Ascorbic Acid of Okra

As shown in (table 2), the interaction between the type of plastic used in packaging and processing was also significant from 4 to 12 DAS in the chemical composition of okra examined. However, at 16 DAS, there was no significant difference except for ascorbic acid where there was a significant difference. Blanched okra fruits packaged in sealed plastic recorded the highest values of crude protein at 4 and 8 DAS, while unblanched okra fruits packaged in sealed plastic and perforated plastic had the highest values of crude protein at 12 and 16 DAS, respectively. Furthermore, blanched okra packaged in sealed plastic and unblanched okra packaged in perforated plastic recorded the highest values of mucilage content at 4 and 8 DAS, respectively, while unblanched okra fruits packaged in sealed plastic had the highest mucilage content from 12 to 16 DAS. Moreover, blanched okra packaged in sealed plastic and unblanched okra packaged in sealed plastic recorded the highest values of ascorbic acid at 4 DAS and 16 DAS, respectively, while unblanched okra packaged in perforated plastic had the highest values of ascorbic acid at 8 and 12 DAS.

Table 1: Approximate mean temperature (^{0}C) and relative humidity (%) of the storage conditions

Time of the day	Storage Conditions	
	ECS	Open shelf
Morning (7:00 – 7:30 am)	20.5	27.8
Afternoon (2:00 - 2:30 pm)	22.0	31.2
Evening (7:00 – 7:30 pm)	20.4	28.1
RH (%)	89	75

Table 2: The effect of blanching and packaging materials on the mean of ascorbic acid, crude protein, and mucilage content of okra fruits

Treatments	Ascorbic acid				Crude Protein				Mucilage content			
	Days of Storage											
	4	8	12	16	4	8	12	16	4	8	12	16
Processing												
Blanched	21.72	21.55			3.510	3.660			2.42	2.56		
Unblanched	22.43	22.58	20.12	18.84	3.625	3.672	3.605	3.258	2.44	2.75	2.42	2.26
LSD (0.05)	0.021	0.029			0.031	0.025			NS	0.03		
Packaging materials												
Sealed plastic	22.56	22.44	20.07	18.88	3.715	3.812	3.688	3.228	2.53	2.74	2.46	2.31
Perforated plastic	21.59	21.69	20.17	18.79	3.420	3.520	3.522	3.289	2.34	2.57	2.37	2.21
LSD (0.05)	0.021	0.029	0.032	0.032	0.031	0.025	0.025	0.049	0.03	0.03	0.02	0.07
Interaction												
Blanched*Sealed plastic	22.74	22.41			3.850	4.070			2.63	2.83		
Blanched*Perforated plastic	20.69	20.69			3.170	3.250			2.21	2.28		
Unblanched*Sealed plastic	22.37	22.46	20.07	18.88	3.580	3.555	3.690	3.227	2.42	2.64	2.46	2.31
Unblanched*Perforated plastic	22.48	22.69	20.17	18.79	3.670	3.790	3.520	3.290	2.47	2.85	2.37	2.21
LSD (0.05)	0.030	0.041	0.045	0.045	0.043	0.036	0.036	NS	0.04	0.04	0.04	NS

NS- Non-significant

DISCUSSION

The unblanched okra recorded the highest crude protein in ECS which is not consistent with the findings of Zaman *et al*. (2015), who reported that blanching of okra fruits resulted in increased protein content due to reduced protein degradation during storage. This may be attributed to differences in storage conditions. The higher crude protein content observed in okra fruits packaged in sealed plastic compared to perforated plastic agrees with the findings of a study by Mustafa *et al*. (2017), who reported that sealed packaging can help reduce moisture loss and prevent spoilage, leading to better retention of nutritional content, including proteins. The observed increase in crude protein content from 4 to 8 DAS and subsequent decline from 8 to 16 DAS in unblanched okra fruits is consistent with the findings of a study by Ali *et al*. (2016), who reported that the protein content of okra fruits decreased during prolonged storage due to protein degradation caused by spoilage microorganisms.

The unblanched okra recorded the highest mucilage content and ascorbic acids at 4 and 8 DAS. However, the decline in mucilage content from 8 to 16 DAS in unblanched okra fruits may indicate changes in the quality of the fruits during prolonged storage, possibly due to physiological degradation, water loss, or microbial spoilage which is consistent with Nzikou *et al*. (2010) who reported that the mucilage content of okra fruits decreased with prolonged storage. Okra fruits packaged in sealed plastic recorded the highest mucilage content and ascorbic acids, this suggests that the type of packaging material used can influence the mucilage content and ascorbic acids of okra fruits during storage. Sealed plastic packaging may have provided a more favorable environment for maintaining mucilage content, possibly by reducing water loss and maintaining the integrity of the okra fruits. These findings are consistent with previous research that has shown the impact of packaging materials on the quality and nutritional content of fruits and vegetables during storage (Lee *et al*., 2003; Rahman *et al*., 2018).

CONCLUSION

Blanching was not able to maintain the chemical composition examined of okra fruits stored in ECS. Unblanched okra performed better in terms of maintaining the crude protein, ascorbic acid, and mucilage content than blanched okra. Additionally, okra packaged in sealed plastic had the best performance in terms of maintaining the crude protein, ascorbic acid, and mucilage content of okra.

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EXAMINING THE ADOPTION OF SUSTAINABLE LAND MANAGEMENT TECHNOLOGIES AMONG CROP FARMERS: A RURAL SOCIOLOGY AND HORTICULTURAL EXTENSION PERSPECTIVE

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ABSTRACT
Factors such as population growth, deforestation and poor farming techniques have been pointed out as the major causes of increased growth in human activities, overgrazing, deforestation, and the use of inappropriate farming practices. Consequently, this research aims to assess the adoption of land management technologies by crop farmers in Offa Local Government, Kwara State Nigeria. A quantitative analytical study was conducted using a Multistage Sampling Technique involving 120 farmers in Kwara state. The collected responses were analyzed using descriptive statistics. The analysis revealed intercropping (98.3%), crop rotation (99.2%), bush fallowing (99.2%), cover cropping (97.5%), whereas strip cropping (3.3%), terracing (9.2%), and contour ploughing (14.2%). This implies that there is high level of awareness of sustainable land management technologies in the study area. which will aid extension agents in making Farmers adopts this method. Extension agents should be made available to the crop farmers in other to help guide the farmers on the use of sustainable land management technologies.
***Keyword**: Adoption, Sustainable Land, Management Technologies, Horticultural Extension, Kwara State*

INTRODUCTION

One out of every three people on earth in some way or the other affected by land degradation per average, latest estimates indicates that nearly 2 Billion hectares of land worldwide are already degraded, some irreversibly (FAO, 2010). Factors such as population growth, deforestation and poor farming techniques have been pointed out as the major causes. Human growth has resulted in increased human activities and land demand, which triggered overgrazing, deforestation and use of inappropriate farming practices (Semgalawe, 1998; Senkodo, 2009). To rescue this situation, the adoption of sustainable land management practices seems to be the best way. Estimate put 300,000 to 400,000 hectares of forest that are cleared every year to meet the demand for farming land, timber, poles and firewood (Semgalawe, 1998; Senkondo, 2009).

Sustainable land management has been defined as the adoption of appropriate land management practices that enables land users to maximize the economic and social benefits from the land while maintaining or enhancing the ecological support functions of the land resources (FAO, 2009). It is the key point for improving land resources resilience and productivity within the context of the potentially devastating effects of climate change in sub-Saharan Africa, bringing the needs of agriculture and environment, with the twin objectives of maintaining long term productivity (quality, quantity and diversity) of goods and services. The major goal of sustainable land management therefore is to develop economically viable agro-ecological system and to enhance the quality of the environment.

The practices include Diversified cropping systems (strip cropping, and mixed intercropping). Integrated agro-forestry practices with the cropping system and soil erosion control structures and practices that is contour farming and grass barriers (Roberts *et al* 2008). These practices are a key mechanism for effecting change in the sustainable use and management of land resources (Webb, 2004). Unsustainable land management practices can threaten biodiversity and increase the release of Carbon especially through destruction of forests as well as impacting adversely on water resource management. On the other hand, they present opportunities for enhancing the livelihoods of the poor and fostering inclusive growth as well as for achieving environmental goals (UNCCD and FAO, 2009).

RESEARCH PROBLEM

Soil erosion remains the most common environmental degradation or ecological problem in Nigeria. This phenomenon which results from the impact of climatic factors, particularly rainfall, and wind is exacerbated by uncertainties arising from climate change effect that occurs both where it directly affects crops or plants where they are growing, and off-site with environmental consequences that manifest as pollution of natural water, impairment of air quality by dust or emission of radio-active gases. Other effects include damage to infrastructure, citation of water ways and reservoirs as well as, increased cost of water treatment.

It has also been observed that information about sustainable and relevant sustainable land management technologies is not readily available to farmers in Nigeria generally, making informed choice about the best possible sustainable land management technologies to be adopted for best result has become difficult due to the fact that most farmers are not informed, government policy do not favor some sustainable land management technologies while some sustainable land management technologies are too expensive to be adopted. It is estimated that millions of metric tonnes of soil are lost to water and wind erosion annually (Souleman et al, 1993). Available statistics in Nigeria shows that over 300gullies existed in Abia state, 270 in Anambra state, 200 in Enugu state, and 250 in Imo state (Ugoriji, 1995). In the light of the above, the question that readily comes to mind is what has been happening to the researches on land management in the study area. Therefore, it is important for the crop farmers in the area to know about the different sustainable land management technologies that can combat this erosion problem and adopt these technologies. It is also pertinent to know the socio-economic and limiting factors associated with the adoption of sustainable land management technologies in the study area

RESEARCH OBJECTIVES

The general objective of this study is to assess the adoption of land management technologies by crop farmers in the study area.

The specific objectives of this study include:

1. ascertaining the level of adoption of the land management technologies
2. determining the constraints militating against the adoption of sustainable land management technologies by the respondents in the study area.

HYPOTHESIS

There is no significant relationship between the level adoption of sustainable land management technologies and the constraints militating against its adoption

JUSTIFICATION OF THE STUDY

It has been observed that there are no studies done on assessing the impact of adoption of sustainable land management strategies in the community. If crop farmers know the impacts of practicing sustainable land management (SLM), it will enable the sustainability of land management practices in Offa local government. In addition, this study will build the strong base to farmers whether offered sustainable land management technologies are worthwhile undertaking or not. Furthermore, study findings will contribute in policy reforms especially on the land conservation.

METHODOLOGY

Study area

The study was carried out in Offa Local Government, Kwara State, Located in central Nigeria with latitude 8.15° North and longitude 4.72° East and 436 meters elevation above the sea level and with population of about 113,830 inhabitants. The population of the study comprised of all crop farmers in Offa local government area.

Sampling procedure

There are 12 wards in Offa local government, thus multistage random sampling technique was used for data collection. First, 5 wards were randomly selected from the 12 wards in the local government area and then a total of 24 crop farmers were randomly selected from the list of crop farmers from each of the 5 randomly selected wards making a total of 120 crop farmers which were interviewed.

Data collection method

Both primary and secondary data were collected for this study. Primary data was collected through the administration of a well structured interview schedule to the selected crop farmers. Information included in the instrument was guided by the objectives of the study. While secondary data was obtained from proceeding reports, textbooks, journals and the internet.

Data analysis

The data for this study was analyzed using both descriptive and inferential statistics. The descriptive statistics used for this study included frequency counts, percentages and mean. Chi-square was the inferential statistics used to test the hypothesis.

RESULTS AND DISCUSSIONS

Table 1: Distribution of respondents according to their level of adoption of sustainable land management technologies, n=120

Sustainable land management technologies	Frequency (%) Always	Frequency (%) Often	Frequency (%) Occasionally	Frequency (%) Not at all	Weighted mean score	Rank
Intercropping	100 (83.3)	5 (4.2)	15 (12.5)	_____	2.71	1st
Crop rotation	78 (65.1)	34 (28.3)	7 (5.8)	1 (0.8)	2.58	2nd
Bush fallowing	13 (10.8)	74 (61.7)	32 (26.7)	1 (0.8)	1.83	3rd
Cover cropping	18 (15.1)	56 (46.7)	41 (34.2)	5 (4.2)	1.72	4th
Use of fertilizer	2 (1.7)	15 (12.5)	62 (51.7)	41 (34.1)	0.82	5th
Mixed farming	3 (2.5)	8 (6.7)	43 (35.8)	66 (55.0)	0.57	6th
Mulching	3 (2.5)	2 (1.7)	28 (23.3)	87 (72.5)	0.34	7th
Strip cropping	_____	1 (0.8)	2 (1.7)	117 (97.5)	0.03	8th
Contour ploughing	_____	1 (0.8)	2 (1.7)	117 (97.5)	0.03	8th
Terracing	_____	_____	2 (1.7)	118 (98.3)	0.02	10th

Table 2: Distribution of the respondents according to the constraints militating against the adoption of sustainable land management technologies, n=120

Constraints	Frequency (%) Very severe	Frequency (%) Severe	Frequency (%) Mild	Frequency (%) No a constraint	WMS	Rank
High cost of production	105 (87.5)	12 (10)	2 (1.7)	1 (0.8)	2.84	1st
Insufficient extension service	30 (25%)	75 (62.5)	5 (4.2)	10 (8.3)	2.57	2nd
High labor cost	85 (70.8)	32 (26.7)	2 (1.7)	1 (0.8)	2.67	3rd
Unavailability of credit	31 (25.8)	73 (60.8)	14 (11.8)	2 (1.6)	2.12	4th
Unavailability of labor	_____	9 (7.5)	61 (50.8)	50 (41.7)	0.66	5th
Inadequate knowledge of modern technique	_____	1 (0.8)	42 (35.0)	77 (64.2)	0.37	6th
Low produce price	_____	2 (1.7)	32 (26.7)	86 (71.6)	0.30	7th
Insufficient land availability	_____	4 (3.3)	7 (5.9)	109 (90.8)	0.13	8th
Transportation problems	_____	_____	11 (9.2)	109 (90.8)	0.09	9th

CONCLUSION

The study concludes that high cost of production, insufficient extension service, high labor costs and unavailability of credit facilities were the major problems affecting the adoption of sustainable land management technologies. By using chi-square the study found that we have enough evidence to reject the null hypothesis that states that; there is no significant relationship between the level adoption of sustainable land management technologies and the constraints militating against its adoption because majority of the constraints have significant relationship with the level of adoption of sustainable land management technologies.

RECOMMENDATIONS

Sustainable land management practices are of great important for their significant positive impacts to our daily life. This has been observed from economic analysis and findings of this study. First, the crop farmers should form financial organizations among themselves to help them generate money in other to solve their problem of high cost of production, high labour cost and unavailability of credit. Second, crop farmers should develop low income methods of land management; this will act as a backup mechanism for those low income farmers to adopt land management technologies. Finally, extension agents should be made available to the crop farmers in other to help guide the farmers on the use of sustainable land management technologies.

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THE ROLE OF ETHICS IN AGRICULTURAL RESEARCH: A REVIEW

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ABSTRACT
Ethics is crucial in research generally. Its role in agricultural research has to do with the application of moral rules and professional codes of conduct to the collection, analysis, reporting and publication of information in the field of agriculture. Respect for persons is an important ethical norm that should guide researcher-farmer relationship. To respect persons means to respect their values, belief and choices; it also means not to use persons as mere resources. Ethics also aims to eliminate misconducts in agricultural research; this it does by rejecting such practices as fabrication, falsification, or plagiarism in proposing, performing or reporting research results. Research misconducts are practices that deviate from those normally accepted within the scholarly or scientific community, that is, deviations from the moral norms of honesty, veracity and integrity, which are essential to responsible conduct of research. Conscious effort must be made, therefore, to teach ethical norms in agricultural research.
Keywords: *Agricultural research, Ethics, Ethical norms, Research misconduct, Responsible conduct of research*

INTRODUCTION
Research is a focused systematic investigation undertaken to increase knowledge and understanding of a subject inclusively to refer to scholarly, empirical, creative, critical, and/ or expressive activities in the sciences, humanities, arts and other scholarly fields, which expand, clarify, reorganize, or develop knowledge or artistic perception. Research conducted for the purpose of contributing towards science by the systematic collection, interpretation and evaluation of data and that [is done] in a planned manner is called scientific research (Caparlar and Donmez, 2016). A researcher is someone who conducts this research.

Ethics and Research Ethics
Ethics is a set of moral principles that distinguishes what is right from what is wrong, i.e., a set of principles or standards by which human conduct is regulated. It is the study of moral obligation involving the distinction between right and wrong. It is the intellectual discipline that investigates the questions "What is the best way for people to live?" and "What actions are right or wrong in particular circumstances?" It is a set of values, principles, and beliefs that guides the behaviour of a specified group, community, or society. In a nutshell, ethics is critical reflection on morality. Ethics studies concepts such as good and evil, right and wrong, virtue and vice, justice and injustice, etc. Ethics aims to achieve two fundamental objectives; to tell us how we ought to act in a given situation, and to provide us with strong reasons for doing so.
Research ethics is the application of moral rules and professional codes of conduct to the collection, analysis, reporting, and publication of information in research involving human beings. Some of the ethical norms that are crucial in the ethics of research are person's right to privacy, confidentiality, and informed consent (https://www.encyclopedia.com/social-sciences/dictionaries-thesauruses-pictures-and-press-releases/research-ethics). Research ethics is based on the principles of equity, justice, and mutual respect, and to manage power relationships effectively, to ensure that the outcomes of the research are used to benefit all parties involved.

Ethical Principles in Research

Ethical principles are the set of values, and standards, used to determine appropriate and acceptable conduct of research at all stages of the research process. Ethical principles include honesty, objectivity, integrity, and openness, respect of intellectual property, confidentiality, responsible publication, responsible mentoring, respect for colleagues, social responsibility, non-discrimination, competence, legality, animal care and respect of persons. These principles are to safeguard human dignity and to promote justice, equality, truth and trust in an effort to create a humane society.

Goal of Ethics in Research

A fundamental aim of the ethics of research is the elimination of research misconducts or deviant behaviours among scientists/researchers. Put differently, research ethics aims among other things to promote the responsible conduct in research, thereby making scientists/researchers good citizens. Research integrity which is a moral quality of life is essential to the good conduct of research, whether in the sciences or any other field of the research endeavour. The lack of integrity is often what is responsible for research misconduct.

Research Misconduct

Research misconducts are practices that deviate from those normally accepted within the scholarly and scientific community for proposing, conducting or reporting research. They are actions or conduct that fall short of the standards of ethics, research and good scholarship. Research misconduct does not include honest error or differences of opinion. Research misconduct means fabrication, falsification, or plagiarism in proposing, performing, or reviewing research, or in reporting research results. Making up data or results (fabrication), changing or misreporting data or results (falsification), and using the ideas or words of another person without giving appropriate credit (plagiarism), improprieties of authorship, misappropriation of the ideas of others, inappropriate behaviour in relation to conduct, conflict of interest —all strike at the heart of the values on which science is based (National Library of Medicine, 2015).

Fabrication is making up data or other relevant information at any stage of the typical scientific process – from research development and application for funding up to the submission of findings for publication.

Falsification is manipulating research materials, equipment, or processes, or changing or omitting data or results such that the research is not accurately represented in the research record.

Plagiarism is the appropriation of another person's ideas, processes, results, or words without giving appropriate credit. It can also involve false attribution. It is a violation of ethical principle because of failure to reveal and credit an existing source. Self plagiarism involves using one's own previously published work (or parts of it) without citing any source, repeatedly publishing copies of one's own research findings or papers in different scientific journals.

Authorship in research: An author is someone who makes substantial intellectual contributions to a publication. He/She contributes substantially to the concept or design of the reported work or data collection, analysis, or interpretation; and drafts or substantively revises the content of the work; and reviews and approves the publication of the final manuscript; and agrees to be accountable for all aspects of the work, or identify which co-authors are responsible for specific parts of the work (Aje Springer Nature, 2023).

Honorary authorship: It is common knowledge that some people who have not contributed to the writing of a paper have their names included in such papers. This is called "Gift" authorship or "Guest" authorship. This practice falls under general name of "honorary" authorship. Studies show that guest/honorary authorship is a common practice among many scholars. However, guest/honorary authorship is an unethical practice that should be discouraged by scholars. Ghost authorship is when someone who substantially contributed to a study is left out of the author list (Aje Springer Nature, 2023).

The Danger of Research Misconduct

Research misconduct violates ethical principles/moral precepts, it undermines the most fundamental tenet of science – trust, undermines the normal progression of science, and also leads to loss of self-esteem. Research misconduct can be prevented by peer review of prepared articles/papers should be standardized and accreditable; institutions can create corporate officers in charge of research integrity, use of international systems to detect scientific plagiarism; using a template of the automated system used by colleges and universities to detect plagiarism in student assignments, collaboration, multiple authorship and mentoring, formal education in ethics, through education and discussion, ethics can impact on moral attitudes and behaviour, critical thinking skills and analytical techniques from the humanities would help researchers understand the implications and context of their actions. Moral integrity is a powerful tool in dealing with the problem of research misconduct. In the context of research, this is what is known as responsible conduct of research (RCR).

Elements of Integrity in Research

Individual: intellectual honesty in proposing, performing and reporting research, accuracy in representing contributions to research proposals and reports, fairness in peer review, collegiality in interaction among researchers, communication and sharing of resources, transparency in (potential) conflicts of interest, protection of human persons in the conduct of research, humane care of animals in research, adherence to mutual responsibilities between researchers and their research teams.

Institutions should provide support needed to ensure responsible conduct of research, respect for everyone involved in the research enterprise, productive mentor-trainee interactions, adherence to rules on all aspects of conduct of research, management individual/institutional conflicts of interests, management of allegations of scientific misconducts, educational opportunities on research integrity, environment that supports integrity in conduct of research.

Improving Integrity in Research

Individuals must be committed to intellectual honesty and personal responsibility. Integrity is an aspect of moral character and experience so attention must be on the issues of integrity in research. There should also be institutional commitment to integrity in form of development and implementation of *programmes* to promote integrity in research, creating a *climate* and promoting a *culture* of responsible conduct of research, supportive *leadership*, effective *educational programmes* and *evaluation* of institutional commitment.

CONCLUSION

The following shared values among scientists is necessary in scientific research; honesty (conveying information truthfully and honouring commitments); accuracy (reporting findings precisely and taking care to avoid errors); efficiency (using resources wisely and avoiding waste); objectivity (letting the facts speak for themselves and avoiding improper bias). Ethical norms are relevant because they promote good science/research. They are a powerful tool for enhancing good working relationships among colleagues. They also help to create a better working environment in society as a whole. “Ethics Counts in Everything” (westafricanbioethics.net). However, conscious effort must be made to teach these norms to people before they can imbibe them.

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THE RELEVANCE OF STALE BED PREPARATION AS A WEED MANAGEMENT STRATEGY IN VEGETABLE PRODUCTION IN NIGERIA

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ABSTRACT
This study investigates the efficacy of stale bed preparation as a weed control strategy in vegetable fields. Stale bed preparation entails creating a seedbed a few weeks in advance of planting and allowing weeds to germinate and be eliminated through various means before sowing the crop. The objective of this research is to assess the impact of stale bed preparation on weed suppression and vegetable crop yield. The study was conducted in a vegetable field over the course of a growing season, comparing stale bed preparation with conventional weed control methods. Various parameters such as weed density, biomass, and crop yield were measured and analyzed. The results indicate that stale bed preparation significantly reduces weed density and biomass, leading to improved crop yield. This study contributes to the understanding of sustainable weed management strategies in vegetable production business. Based on the findings of this study and the existing literature, the following recommendations are made: Farmers and vegetable growers should consider implementing stale bed preparation as a weed control strategy in their fields. This technique has the potential to improve crop yield and reduce reliance on herbicides, further research should be conducted to explore the effectiveness of stale bed preparation in different vegetable crops and under varying environmental conditions. This will help to expand our understanding of its applicability and potential benefits, Extension services and agricultural organizations should provide training and education on stale bed preparation to farmers, highlighting its advantages and proper implementation techniques.
Keywords: *stale bed, weed control, vegetable fields, weeds suppression, crop yield*

INTRODUCTION

Success of the global achievement of food security by the year 2020 as stipulated by the food and agriculture organization of United Nations, largely depend an adequate and proper crop management system. Weeds compete with crops for water, light and nutrient and thereby adversely reduce their yields, quality and exposed then to other pests and diseases (Akobundu, 1997; Melifonwu *et al*., 2000; Onwueme, 1999). Crops exposed to effect of early emerging weeds are said to suffer critical consequences than later (Zimdahl, 2013), Weed control is a critical aspect of vegetable production as weeds compete with crops for resources, reducing yield and quality. Traditional weed control methods often rely on herbicides, which may have adverse effects on the environment and human health/Stale bed preparation is a technique that involves preparing the seedbed in advance, allowing weeds to germinate and be eliminated before planting the crop. This method has shown promise in reducing weed pressure and improving crop yield in other cropping systems, but its efficacy in vegetable fields remains relatively unexplored. Stale bed preparation is a technique that involves creating a seedbed a few weeks before planting and allowing weeds to germinate and be eliminated before sowing the crop.

The crops would have emerged a potential status to submerge any subsequent emerging weeds or to fight back overwintering weed species (Labarada & Parker, 1994). Stale bed preparation in the tropical agriculture is better accomplished by the use of non-selective herbicides which could be used pre-emergence or pre-planting. It means that the field is prepared for crop and the early weeds allowed to emerged and controlled optimally before the sowing or planting of the crop seeds or propagules using selective herbicides. Agricultural areas dedicated to the cultivation of vegetables or staple food crops especially in the tropics are often adversely affected by numerous weed flora of different types which the farmer has to contend with timely and justifiably. Weed suppression or The reduction in weed density and biomass through various means such as cultural practices or herbicides amount to a high percentage of production cost. Unlike in the temperate regions where most weeds appear only once annually, tropical weeds appear and reappear as many times as possible all through the production year (Abdullahi, 2023). It is therefore recommended (Zhimdal, 2013; Abdullahi *et al*., 2017) to appropriate control measures at the critical periods of weed competition with crops. The critical periods of weeds competition in vegetable crops like many other arable or horticultural crops are usually at the early stage of production life of the crops (Abdullahi *et al*., 2017), and hence the relevance of stale bed preparation as a strategy for checking early emerging weeds on vegetable fields.

LITERATURE REVIEW

Previous studies have shown that stale bed preparation can effectively reduce weed pressure and improve crop yield in various cropping systems. For example, Smith *et al*. (2010) reported a significant reduction in weed density and biomass in stale seed. Several studies have investigated the efficacy of stale bed preparation as a weed control strategy in different cropping systems. Smith *et al*. (2010) conducted a study in a cornfield and found that stale seedbeds reduced weed density by 50% compared to conventional methods. They also reported a 20% increase in corn yield in the stale seedbed plots. Similarly, Brown *et al*. (2015) evaluated stale bed preparation in a soybean field and observed a 30% reduction in weed density and a 15% increase in soybean yield. Other researchers have also explored the mechanisms behind the effectiveness of stale bed preparation. Recent advances made in weed management practices brought to notice that the early emerging weeds overcome constitute critical competition with crops for light, water and nutrient in arable fields (Chauhan *et al*., 2012). Several studies of certified periods of weed competitions between crops (Zimdahl *et al*.,1988 and Nazarko *et al*.,2005) that crops face fierce competitions between them and weeds at early stage of their lives. Crops exposed to effect of early emerging weeds are said to suffer critical consequences than later (Zimdahl, 2013), it become wind that it early weeds are checked timely little or no yield loss will be recorded. Management of early emerging weeds cured be pre-planting, pre-emergence or post emergence of crop seedlings (Labrada & Parker, 1994)

Jones *et al*. (2012) conducted a study in a wheat field and found that the process of seedbed preparation and subsequent disturbance caused weed seeds to germinate. These early emerging weeds were then eliminated through shallow cultivation and harrowing before planting the crop. This process reduced weed competition and improved wheat yield. Stale bed preparation is a weed control strategy that involves creating a seedbed a few weeks before planting and allowing weeds to germinate and be eliminated before sowing the crop. This technique has been studied in various cropping systems, and the literature provides valuable insights into its efficacy and potential benefits. Furthermore, studies have shown that stale bed preparation can reduce reliance on herbicides. For example, Smith and Johnson (2014) compared stale seedbeds with herbicide-based weed control in a vegetable field and found that stale seedbeds resulted in similar weed control efficacy while significantly reducing herbicide use. This has important implications for sustainable weed management in vegetable production.

METHODS AND MATERIALS

To assess the efficacy of stale bed preparation as a weed control strategy in vegetable fields, a randomized complete block design (RCBD) was implemented in an additive weed-crop competition experiment on vegetable field in horticultural garden of Federal College of Education, Okene (Latitude 7^0 36’37.34”N, Longitude $6^0$15’ 45.67”67^0 E and Altitude 1236 above sea level), Kogi state , Nigeria. The study included two treatments: stale bed preparation and conventional weed control methods. The vegetable crop chosen for this study was Okra (*Abelmoschus esculentus* L. Moench), NHAE-47.

In the stale bed preparation treatment, the seedbed was prepared four weeks prior to planting the Okra. This allowed weed seeds to germinate, and they were subsequently eliminated through shallow cultivation and harrowing. In the conventional treatment, weeds were controlled using herbicides and mechanical cultivation.

RESULTS

The early emerging weed floras in the Okra field include:

WEEDS	F	RF	RD	SDR
Ageretumconyzoides	50	6.5	3.2	29.1
Borrerialaviculus	50	6.5	1.6	29.1
Borrrerialatifolia	50	6.5	2.0	29.3
Mimosa invisia	50	6.5	1.1	28.9
Mimosa pudica	50	6.5	1.1	28.9
Phyllathusnuriri	50	6.5	3.2	29.9
Imperata cylindrical	50	6.5	1.2	29.0
Croton hirta	50	6.5	2.1	29.3

D = Density, **F**=Frequency, RD= Relative Density and **RIV**=Relative Importance Value

The early emerging weed species were observed in the controlled field which was capable of undermining the germination, growth and development of the Okra seeds as observed on the fields six weeks after planting (6WAP).

Regime	Canopy	PHT	Leaf	Branch	Remark
W_O	55.7a	16.7a	16.8a	3.0a	Weed free (a)
W_n	21.3b	8.0b	13.3b	1.3b	Weedy (b)

The above ANOVA table of mean differences revealed that the early emerging weeds affects the canopy, plant height (PHT), Number of leaves (LEAF), Number of Branches in the fields under the different weeding regimes.

DISCUSSION

Throughout the growing season, various parameters were measured and recorded. These included weed density, biomass, and crop yield. Weed density was determined by counting the number of weeds within randomly selected quadrats. Weed biomass was measured by harvesting and weighing the above-ground plant material. Crop yield was determined by harvesting and weighing the tomatoes. The results showed that stale bed preparation significantly reduced weed density compared to conventional methods. Weed biomass was also significantly lower in the stale bed preparation plots. Additionally, the tomatoes grown in the stale bed preparation treatment exhibited a higher yield compared to the conventional treatment.

The findings of this study align with previous research that has demonstrated the effectiveness of stale bed preparation as a weed control strategy. The process of allowing weeds to germinate and eliminating them before planting the crop reduces weed competition and improves crop yield. This method also offers the advantage of reducing reliance on herbicides, making it an environmentally friendly option for weed management in vegetable fields.

Stale bed preparation offers several advantages as a weed control strategy in vegetable fields. Firstly, it reduces weed density and biomass, leading to improved crop yield. By allowing weeds to germinate and be eliminated before planting, weed competition is minimized, allowing the crop to establish and grow more effectively. This has been observed in various crops, including corn, soybeans, and wheat. It can reduce the reliance on herbicides. Herbicides are commonly used for weed control in vegetable production, but they can have negative impacts on the environment and human health. Stale bed preparation provides an alternative approach that can significantly reduce herbicide use while maintaining effective weed control. This is particularly important in the context of sustainable agriculture and the need to minimize chemical inputs. Additionally, stale bed preparation can improve the efficiency of weed management operations. By allowing weeds to germinate and be eliminated before planting, subsequent weed control measures can be more targeted and efficient. Shallow

CONCLUSION

A close look at the above results revealed that stale bed preparation helps to minimize the presence, density, relative importance value and consequential impact of early emerging weeds on okra like any other arable crops. It has proved to be an effective weed control strategy in weeds management in vegetable fields. This in line with previous studies, which have consistently demonstrated that stale bed preparation, can reduce weed density and biomass, leading to improved crop yields in quantity and quality. It also offers the advantage of reducing reliance on herbicides, making it a more sustainable weed management option in the tropics.

RECOMMENDATIONS

Based on the findings of this study and the existing literature, the following recommendations are made:

1. Farmers and vegetable growers should consider implementing stale bed preparation as a weed control strategy in their fields. This technique has the potential to improve crop yield and reduce reliance on herbicides.
2. Further research should be conducted to explore the effectiveness of stale bed preparation in different vegetable crops and under varying environmental conditions. This will help to expand our understanding of its applicability and potential benefits.
3. Extension services and agricultural organizations should provide training and education on stale bed preparation to farmers, highlighting its advantages and proper implementation techniques.

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UTILIZATION OF FRESH *Sida acuta* AS SUBSTRATES FOR GROWTH AND YIELD OF *Pleurotus pulmonarius*

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ABSTRACT
Mushrooms served as food for man due to their nutritional and medicinal compositions. Sida acuta has been reported to have many medicinal properties but information is limited on its use as mushroom substrate. Thus, this research work aimed at using the plant as a mushroom substrate. P. pulmonarius spawn was obtained from Mushrooms unit, fresh Sida acuta with the roots (substrate) was collected within the premises of the National Horticultural Research Institute (NIHORT) and sawdust was collected from Sanngo sawmill in Ibadan metropolis. Composting was done for 24 hours and 5% ricebran was added to a portion while none was added to the other part. 500 g were separately bagged, replicated 5 times, sterilized and inoculated with the spawn and laid out in a complete randomized design. Cultivation was done on fresh Sida acuta alone, sawdust alone, fresh Sida acuta and sawdust in combination ratios of 1:1, 1:3 and 3:1. Sawdust alone and fresh Sida acuta with sawdust ratio combinations (1:1, 1:3 and 3:1) recorded mushroom fruit bodies yield but none on fresh Sida acuta. Highest fruiting bodies yield (42.67 g) was observed in substrate combination of ratio 1:3 supplemented with ricebran but none on fresh Sida acuta. In contrast, the highest fruit weight (31.67 g) was observed on sawdust alone not supplemented with ricebran. Fresh Sida acuta alone and substrate ratio combination of 3:1 yielded no fruits. With or without ricebran supplementation, Biological and Production efficiencies followed the same trend and the combination of fresh Sida acuta and sawdust yielded mushroom fruiting bodies thus Sida acuta and sawdust combination could be used for oyster mushroom cultivation.
Keywords: *Biological and Production efficiencies, Pleurotus pulmonarius, Ricebran, Sida acuta,*

INTRODUCTION

Mushrooms are fleshly saprophytic spore forming reproductive fungi grown on organic substrates. It had played important roles in environmental cleaning up (bioremediation, mycoremediation) and serve as food for man with regards to its nutritional and medicinal compositions (Tamokou *et al*, 2017). *Sida acuta*, an organic plant of Malvales order, family Malvaceae, is employed by traditional healers in Nigeria and other parts of Africa in the treatment of fever and malaria (Builders, 2017). Its extracts have been reported to have larvicidal effects on *Anopheles stephensi* (Aarthi *et al*., 2014), analgesic (Konate *et al*., 2012), antioxidant (Krishnaveni *et al*., 2018), antibacterial (Mbajiuka *et al*., 2014), neuromodulatory and anxiolytic activities (Benjumea *et al*., 2016). Information is limited on the utilization of this plant for the cultivation of mushroom thus this research work was designed to access the possibility of using the plant as a mushroom substrate bearing in mind the immense medicinal properties of the plant.

MATERIALS AND METHODS

Collection of substrates and P. pulmonarius spawn

Fresh *Sida acuta* with the roots (substrate) was collected within the premises of the National Horticultural Research Institute (NIHORT), while *P. pulmonarius* spawn was obtained from Mushrooms unit, Vegetable and Floriculture Department, NIHORT, Ibadan.

Substrate preparation, sterilization and Spawning

After collection in bags, the substrates were conveyed to the Mushroom Unit, NIHORT, washed and allowed to drain. They were chopped into pieces of size 1-3 cm with a hand cutter. The sawdust used in this experiment was collected from Sanngo sawmill located within Ibadan metropolis. Composting was done for 24 hours and 5% ricebran was added to a portion while none was added to the other part. Substrate bagging was done as follow: *Sida acuta* alone, sawdust alone, fresh *Sida acuta* and sawdust in combination ratios of 1:1, 1:3 and 3:1 with each bag weighing 500 g. After being tucked with PVC (Polyvinyl chloride) neck and cotton wool plug, the bags were arranged in the sterilizing unit and sterilized at 121 ºC for 15 minutes. On cooling, the bags were inoculated with the spawn of *P. pulmonarius* (10% by weight), properly labelled and arranged on the shelves in the dark or vegetative room at the temperature of 25 °C and relative humidity of 81-83%.

Incubation and Cropping

The inoculated substrate bags were observed for a period of 3-4 weeks for mycelia running within the vegetative room. They were brought out for weighing after full mycelia colonization and transferred into the cropping or fruiting house for emergence of mushroom fruit bodies. The temperature within the cropping house was 24-28 ºC and relative humidity at 84-87%.

Mycelia proliferation (extension)

Into test tubes of size 20 x 2.5 cm, *Sida acuta* alone, sawdust alone, fresh *Sida acuta* and sawdust in combination ratios of 1:1, 1:3 and 3:1 were tucked in after being moistened with water and allowed to stay for 24 hours. While a part of each treatment was supplemented with ricebran, none was added to the other part. They were replicated 5 times, tucked with cotton plug, sterilized in an autoclave at 121 ºC for 15 min and inoculated with the spawn of *P. pulmonarius* after cooling. These test tubes were kept in a test tube rack in the vegetative room at room temperature (30 ± 2 ºC) to monitor the mycelia growth. Vertical mycelia extension was recorded and the average extension per day calculated.

Harvesting

Fully opened mushroom fruit bodies were removed manually by twisting the base without leaving any remnants on the substrate bags to avoid rotting. The number of fruits were recorded and weighed with a sensitive scale.

Research design

The experiment was conducted with 5 replicates and laid out in a complete randomized design.

Data Analysis

Data collected were analyzed using ANOVA and significant means separated using Duncan's multiple range tests.

RESULTS

Not all the substrates supported the growth of the mushroom. While the sawdust alone and fresh *Sida acuta* with sawdust ratio combinations (1:1, 1:3 and 3:1) recorded mushroom fruit bodies yield, there was none on fresh *Sida acuta*. From the substrates supplemented with ricebran, a total of 10.00 fruits were harvested from fresh *Sida acuta*/ sawdust substrate combination ratio of 1:3 followed by sawdust alone which was comparable with what was recorded on the ratio 3:1 (5.33 and 5.00 respectively). The least (3.33) was observed on ratio combination of 1:1 while there was no harvest on fresh *Sida acuta* alone. However, from the substrate without ricebran, the highest number of fruits (14.33) was recorded on sawdust alone. This was significantly different from what was observed in fresh *Sida acuta*/ sawdust ratio combination of 1:3 (6.67) while the least (3.00) was recorded in substrate ratio of 1:1. Both fresh *Sida acuta* alone and substrate ratio combination of 3:1 yielded no fruits.

The highest fruiting bodies yield (42.67 g) was observed in substrate combination of ratio 1:3 supplemented with ricebran. However, this was not significantly different from what was harvested on sawdust alone (38.67 g). This was followed by what was observed on the substrate ratio of 3:1 as no fruit was harvested on fresh *Sida acuta* (Figure 1). In contrast, the highest fruit weight (31.67 g) was observed on sawdust alone not supplemented with ricebran. This was significantly different from what was recorded on substrate ratio combination of 1:3. Also, both fresh *Sida acuta* alone and substrate ratio combination of 3:1 yielded no fruits (Figure 1).

With the substrates supplemented with ricebran, the largest width of pileus was recorded on sawdust alone but not significantly different from what was observed on substrate ratio combination of 1:3 (7.07 cm and 6.87 cm respectively). This was followed by ratio combination of 3:1 (3.07 cm). No fruit was harvested on *Sida acuta* alone. From the substrates not supplemented with ricebran, the largest width of pileus was recorded in sawdust alone but not significantly different from what was harvested on the substrate ratio of 1:1 (5.60 cm and 4.60 cm respectively). However, comparable harvest (3.43 cm) was recorded in ratio combination of 1:3. None was recorded in fresh *Sida acuta* alone and ratio combination of 3:1.

From the substrates supplemented with ricebran, the longest length of stipe (4.67 cm) was observed on sawdust alone which was not significantly different from what were recorded on substrate ratio combination of 1:1 and 1:3. The least (1.47 cm) was observed on substrate ratio combination of 3:1 and there was no harvest on *Sida acuta* alone (Table 1). From the substrates without ricebran, the longest length of stipe (3.63 cm) was recorded on sawdust alone. However, this was not significantly different from what was recorded in substrate ratio combination of 1:3 and 1:1 (3.00 cm and 1.90 cm respectively). There was no harvest from substrate ratio combination of 3:1 and *Sida acuta* alone.

The longest mycelia extension (5.88 cm) was recorded in *Sida acuta* alone supplemented with ricebran. All other mycelia extension recorded in the remaining substrates were not significantly different from each other. However, on the substrates without ricebran, the longest mycelia extension was observed on sawdust alone which was statistically similar to what was recorded on ratio combination of 1:1 and 1:3 (Table 1). The least was recorded in substrate ratio of 3:1 (2.75 cm). From the substrates supplemented with ricebran, the longest average mycelia extension per day of 0.24 cm was recorded on the substrate ratio combination of 1:3 but comparable with that of sawdust alone (0.21 cm). What was observed on fresh *Sida acuta* alone (0.15 cm) was significantly different as the least (0.07 cm) was recorded in substrate ratio combination of 1:1. In the substrates without ricebran, the longest (0.20 cm) was recorded in sawdust alone followed by what was observed in substrate ratio of 1:3 (0.20 cm and 0.14 cm respectively) and the least was observed on substrate ratio 3:1.

The least number of days for full mycelia colonization in the substrates supplemented with ricebran was observed in sawdust alone and substrate combination of ratio 1:3 (27.00 days). This was followed by that of ratio 1:1 (33.67 days) which was significantly different from what was observed in that of ratio 3:1 (38.00 days). The longest (40.67 days) was recorded in *Sida acuta* alone. Without ricebran in the substrates, the shortest number of days for full mycelia colonization (10.00 days) was recorded in substrate ratio of 3:1 followed by sawdust alone (30.00 days). On the substrate ratio of 1:3 and 1:1, observations were significantly different from that of sawdust alone (37.67 days and 38.00 days respectively). In agreement with earlier observation on the substrate supplemented with ricebran, the longest (41.33 days) was also recorded on *Sida acuta* alone.

The number of days to mushroom primordia (pin head) in the substrates with and without ricebran followed the same trend and not significantly different from each other. It should be noted that there were no observable pin heads in *Sida acuta* alone (Table 1). Both Biological and production efficiencies followed the same trend with or without ricebran supplementation i.e. fresh *Sida acuta* : sawdust ratio 1:3 > sawdust alone > ratio 3:1 > ratio 1:1 > fresh *Sida acuta* alone (Table).

DISCUSSION

The differences in the support of the substrates to mushroom growth could be attributed to variation in moisture holding capacity and nutrient contents. Chukwurah *et al*. (2013) stated that better performance is obtained from substrates with higher moisture retaining capacity. While minimal harvest was observed on substrate ratio combination of 3:1, no harvest was recorded on fresh *Sida acuta* alone. This may be due to nutrient availability and nature of the substrates as observed by Sharma *et al*. (2013) and Girmay *et al*. (2016). It should be noted that *Sida acuta* was freshly used. Fruiting body yield could be as a result of supply of carbon, nitrogen and minerals from ricebran supplement (Shah *et al*., 2004) with additional supply of carbon from the sawdust. Variations in the nutrient composition of the substrates could be attributed to the weight disparities of the harvested individual fruiting bodies. Moisture holding capacity, lignin and cellulose availability of the substrates could be consequential of the mycelia extension. The result of the spawn running was contrary to an earlier report by Shah *et al*. (2004) that stated 2-3 weeks of *Pleurotus* species on wheat straw, rice husk and sawdust. Also, Otunla *et al*. (2016) reported three weeks after inoculation. The results from the substrate ratio combinations could be attributed to co-substrate properties (Otunla *et al*., 2016). Furthermore, chopped *Sida acuta* in the various ratio combinations could have created crevices within the sawdust to enhance mycelia running and aid aeration of the substrate bags.

CONCLUSION

Fresh *Sida acuta* alone produced no fruiting bodies. However, combination of fresh *Sida acuta* and sawdust, with or without ricebran supplementation, yielded mushroom fruiting bodies. *Sida acuta* must have aided mycelia running in the sawdust combination leading to high mycelia density which resulted in enhanced mushroom yield with large pileus but short stipe. Fruiting bodies with larger pileus and shorter stipes are better than those with smaller pileus but longer stipes (Synytsya *et al*., 2008).

RECOMMENDATION

Fresh *Sida acuta* in combination with sawdust could be used for oyster mushroom cultivation. However, further studies could be carried out on the utilization of the dried *Sida Acuta* as a result of its nutritional and medicinal constituents.

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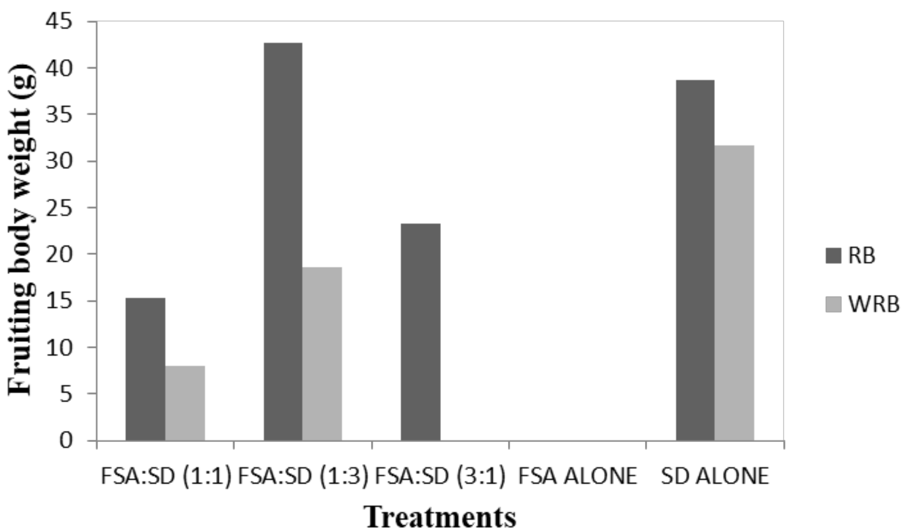

FSA = Fresh *Sida acuta* SD = Sawdust
RB = With ricebran WRB = Without ricebran

Figure 1: Effects of substrates on the mushroom fruiting body weight

Table 1: The effects of substrates on the growth and yield of *Pleurotus pulmonarius*

Parameters	Treatments						
	Ricebran	FSA:SD (1:1)	FSA:SD (1:3)	FSA:SD (3:1)	FSA Alone	SD Alone	LSD
NF	+ +	3.33	10.00	5.00	0.00	5.33	3.84
	- -	3.00	6.67	0.00	0.00	14.33	4.44
Width of pileus (cm)	+ +	5.63	6.87	3.07	0.00	7.07	2.79
	- -	4.46	3.43	0.00	0.00	5.60	3.71
Length of stipe (cm)	+ +	3.08	3.80	1.47	0.00	4.67	1.60
	- -	1.90	3.00	0.00	0.00	3.63	1.79
Mycelia extension (cm)	+ +	5.25	5.63	4.55	5.88	5.25	2.24
	- -	5.75	5.75	2.75	3.75	6.13	2.79
Extension/ day (cm)	+ +	0.07	0.24	0.12	0.15	0.21	0.06
	- -	0.12	0.14	0.03	0.08	0.20	0.04
Primordia initiation (Days)	+ +	36.67	30.00	26.67	0.00	30.00	19.20
	- -	41.00	40.67	41.33	0.00	33.33	2.00
Biological Efficiency (%)	+ +	8.76	24.38	13.33	0.00	20.57	9.67
	- -	6.48	9.52	0.00	0.00	9.39	8.32
Production Efficiency (%)	++	3.15	7.53	4.49	0.00	7.63	3.75
	- -	2.33	3.47	0.00	0.00	5.07	3.02

+ + = Substrate supplemented with ricebran FSA = Fresh *Sida acuta*
- - = Substrate not supplemented with ricebran SD = Sawdust

NUTRIENTS DYNAMICS IN OLD ON-STATION SOLE AND ON-FARM INTERCROPPED COFFEE FOR APPROPRIATE REHABILITATION INTERVENTIONS IN KUSUKU, TARABA STATE, NIGERIA.

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ABSTRACT
Most coffee plantations in Nigeria are on small holdings, old, unproductive and needs rehabilitation. A field assessment by soil and plant nutrient analysis was carried out in Kusuku, Taraba State, Nigeria, on old sole and intercropped coffee plantations to know their nutrient status for appropriate rehabilitation needs. Three coffee fields: on-station plot (sole coffee), on-farm plot A (sole coffee) and on-farm plot B (coffee/kola intercropped), each mapped out to contain 40 stands of coffee plants. Soil samples were collected randomly at 10 different points per plot at 0-30cm using soil auger and the collected soils per plot were mixed to form composite sample per plot. The 4th leaf (indicator leaf) was collected from the 4 coffee stands closed to the soil sample collection points. Collected soil samples were air dried, sieved with 2mm sieve and analysed for textural class, pH, organic C, total N, available P, K, Ca, Mg, Na and exchangeable acidity (Al^{+3} + H^{+}). The plant leaf samples were oven dried at 70 ^{O}C, milled and analysed for N, P, K, C, Ca, Mg, Na, Mn, Fe, Cu and Zn contents. Results showed that the on-station coffee plot soils were acidic and low in organic C, while all the plots were low in the soil Ca, Mg and K contents. However, there was short supply of N and P in the plant leaves indicating N inhibition and P fixation in the soils, which suggest the need to guide against this in the soils, through appropriate organic fertilizer utilization at the rate of 5 tonnes ha^{1-} year^{1-} for 3 years would build up the soil organic C and buffer capacity. Application of liming materials would help to immediately correct the soil acidic condition as well as supply Mg in the soils to rectify the soil Mg/K ratio imbalance. The intercropped coffee with Cola acuminata indicated farmers ingenuity at maximising limited land resource in view of climate change.
***Keywords**: soil nutrients, old, sole, intercropped coffee, economic gain, climate, rehabilitation*

INTRODUCTION
Coffee is a commodity crop of economic importance that is cultivated for the berries which are of high health benefits to man. It is one of the major sources of export revenues for a large number of countries with more than 125 million people worldwide depending on the commodity for their livelihood (Giovannucci, *et. al.*, (2002). Coffee is the second most traded commodity after petroleum and it is the most widely consumed beverage after water (Cyamweshi, *et. al*, 2013). Coffee originated from the highlands of Ethiopia where it is known to have spread to other parts of the world, and finally to Nigeria in the 19th century, with the Arabica and Robusta Coffee being the only two species commercially cultivated and traded in Nigeria. As a major cash crop, Nigeria has fared prominently in coffee cultivation and trade for the past several decades but presently, Nigeria contribution to the world market had dwindled due to oil boom that had led to many farms to be abandoned by the poor resource farmers, while some coffee farmers had converted their coffee farms to arable crop production (Agbongiarhuoyi, *et. al.*, 2006). Most of the remaining available coffee farms are very old and the old age had resulted to gross reduction in berry production. Soil fertility problems and detrimental climate change are two of the major factors that are hindrances to optimal coffee production in Nigeria (Akinpelu, *et al.*, 2021).

The present shifts of Nigeria government from petrol dependent economy to broad based multi-facet resources economy and more importantly, looking at the possibility of improving the economy through cultivation of commodity crops of which coffee is prominent. This could be achieved through interest in new plantations establishment and rehabilitation of old moribund coffee plantations in Nigeria. Presently, lots of research findings have evolved at addressing some of these problems by Cocoa Research Institute of Nigeria. Among rehabilitation technologies include: coppicing method to generate new chupons; the planting of improved varieties of coffee seedlings under old stands and top grafting of improved varieties on regenerated chupons among others. Coffee in the country of origin (Ethiopia), have been known to exist as an under-storey crop but due to commercialisation and large demand for large quantities of quality coffee, the farming system has adopted mono-cropping in high producing countries. However in many parts of the world especially in Africa, coffee is intercropped with crops like *Persea americana*, *Macadamia integrifolia*, *Mngnifera indica*, *Psidium guajava*, *Eriobotrye japonira*,*Musa sapientum* (Mithamo, *et. al.*, 2017). In Nigeria, coffee had been intercropped with both arable and trees crops like rice, cocoa, oil palm and kola, among others (Famaye, *et. al.*, 2020). This study made use of soil test and coffee leaf analysis evaluation to know the nutritional status of some old coffee plots both as sole coffee and as coffee/kola intercrop at both on-station and on-farm plots for appropriate soil nutrient management needs as veritable inputs for proper rehabilitation of Arabica coffee plantations at Kusuku,Mambilla Plateau, Nigeria.

MATERIALS AND METHODS

The field study was conducted at Kusuku using three coffee field locations A, B and C with location A being an on-station site in CRIN Kusuku Sub-station, cropped to sole coffee that has become very old and moribund, while location B was on-farm sole coffee plot site in Kusuku and location C was a coffee/kola intercropped plot. The studied plots were mapped out to contain 40 stands of coffee plants that were identified and leaf samples were collected for laboratory analysis. For the leaf sample collection, 4 coffee stands closed to the soil sample collection site were used. The 4^{th} leaf (indicator leaf) from the upper branches of the coffee plants was sampled. Soil samples at 0-30cm were also collected randomly at 10 different points per plot using soil auger. The soils collected per plot were mixed to form composite sample that represents each plot.

Collected soil samples were air dried in the laboratory, sieved through 2mm sieve and analysed using standard laboratory methods (AOAC, 1990) for the textural soil separates, pH, organic C, total N, available P, exchangeable cations which includes the K, Ca, Mg, Na and the exchangeable acidity (Al^{+3} + H^{+}). Soil particle size analysis was by hydrometer method (Bouyoucos, 1951), total nitrogen content was by Kjeldahl method (Bremner, 1996) and the pH was by pH meter in soil/water ratio of 1:1. Soil organic Cr was by Walkley – Black wet oxidation method (Nelson and Sommers, 1982). The soil available phosphorus was by Bray 1 method (Olsen and Summers, 1982), while the soil cation contents- Ca, Mg, K and Na were extracted with 1.0 M ammonium acetate (NH_4OAc) solution at pH 7.0. Exchangeable Ca and Mg in the leachate were determined by atomic absorption spectrophotometer (AAS) while the exchangeable K^{+} and Na^{+} was determined using flame photometer. The soil exchangeable acidity (Al^{+3} and H^{+}) was by leaching the soils with 1.0N KCl and titrated with 0.05N NaOH and HCl solutions (Mclean, 1982). The ECEC and base saturation levels were calculated. The soil micronutrients – Cu, Zn, Mn and Fe were determined after extracting the soils with 0.1N HCl and the filtrate was read using AAS (AOAC 1990). The micro-nutrient contents were determined and they include Mn, Fe, Cu and Zn.

The coffee and kola leaf samples were oven dried at 70 ^{O}C to constant weight, milled with stainless harmer mill and analysed for the N, P, K, C, Ca, Mg and Na contents in percentage, while the Mn, Fe, Cu and Zn contents were in mg/kg. The samples were digested using nitric-perchloric-sulphuric acid mixture (AOAC 1990) and N content was determined by micro-kjeldah approach while P was done by vandomolybdate colorimetry (IITA 1979) and K, Ca, Mg, Mn, Fe, Cu and Zn contents were read through AAS. The analytical results were compared with each crop corresponding soil and foliar nutrient critical needs (Egbe et. al., 1989; FAO, 2005).

RESULTS AND DISCUSSION

Soil textural properties

The soil separate analysis showed that the soils contained 638-688, 258-294 and 48-68 g/kg soil of sand, silt and clay respectively (Table 1). The soil separate distribution indicates that the soils were generally sandy loam in texture. The silt + clay contents ranged from 332-362 g/kg soil, which was higher than the critical level of 32 g/kg soil ideal for coffee and other tree crops cultivation (Egbe, *et al.*, 1989).This entails that the soils were able to hold sufficient water for the coffee plants, reduce seepage loss and guide against surface run-off that usually leads to soil structural damage (Palmer and Smith, 2013). Similar trend had been reported for soils under coffee cultivation in Uhonmora area of Edo State, Nigeria (Ipinmoroti and Ogeh, 2012)

Tables 1: Soil separate composition and textural class

Properties	On-Station plot	On-Farm Plot	kola/coffee plot
Sand (g/kg)	638	688	658
Silt (g/kg)	294	264	294
Clay (g/kg)	68	58	48
Texture	Sandy loam	Sandy loam	Sandy loam

Soil pH, Organic C and Nutrient Contents

The soil pH, organic C, macronutrients and ECEC contents (Table 2) indicates that the soil pH (4.44-5.90) were acidic. The on-station plot with pH of 4.44 was more acidic compared with the on-farm and coffee/kola intercropped plots. The on-station plot had history of repeated use of nitrogenious fertilizers hence the high acidic nature. However, the soil pH for both the on-farm and coffee/kola intercropped plots were within the soil pH range of 5.5-6.5 stated to be ideal for coffee cultivation, while it was below the critical for on-station plot. This calls for the use of liming materials on the on-station plot to checkmate the acidic condition of the soils, so that it will not become detrimental to coffee performance. Acidic soil condition had been reported to be of great influence on coffee production. A healthy coffee plant requires more than just nutrients; its acidity also needs to be at an optimal pH level, which is between 4.9 and 5.6, and between these levels, the plant is better able to absorb nutrients, resulting in more coffee cherries and less pest and disease-related issues (Cyamweshi, *et al.*, 2014).

The soil organic C for the on-farm and coffee/kola plots was 3.48 and 3.21% respectively, while it was 2.27% for the on-station plot. While the on-farm and coffee/kola plots had soil Organic C levels above the critical level of 3.0%., the on-station plot was below the critical level. The very low soil organic C of the on-station plot must have contributed to the very low pH level of the soil. The soil organic C must be improved upon through the use of organic fertilizers or judicious management of farm wastes and mulching materials on the plot. This act will help to correct the soils acidic nature on the on-station plot. This may be done along with the use of liming materials like dolomite. Organic manure usage had been reported to, among other benefits, helps to reduce soil acidity (Owaiye, 1993; Cyamweshi, *et al.*, 2014)

Table 2: Soil macronutrient contents across the coffee plots

Properties	On-Station plot	On-Farm Plot	Coffee/kola Plot
pH	4.44	5.50	5.90
N (g/kg)	1,45	1.86	2.13
Org. C (g/kg)	22.70	34.80	32.10
P (mg/kg)	27.09	20.84	18.97
K (cmol/kg)	0.32	0.58	0.41
Ca (cmol/kg)	1.86	6.06	7.48
Mg (cmol/kg)	0.60	0.85	1.15
Na (cmol/kg)	0.36	0.52	0.48
Al^{+3}+H^{+} (cmol/kg)	0.13	0.14	0.13
ECEC (cmol/kg)	3.17	8.13	9.62
BS (%)	95.99	98.34	98.63

The soil total N ranged from 1.45 – 2.13 g/kg soil, which was higher for the coffee/kola intercropped plot and it was least for the on-station plot. However, the amounts of N in the soils were higher than the critical level of 0.9 g/kg soil for coffee and 1.10g/kg for kola (Table 3). However, to maintain continuous coffee production on the plots at a sustainable level, it is advised that rational application of nitrogen supplying fertilizers based on yearly removal through crop harvest be made. This becomes imperative due to the very low contents of the soils organic C, which can result to sharp reduction in the soil nutrient supply and more importantly, N supply (Owaiye, 1993; Chatzistathis, *et. al.*, 2021). The soil available P ranged from 18.97 – 27.09 mg/kg soil. This range was higher than the soil critical level of 6.0 mg/kg soil for coffee. However, the value was least for the coffee/kola plot. This trend might be as a result of the additional demand and competition for nutrient by the kola plants in the intercrop. This suggests that a plantation of coffee/kola intercrop will need more attention in soil nutrient management in order to meet the needs of the component crops in the intercrop. This is because intercropping leads to competition for nutrients and may reduce coffee yields and quality (Mithamo, *et al.*, 2017).

Table 3: Coffee soil and foliar nutrient critical levels

Sample	N	P	K	Ca	Mg
	g/kg	mg/kg	←	cmol/kg	→
Soil	0.9	6.0	4.0	8.9	8.0
	←	%		→	
Foliar	1.10	0.07	1.40	0.37	0.13

The soil exchangeable cations indicated that K was 0.32 – 0.58cmol/kg soil. It was least for the on-station coffee plot (0.32cmol/kg) and highest for the on-farm coffee plot (0.58cmol/kg). The values were lower than the soil critical level of 4.0cmol/kg soil. The soil Ca content ranged from 1.86 – 7.48cmol/kg soil. The value was least (1.86cmol/kg) for the on-station plot and highest (7.48cmol/kg) for the coffee/kola plot. However, the Ca contents across the plots were lower when compared to the critical level of 8.9cmol/kg soil. The soil Mg content ranged from 0/503 – 1.151cmol/kg soil. The values were lower compared to the soil critical level of 8.0cmol/kg soil, which was in similar trend as obtained for the soil Ca and K contents. The soil Na content was 0.36 – 0.52cmol/kg soil. The values were low and could not pose any threat to coffee plants and the soil structure.

On the overall, the lower levels of the exchangeable cations compared to their critical levels indicated that there is need for appropriate fertilizer application for adequate supply of the nutrients for optimal and sustainable coffee berry yield on the plantations. This was in trend with the reports by Ipinmoroti and Ogeh (2014) when soils under coffee cultivation were evaluated in Uhonmora area of Edo State, Nigeria. The use of organic fertilizers or manures will be very appropriate so that the goal of improving the soil organic matter content could be achieved along with nutrients supply. Organic manures had been reported to meet the nutritional needs of tree crops like cocoa, kola, cashew and tea in Nigeria (Owaiye, 1993; Ipinmoroti, *et. al.*, 2008). The soil contents for Mg and K showed that the Mg/K ratios were 1.45, 1.57 and 2.48 for the on-station, on-farm and the coffee/kola intercropped plots respectively. It indicated that the coffee plots had inherent problem of nutrient imbalance supply, this is because the soil Mg/K ratio should be 2.0. Therefore, in the soil nutrient management activities, fertilizer application efforts should be geared towards correcting the Mg/k ratio imbalance, the coffee/kola intercrop seems to improve Mg/K ratio.

The soil exchangeable acidity (Al^{+3}+H^{+}) contents ranged from 0.127 – 0.135cmol/kg soil. This shows that the level of soil exchangeable acidity was very low compared to the exchangeable cations. This was reflected in the soil base saturation levels of 96.00 – 98.63% calculated for the soils. The soil effective cation exchange capacity (ECEC) ranged from 3.17 – 9.62cmol/kg soil. The value was least (3.17cmol/kg) for the on-station plot and highest (9.62cmol/kg) for the coffee/kola intercropped plot. The soil level of ECEC was considered to be too low when compared to 30cmol/kg soil that was ideal for soils suitable for the cultivation tree crops production on a sustainable level, with high quality produce (Solly, *et. al.*, 2020). The low ECEC level is of great concern since it is a useful indicator of soil fertility with ability to supply Ca, Mg and K. Inherently, the soils are very low in organic matter contents; this is coupled with the very low clay contents of 48-68g/kg soil (Table 1). These traits are characteristic of tropical soils of which Nigeria soils are inclusive (Igwe, 2011).

Micro-nutrients

The soil micro-nutrient contents (Table 4) showed that the soils Mn ranged from 14.45 – 48.05 mg/kg soil, while Fe content was 25.2 – 42.8 mg/kg soil, it was 3.295 – 5.15 mg/kg soil for Cu and 16.81–61.73 mg/kg soil for soil Zn content. Generally, the soil micro-nutrient levels were within the soil critical level sufficient for coffee production which forecloses the problem of micro-nutrients deficiency in the coffee plots. However, the use of fertilizer materials that could supply some quantity of the various micro-nutrients to the soils will be an added advantage in helping to replenish the soils of nutrients removed through berry harvest. This will help to maintain the soil nutritional level for healthy coffee productions (Abdulmumin, 2014). It helps in maintaining proper plant function and their deficiency can lead to variously physical symptoms in coffee plants.

Table 4: Plots soil micronutrient contents

Properties	On-Station plot	On-Farm Plot	kola/coffee plot
Mn	14.45	48.05	42.95
Fe	25.20	42.85	41.05
Cu	3.495	3.295	5.150
Zn	16.81	61.73	32.85

Coffee foliar nutrient contents

The coffee leaf N content ranged from 0.85 – 1.09% (Table 5) with the least value obtained for the on-station plot, and was highest for the on-farm plot. The values were however lower compared with the critical level of 1.10%. It was observed that despite the high soil N content, it does not reflect in the coffee plant. This might be as a result of N inhibitions in the soil (McCarty and Bremmer, 1989), this was in addition to the nutrient imbalance due to the Mg/K ratio. The leaf P content ranged from 0.04 – 0.11%. The on-farm and coffee/kola intercropped plots were higher in P contents than the critical while it was lower than critical for the on-station plot. This is a sign of P fixation in the soils of the on-station plot. This might be due to the very low organic C contents of the soil with resultant low organic matter and high acidic nature, with high tendency for P fixation (Mahdi, et. al., 2012).

The coffee leaf Ca contents (Table 5) showed Ca contents ranged from 0.61 - 0.74% with the on-station having the highest value of 0.74%, which was followed by the on-farm plot (0.64%) and it was least

(0.61%) for the coffee/kola intercropped plot. The coffee leaf Ca contents were higher than the critical value of 0.37% and were considered adequate for the coffee plants. On the other hand, the coffee leaf Mg content ranged from 0.10 – 0.12% which was low compared to the critical value of 0.13% and was not adequate for the coffee plants need across the various plots. Similar trend was obtained for the leaf K content with a ranged 019 – 0.52% which were lower than the critical level of 1.40%. This could have resulted from the Mg/K ratio imbalance in the soils. This trend is common in most tropical soils with continuous cropping without fertilizer usage and no soil evaluation practice to monitor soil conditions (Ipinmoroti and Ogeh, 2012).

The coffee leaf micro-nutrient contents showed that Mn, Fe, Cu and Zn ranged from 202 – 271, 905 – 952, 30.8 – 40.40 and 197.3 – 293.2 mg/kg soil respectively. These values were high when compared to the soil contents for the elements. It showed that crop removal was higher than their supply to the soil and this would not be able to maintain sustainable optimal quality coffee berry production on the plots. There is needed to make efforts at supplying the soils with adequate amounts. Hence, coffee produce from such plantations would not meet quality standard needed in the world market. This would eventually lead to low produce price at the world market (Agbonguironyi, *et. al.*, 2006; Abdulmumin, 2014).

Table 5: Coffee foliar nutrient contents across the plots

Nutrients	On-station Plot	On-farm plot	Coffee/kola plot
N (%)	0.89	1.09	1.07
P (%)	0.04	0.09	0.11
K (%)	0.19	0.41	0.52
Ca (%)	0.74	0.64	0.61
Mg (%)	0.11	0.12	0.10
Na (%)	0.33	0.31	0.29
Org. C (%)	17.83	22.57	20.41
C/N ratio	20.03	20.71	19.07
Mn (mg)	202.00	264.00	271.00
Fe (mg)	905.00	952.00	944.00
Cu (mg)	30.80	24.20	40.40
Zn (mg)	293.20	20.71	2 48.10

Nutrients needed based on deficiency levels

The overall data collected and analysed showed that there were significant variations in the soil organic C and nutrient contents of the various coffee plots (Tables 2 and 4). These suggested that the soil nutrient management needs would vary from one plot to the other, this calls for plot specific soil fertility managements of the coffee plots, for a sustainable coffee productions. The nutrient status of the various coffee plots showed that the on-farm coffee plot would need C, N, K, Ca and Mg applications while the other two coffee plots would need only the application of K, Ca and Mg. The on-station coffee plot would need 14.6 tonnes of organic manures while 20kg N ha^{1-} would be needed (Table 5). The coffee plots would need 6.24-7.36kg K, 2.84-14.08kg Ca and 13.7-14.8kg Mg ha^{-1} to meet the nutrient demand of coffee plants on the plots. From the Table, Mn, Fe, Cu and Zn supplying fertilizers would not be needed because the location soils are sufficient in these nutrients. However, for good soil health and quality coffee bean production, application of Mn, Fe, Cu and Zn should be based on their yearly removal through coffee berries harvests from the plantations.

The soil organic C need of 14.6 tonnes ha^{-1} was considered enormous that may difficult to cope with at ago (Farouque and Takeya, 2008), it could made a gradual process application of an average of 5.0 tons ha^{-1} year^{-1} until the soil organic C is sufficient for continuous and sustainable coffee production. This could be done through recycling of coffee wastes from the harvested berries, the use of other farm wastes like kola pod husks, cow-dungs, poultry droppings and market wastes that abounds in Nigeria (Adeoye, *et al*., 1993; 2005; Ipinmoroti, *et. al.*, 2007).

Nutrients	Plot Description		
	On-Station	On-Farm	Coffee/kola
Organic C (t/ha)	14.60	-	-
N (kg/ha)	20.00	-	-
K (kg/ha)	7.36	6.24	7.18
Ca (kg/ha)	14.08	5.68	2,84
Mg (kg/ha)	14.80	14.30	13.70

CONCLUSION

The study revealed the need for regular soil and plant nutrient content assessment in order to know the true condition of the coffee plantations and the need for appropriate ways to ameliorate the situation. The coffee plots were very low in the soil organic C, Ca, Mg and K contents. However, the short supply of N and P in the plant leaves requires that steps should be taken to reduce nutrient fixation in the soils. This could be achieved through appropriate organic fertilizer utilization to supply the nutrients and also helps to build up the soil organic matter and buffer capacity. Appropriate application of dolomites liming materials would help to correct the acidic condition as well as supply Mg in the soils to correct the imbalance in the soil Mg/K ratio.

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EFFICACY OF GUM ARABIC FUNCTIONALIZED WITH CINNAMON OIL ON THE NUTRITIONAL AND PHYSICOCHEMICAL QUALITIES OF SCOTCH BONNET (*capsicum chinense*)

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ABSTRACT
The postharvest losses of horticultural products are very high and the rate of losses significantly depends on the type of products and postharvest handling practices. Effect of gum Arabic coatings combined with cinnamon oil on freshly harvested mature scotch bonnet fruits during storage was studied. The scotch bonnet was grouped into 3; Group A was the control and it was dipped in distilled water, group B was dipped in 10% gum Arabic + 3 ml of cinnamon oil and group C was dipped in 10% gum Arabic. The coated fruits were stored for 16 days and observed every 4 days for nutritional and physicochemical changes using standard methods. It was observed that Group C had the least incidence of decay and moisture loss at 40.80 % and 49.91 % respectively. Significantly ($p<0.05$) lower pH (5.98) and 0.56 % Total titratable (TTA) recorded for Group B revealed that the coating caused a reduction in the ripening rate of the fruit compared with the control (Group A) and Group C. Group B was effective in preserving the carotenoid contents of the stored fruits as it recorded the significantly highest values at day 16 for both Lycopene and β-carotene. Results from this study has revealed that 10 % Gum Arabic coating is an effective storage medium for scotch bonnet fruits, while the presence of Cinnamon essential oil helps to maintain the nutritional contents and as well slow down the ripening rate.
Keywords: *Postharvest, essential oil, horticultural, coating*

INTRODUCTION

On a global scale, postharvest losses of fresh produce are estimated to range from 15% to 50%. The main causes of this loss are microbial deterioration, a rapid rise in respiration, and the generation of ethylene, which causes fruit to ripen quickly even after harvest (Borah *et al*., 2016; FAO, 2019; Bist and Bist, 2021). In developing nations, where appropriate methods for storing fruits and vegetables are unavailable, this percentage is far higher (FAO, 2019). The principal causes of losses across the supply chain are postharvest pathogens and disease incidence, which are favored by these changes.Due to the non-degradability of synthetic coating materials, awareness is being drawn to use of eco-friendly biodegradable and bio-polymeric materials in preservation, of which Gum Arabic and essential oils are part.Essential oil, which is a natural compound extracted from aromatic plants. Most of these oils are generally recognized as safe (GRAS) for the environment and human health, and there is growing interest in using these oils for sustainable agriculture. A lot of research has been done with records to backup this claim that plant essential oils and extracts can serve as pharmaceuticals and food preservatives (Miguel *et al*., 2006).

In order to decrease these post-harvest losses, decay-control measures must be developed to retain the quality of fruits and vegetables and offer protection against post-harvest diseases.Thus, this study aims at development of an edible coating from natural bio-materials (gum Arabic and cinnamon oil) for postharvest management of scotch bonnet.

MATERIALS AND METHODS

Collection of materials

Cinnamon bark was procured from mandate market, Ilorin, Kwara State, while fresh Scotch Bonnet was obtained from a farm in Ilorin Kwara State and transported to Nigerian Stored Products Research Institute (NSPRI), Ilorin, Kwara State laboratory in reusable plastic crates in the early hours of the morning.

Extraction of cinnamon oil

Cinnamon oil was extracted as described by Abubakar *et al.* (2014)

Preparation and Application of coating medium

Gum Arabic coating was prepared according to the method of Utami*et al*., (2014) with modification. Ten gramme (10 g) Gum Arabic was dissolved in 100 mL distilled water at 50 °C on a hotplate and stirred for 60 minutes using a magnetic stirrer. The solution was filtered using a muslin cloth to eliminate impurities and 2 mL of glycerol was added as plasticizer to enhance the potency and elasticity of the solution. This was followed by the addition of 3 mL cinnamon oil and tagged solution A. Solution B was prepared as solution A above but without the addition of cinnamon essential oil. The Scotch Bonnet fruits were sorted washed and surface sterilized by immersing in 0.01% hypochlorite solution for one minute and air-dried. The fruits were divided into three (3) lots;Group A (control) was dipped in distilled water for 1-2 minutes,group B was dipped in solution A, and group C was dipped in solution Band allowed to air dry. The treated and untreated fruits were subjected to the same storage conditions and closely monitored with a data logger and stored for 16 days with chemical analysescarried out at 4 days interval.

Estimation of Decay Incidence (%) and Weight Loss (%)

The decay incidence and weight loss was calculated according to the procedure outlined by Lawal*et al*. (2019) and Fashanu*et al.* (2019) respectively.

Determination of Moisture content, Total Soluble Solid (TSS), pH and Total Titratable Acidity (TTA) (%)

Moisture content, pH, TTA and TSS of the stored fruits were determined according to the methods of AOAC (2019).

Carotenoids determination

Lycopene and β-Carotene contents were determined and calculated using the spectrophotometric method reported by Fashanu *et al*. (2019)

Determination of vitamin C content

Vitamin C content was determined using the 2, 6-dichlorophenol indophenol titrimetric method described by Lawal *et al*. (2019).

Statistical analyses

Triplicate data was subjected to Analysis of Variance (ANOVA) and tested for significant difference among treatments by New Duncan's Multiple Range F-Test (DMRT) at ($p<0.05$) using SPSS software package version 20.0.0

RESULTS AND DISCUSSIONS

Decay incidence and weight loss

Figure 1 shows the decay incidence and weight loss of the tested and control groups. Group C had the lowest decay incidence and weight loss at 40.80 and 49.91 % respectively after the experimental period. This group showed more pronounced effects in reducing the decay incidence and weight loss as compared with Group B, (treated with gum Arabic + cinnamon essential oil) and Group A (control). However the increased decay incidence recorded in group B could be as a result of reduced respiration rate caused by cinnamaldehyde; a major organic compound of cinnamon essential oil (Shen*et al*., 2021) thereby putting the fruits in a complete anaerobic state. This result is in agreement with the findings of Maqbool *et al*. (2011) where Gum Arabic and essential oil was used to prevent anthracnose in banana and papaya.

Total soluble solid (TSS)

The total soluble solids, ranged from 0.1 to 0.9 ºBrix (Fig. 2) with group A having significantly ($p<0.05$) higher value (0.9 ºBrix) compared to groups B and C at the end of the experimental period (Day 16).

Generally, there was an increase in total soluble solid as the storage days progressed, however there was no significant (p>0.05) difference between groups B and C at day 16. The increase in total soluble solid of both the treated and the control groups might be due to change in carbohydrate composition from starch to sugar as well as increased respiration rate which can be attributed to environmental conditions thus causing an acceleration to ripening of the fruits (Fashanu*et al.,* 2019).

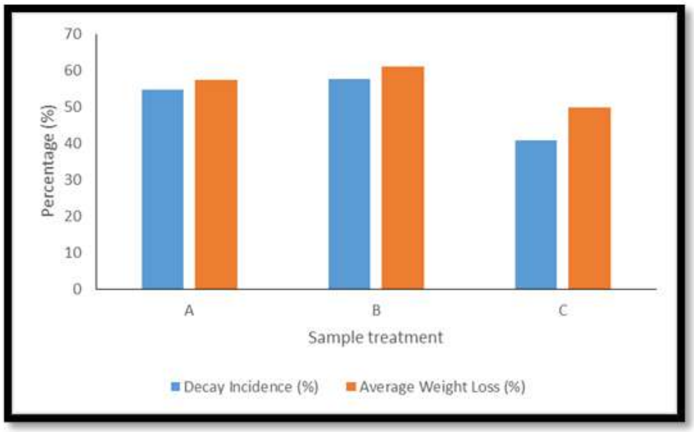

Figure 1: Effect of gum Arabic functionalized with cinnamon oil coating on Decay incidence and average weight loss of scotch bonnet. A=Control; B=10% Gum Arabic + 3mL cinnamon oil; C=10% Gum Arabic

pH and total titratable acidity (TTA)

The pH of both the control and tested groups ranged from 5.8 to 6.8 as shown in Figure 2. The control group had a significantly (p<0.05) higher value (6.8) at day 16 which was above the normal pH range of scotch bonnet (5.0-6.0) as reported by Bray, (2022). This result indicates that group B maintained the normal pH range of scotch bonnet and thus could be used in extending the shelf life of scotch bonnet. On the other hand, the TTA value recorded within the storage period ranged from 0.48– 0.95% (Table 1). There was no significant (p>0.05) difference in the TTA of control and treated samples at day 0, this was expected because they were all from the same source. Conversely, a significant (p<0.05) decrease was recorded for all Groups at day 16, with Group A and C showing no significant (p<0.05) difference. This showed that the acidity of the scotch bonnet reduced over the storage period. The results of pH and acidity are in agreement because, increase in fruit acidity correspond to decrease in pH. This result shows similar trend with the findingsof Maqbool*et al.* (2011)where Gum Arabic and essential oil was used to prevent anthracnose in banana and papaya.

Moisture Content (MC)

The moisture contents of the stored scotch bonnet fruits, as shown in Table 1, reduced as the storage days progressed and it ranged from 71.08to 88.07%. Group C had a significantly higher MC (79.98%) at the end of the experimental period. This showed that Gum Arabic alone is capable of reducing water loss during the storage period, which is in agreement with Ogungbemi *et al.*(2020).

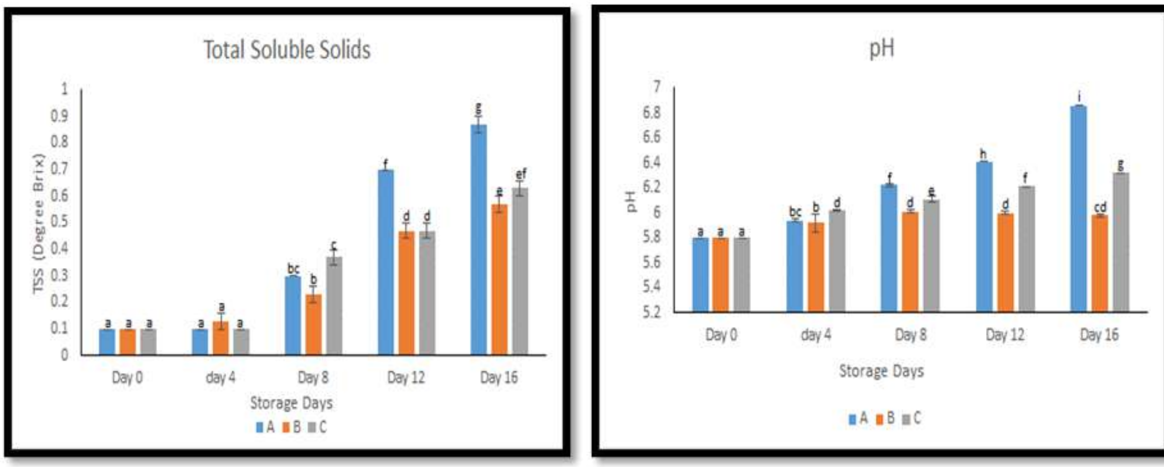

Figure 2: Effect of gum Arabic functionalized with cinnamon oil coating on total soluble solids and pH of scotch bonnet.

Each bar represents mean of triplicate readings (n=3). A=Control; B=10% Gum Arabic + 3 mL cinnamon oil; C=10% Gum Arabic. Bars with unshared alphabet are significantly different ($p<0.05$). Error bars represent standard error (SE) of the mean

Table 1: Effect of gum Arabic functionalized with cinnamon oil coating on moisture content and total titratable acidity of scotch bonnet.

Sample	Days	Moisture (%)	TTA (%)
A		$88.07^{i}\pm0.06$	$0.95^{h}\pm0.02$
B	0	$88.07^{i}\pm0.03$	$0.95^{h}\pm0.03$
C		$88.07^{i}\pm0.02$	$0.95^{h}\pm0.03$
A		$85.41^{gh}\pm0.18$	$0.82^{fg}\pm0.01$
B	4	$85.15^{fgh}\pm0.32$	$0.84^{g}\pm0.01$
C		$86.17^{h}\pm0.69$	$0.84^{g}\pm0.02$
A		$83.82^{ef}\pm0.55$	$0.78^{ef}\pm0.01$
B	8	$83.78^{ef}\pm0.39$	$0.76^{e}\pm0.01$
C		$84.59^{fg}\pm0.19$	$0.69^{d}\pm0.00$
A		$80.76^{d}\pm0.34$	$0.62^{c}\pm0.02$
B	12	$75.10^{b}\pm0.66$	$0.69^{d}\pm0.00$
C		$82.97^{e}\pm0.42$	$0.67^{d}\pm0.00$
A		$78.58^{c}\pm0.80$	$0.48^{a}\pm0.01$
B	16	$71.08^{a}\pm0.88$	$0.56^{b}\pm0.01$
C		$79.98^{d}\pm0.29$	$0.49^{a}\pm0.00$

Result shows mean ± SE of triplicate readings (n=3). A=Control; B=10% Gum Arabic and 3ml cinnamon oil; C=10% Gum Arabic. Bars with unshared alphabet are significantly different ($p<0.05$)

Lycopene, β-carotene and Vitamin C content

The lycopene contents range from 14.91 to 64.21µg/100g (Table 2) with group B having a significantly ($p<0.05$) higher value (64.2 µg/100g) while group C was significantly lowest (33.53 µg/100g) after the experimental period which lasted for 16 days. β-carotene content ranged from 14.34 to 36.77 with group B having a significantly ($p<0.05$) higher value (36.77 µg/100g) and group C (15.30 µg/100g). The Ascorbic acid content observed in Group C was significantly higher ($p<0.05$) than the other groups (28.27mg/100g) at day 16. The result from this study correlated with the studies of Guo *et al*. (2020) who noted that the incorporation of cinnamaldehyde with the carboxymethylcellulose based film packaging helps to maintain the storage quality of cherry tomatoes by suppressing some metabolic activities including respiration.

Table 2: Effect of gum Arabic functionalized with cinnamon oil coating on lycopene, β-carotene and vitamin C content of scotch bonnet

Sample	Days	Lycopene (µg/100g)	β-Carotene (µg/100g)	Ascorbic Acid (mg/100g)
A		$14.91^{a}\pm0.15$	$14.34^{a}\pm0.61$	$10.42^{a}\pm0.17$
B	0	$14.91^{a}\pm0.15$	$14.34^{a}\pm0.61$	$10.35^{a}\pm0.11$
C		$14.91^{a}\pm0.15$	$14.34^{a}\pm0.61$	$10.35^{a}\pm0.08$
A		$26.73^{d}\pm0.04$	$22.68^{e}\pm0.23$	$24.00^{def}\pm2.04$
B	4	$21.64^{b}\pm0.06$	$15.85^{ab}\pm0.41$	$28.81^{g}\pm0.11$
C		$23.77^{c}\pm0.14$	$21.89^{e}\pm1.12$	$22.46^{d}\pm0.10$
A		$29.55^{e}\pm0.34$	$28.65^{f}\pm0.32$	$19.48^{c}\pm0.12$
B	8	$33.82^{f}\pm1.18$	$17.49^{bc}\pm0.31$	$25.17^{f}\pm0.17$
C		$36.23^{h}\pm0.12$	$21.45^{e}\pm0.04$	$18.75^{c}\pm0.07$
A		$49.30^{i}\pm0.10$	$32.28^{g}\pm0.18$	$24.55^{ef}\pm0.06$
B	12	58.52k±0.16	$18.73^{cd}\pm0.13$	$23.36^{de}\pm0.25$
C		$35.04^{g}\pm0.08$	$16.42^{ab}\pm1.92$	$24.50^{ef}\pm0.03$
A		51.09j±0.19	$20.73^{de}\pm0.49$	$14.39^{b}\pm0.54$
B	16	64.21i±0.07	$36.77^{h}\pm0.72$	$18.90^{c}\pm0.07$
C		$33.53^{f}\pm0.21$	$15.30^{a}\pm0.10$	$28.27^{g}\pm0.04$

Result showsmean±SE of triplicate readings (n=3). A=Control; B=10% Gum Arabic and 3mL cinnamon oil; C=10% Gum Arabic. Bars with unshared alphabet are significantly different ($p<0.05$)

CONCLUSION

The study has revealed that 10 % Gum Arabic coating is an effective storage medium for scotch bonnet fruits, while the presence of Cinnamon essential oil helps to maintain the nutritional contents and as well slow down the ripening rate.

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INFLUENCE OF SOIL DEPTH ON JUICE VOLUME OF CITRUS FRUITS

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ABSTRACT
Citrus juice production is a prominent component of its productivity as it is one of the most utilized part of a citrus fruit. However, citrus juice volume and quality is affected by many factors including soil, agronomy and environmental factors. Juice volume assessment was conducted on Citrus Spp var Parson Brown cultivated on soils with degrees of shallowness (60cm, 90cm. >120cm). Matured Fresh citrus fruits were harvested and taken to the laboratory for juice volume assessment. Minimum juice volume varied from 50% (60cm depth) -52% (>120cm depth). Juice Mean values were 52.38%, 53.38% and 53.5% for tree growing on 60cm, 90cm and >120cm soil depths respectively. Highest volume was recorded in >120cm soil depth but this was not significantly different from 90cm depth although both soil depths were significantly different from 60cm soil depth. Soil factors can affect the volume of juice produced. Consequently, it is important to consider this; alongside other factors such as root stock and availability of moisture.
Keywords: *Citrus, fruits Juice volume, soil depth*

INTRODUCTION
Citrus juice contains 86-90% water. The quantity of water in citrus juice affects its acceptability in the market. Many factors affect the quality and quantity of citrus juice. These include soil, weather, rootstock and age of trees. Soil has always played an important role on human health and development. Post-harvest Reduction in juice water creates interesting opportune to remove moisture and making it store longer. Citrus fruit juice are highly nutritious and rich in Vitamins. Consequently, its production for juice need in Nigeria needs to be taken more seriously because of its export and nutritional values. The role of soil is of importance in considering citrus production because water and nutrient retention and absorption by plants are highly affected by soil properties. Shukla *et al.,* 2014 observed positive correlation between fruit parameters such as titrable acidity, total sugars, vitamin C, soluble solids concentration and available soil micro nutrients and macro properties. Environmental factors, moisture availability and absorption moisture have been reported as factors responsible for granulation in citrus. Subsoil constraints that can lower moisture availability in soils and its retention include presence of hard pans/impenetrable layers and high gravel content. Although citrus is a tree crop, over 60% of its roots are concentrated within 60cm of the root surface. This makes it very susceptible to drought and moisture stress; which will ultimately affect juice volume of fruits if it is not corrected by irrigation, This study was carried out to assess the percentage juice volume of *Citrus Sinensis var* Parson Brown as affected by soil depth due to presence of restrictive soil layers.

MATERIALS AND METHODS
Matured citrus fruits were harvested from 3 citrus orchards in NIHORT growing on soils with different levels of suitability due to presence of hard pans. Hard pans in the soils were observed at 60cm, 90cm and >120cm soil depth. Depths of restrictive layer were determined through auger borings in the orchards. Fruits harvested were labeled and taken to the laboratory for analysis. Fruits weight and juice volume were taken and percentage fruit juice was calculated as

$$Juice\ volume = \frac{Juice\ quantity}{Fruit weight} X\ 100.$$

RESULTS AND DISCUSSION

Table 1 shows the effective soil depth, minimum and maximum juice volume recorded per soil type. Highest juice volume was obtained in the soil with higher effective soil depth (>120cm).

Table 1: Descriptive statistics of juice based on soil depths

Soil types	ESD (cm)	Minimum Juice volume (%)	Maximum Juice volume (%)
A	60	50	53
B	90	51	56
C	120	52	55

NB: ESD = Effective Soil Depth

Nutrient and water absorbed by roots from soil are used for plant development. In the case of citrus, level of water absorption from the soils and extent of water availability affect the juiciness of citrus fruits. In citrus production, soil factors are issues to consider. Citrus responds significantly to drought in soils. This causes granulation and low juice quality. Soils vary in their properties and this also affects crop performance. Working on Mango in Brazil, Sequieira *et al* (2019) observed that soil K content and level of gravel contributed to the yield of Mango var Palmer. High gravel in soil affects citrus as gravel contents affect quantity of available soil water and further predisposes the soil to evaporation and low moisture content. According to Hartman (1981), high variability of tropical soils requires thorough studies for good management in order to attain sufficiency in food production. Spatial variability in soil properties results in unevenness in crop performance and makes modeling for soil management difficult (Doberman *et al.,* 1995; Lobell, 2004). Understanding soil variability offers a ley way to sustainable soil management as its response to treatment and use varies significantly with soil type (Jaradat, 2005). Citrus has a fibrous root system which decreases significantly below 60 cm depth. About 60 % of citrus roots reside within 0 – 50 cm, 30 % in 50 – 100 cm and 10 % in > 100 cm. Fibrous root system decreases significantly below 60 cm depth. Few roots are found at 120 cm soil depth (FAO, 2012; Paramasivum *et al.,* 2001; Alva, 2006). In cases where there is low utilization of irrigation, especially in the dry season, most citrus fruits shrivel and produce less juice. However, ability to tap into the water reservoir in lower soils depth can be used to advantage. This is more critical in the dry season and tree roots within the depth of available soil water tend to have more moisture than trees whose roots cannot reach the sub soils. This can reduce juice within fruits of harvested citrus. Juice volume recorded in the three soil types had significantly higher volume in soil types with higher effective soil depth compared to soils with lower soil type Table 2. Soil type A which has severe limitation due to rooting depth was highly marginally suitable for citrus production and was evident in the volume of juice produced by fruits grown on it.

Table 2: Variation in juice volume as affected by soil types

Soil types	Juice volume (%)
A	52.43b
B	53.39a
C	53.49a

CONCLUSION

Soil properties affect juice volume of citrus. It is important to ensure that citrus is cultivated in soils with little or no subsoil constraints such as gravel. Otherwise, adequate irrigation facilities should be put in place to unsure steady supply of water and forestall granulation of citrus fruits

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PERCEPTION OF URBAN GREEN PARK IN IBADAN METROPOLIS OYO STATE

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ABSTRACT
The study examined the perception of urban green park in Ibadan metropolis Oyo state, Nigeria. Structured questionnaire were administered to eighty respondents. Descriptive statistics and logit regression were used to analyze the data. The result showed that nature friendly environment is one of the major factors that may influence the respondents visit to the park. The logit regression shows that age, gender, educational qualification, monthly income, marital status and awareness of the park variable were not statistically significant. Only the variable "Need for the park was statistically significant which means the odd that respondents will be willing to support conservation of the park. Based on the study it was observed that most of the respondents appreciate nature friendly environment and are willing to support conservation of the nature park.
Keywords: *Perception, urban, Green park, Ibadan*

INTRODUCTION

Green Park is a powerful tool in counteracting urban health dilemma. It is a land partly or completely covered with grass, trees, shrubs or other vegetation. Its presence in an area can serve a lot of benefit like providing recreational space for residents, improving physical activit, improve psychological well-being, enhance air and water quality, build climate resilience to flood risk and heat stress Its principally improves the quality of life of the citizen and contribute to the sustainable development of cities People who have more access to green environments tend to walk and be more physically active than those with limited access. Research has shown that when people are exposed to prolonged periods of excessive heat it creates health issues. This problem is made far worse when there is an absence of vegetation. In the face of expanding urbanization and urban population, which have adverse impact on environmental sustainability (Haq, 2011), green infrastructure is considered one of the best planning tools for adaptation to climate change (Yiannakou and Salata 2017). Studies have shown that lands with trees and vegetation produce more relaxed physiological states in people than lands that lack these natural structures, while supporting ecological constancy by providing habitats for wildlife, conserving soil, and enhancing biodiversity.

In Nigeria, urban green areas are scarce and well below the acceptable standards ($9m^2$ of green space per city dweller), as suggested by the World Health Organization (WHO, 2010). Despite all the apparent benefits of urban green space the development of a long-term planning strategy for urban green structure has never been a key priority for local (city and regional) policy makers. In light of the above, it is now predominantly essential to incorporate citizens' concerns, preferences and perceptions into the decision-making and planning processes regarding urban green infrastructure. The benefits derived from urban green area and their objective properties should be understood individually (Kothencz and Blaschke 2017). There is need to examine the perception of open green spaces.to encourage and promote green area.

METHODOLOGY

STUDY AREA

The study area is Agodi gardens and park. The garden is located in Ibadan North Local Government area. Agodi garden is situated near the Oyo state secretariat complex. It stands out as a green lung in the surrounding urban landscape with a great recreational potential. The garden was established as a biological and relaxation centre to provide recreational as well as educational services for inhabitant and visitor. In 1967 it lost it glory as a foremost centre particularly following its destruction by the famous 1980 flood disaster dubbed Omiyale that swept through the ancient city. The Agodi garden of Oyo state has been completely renovated to contain a zoo, swimming pool, bar and restaurants. It equally contains an indigenous forest, lake, tree plantation, and an abundant of medicinal plants and some rare tree species.

Table 1: Distribution of Demographic characteristic of respondent (visitors in the park)

Variable	frequency	percentage
Gender		
Male	37	47.4
Female	41	52.6
Total	78	100.0
Education status		
Secondary	8	10.25
HND/B.Sc	36	46.15
Postgraduate	34	43.59
Total	78	100.0
Marital status		
single	38	48.72
Married	40	51.28
Total	78	100.0
Occupation		
Government	19	24.42
Private organization	14	17.94
Self employed	14	17.94
Others (business)	31	39.80
Total	**78**	**100.0**
Household size		
1 - 3	17	21.79
4 – 6	44	56.41
7-12	12	15.39
Total	**78**	**100.0**
Age		
13-20	9	11.54
21-30	22	28.20
31-40	27	34.62
41-50	15	19.23
51-56	5	6.41
Total	**78**	**100.0**

Table 1 shows that most of the respondents are female (52.6%) this may be due to the fact that female like outing and excitement. This is in line with Ode Sang et al. (2016) who identified that women associate a greater sense of well-being with urban green area than men. In this sample size it was also observed that (40%) were married. High percentage of the respondent have formal education, (34%) have HND/B.Sc and (34%) have postgraduate degrees. This may be due to the fact that they are more enlightened about the need and benefit of recreation. (39.8%) of the visitors to the site are business men and women. This may be due to the nature of their job (not stereotype). It was also revealed that the middle age classes (31-50) have the highest visit to the park. this may be due to the fact that they are in their active age.

Table 3: Respondents perception on factors that influence visits to the park (park user)

Variable	Very well	%	Well	%	Don't know	%	Not at all	%
Proximity	23	(29.5)	26	(33.3)	10	(12.8)	6	(7.7)
Services rendered	20	(25.6)	36	(46.2)	10	(12.8)	2	(2.6)
Facilities in the site	26	(33.6)	31	(39.7)	5	(6.4)	8	(10.8)
Accessibility	29	(37.2)	34	(43.6)	4	(5.1)	1	(1.3)
Nature friendly environment	47	(60.3)	26	(33.3)	1	(1.3)	1	(1.3)
Cost of transportation Health benefit	17	(21.8)	35	(44.9)	8	(10.3)	6	(7.7)
Improvement in quality of air	27	(34.6)	23	(29.5}	15	(19.2)	2	(2.6)
Affordability	26	(33.3)	30	(38.5)	6	(7.7)	2	(2.2)
Learning and education	11	(14.1)	41	(52.6)	2	(2.6)	5	(6.4)
	16	(20.5)	32	(41.0)	9	(11.5)	4	(5.1)
Relaxation	41	(52.6)	32	(41.0)	4	(5.1)	1	(1.3)
Fun and entertainment	39	(50.0)	27	(34.6)	2	(2.6)	3	(3.8)

The result in table 3.0 revealed the perceived factors that influences visit to the park (that is those in the park during the administration of the questionnaire. (33.3%) consider proximity as one of the factors that influences their visit and 46% consider services rendered as one of the factors that influences their visits to the park, Also 39.7% sees facilities in the site as one of the factor that influences their visit), 43.6 % consider accessibility as one of the factor that influences their visit. Most of the respondents (60%) see nature friendly environment as a factor that influences visits to the park. 44.9% consider cost of transportation as one of the factor that influences their visit. 34.6% consider health benefit as one of the factor that influences their visit, 52.6% consider relaxation as one of the factor that influences their visit while 50.6% consider fun and entertainment as one of the factor that influences their visit to the park. From the table above it was observed that majority of the respondent appreciate green environment.

Factors determining respondents' willingness to support conservation

	B	S.E.	Wald	Df	Sig.	Exp(B)
Age	-.046	.062	.534	1	.465	.955
Gender	-.280	.740	.143	1	.705	.756
Education	.406	.513	.625	1	.429	1.500
Marital status	.170	.292	.339	1	.561	1.185
Monthly income	.000	.000	.939	1	.332	1.000
Park awareness	-18.636	2.838E4	.000	1	.999	.000
Need for park	2.886	1.319	4.789	1	.029	17.928
Constant	-.773	2.212	.122	1	.727	.461

From the logistic regression result, age, gender, educational qualification, monthly income, marital status and awareness of the park variables were not statistically significant. This implies that age, gender, education, marital status, monthly income and awareness of respondent of Agodi park do not have any meaningful influence on the decision of the respondents to support the conservation of the park. Only the variable "need for the park" was statistically significant. This means that the odds that respondents will be willing to support conservation of nature park in Ibadan based on their perceived need for the park is about 17.9 times more than those that will not be willing to support conservation of the nature park.

CONCLUSION AND RECOMMENDATION

The study has clearly shown that recreational park in Ibadan is highly esteemed with great multifarious potentials to meet both the social and economic needs of the teeming Ibadan metropolitan populace. Based on the result it is obvious that most of the respondents will be willing to support conservation of nature park in Ibadan based on the variable "need for the park" that is about 17.9times more than those that will not be willing to support conservation of the nature park. It is therefore recommended that Non-governmental Organization should be encourage to go into the establishment of more urban green recreational park, this will generate income as well as stimulate a clean and healthy environment.

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A REVIEW ON NUTRITION AND SOIL FERTILITY MANAGEMENT OF COCOA IN NIGERIA

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ABSTRACT
Majority of the soils in Nigeria are exposed to leaching effects due to incessant rainfall that leads to low organic matter and nutrients contents. The importance of cocoa nutrition cannot be exaggerated because nutrition affects the size and cocoa bean quality. This study was carried out to review nutritional conditions and fertility status of soils for cocoa production in Nigeria. It was revealed that most soils under cocoa production in Nigeria are moderate to marginally suitable in fertility status. However, some of the soil contents for the nutrients needed for high cocoa yield were below critical levels. Therefore, good management practices that would replenish lost nutrient elements in the soil were considered necessary. Recommended rates of organic and inorganic fertilizers for cocoa cultivation are highlighted in this paper.
Keywords*: Nutrition, Soil fertility, Management, Cocoa, Nigeria.*

INTRODUCTION

Still called the "food of the gods", the cocoa tree (*Theobroma cacao* L.), of the Malvaceae family, is a tropical plant cultivated for its beans, from which cocoa powder and butter are extracted. There are three varieties of cocoa: "Forastero", usually yellow but occasionally red when the pod is ripe, "Criollo", more sought after and more expensive, whose pods are red-orange when mature, and "Trinitario", which is hybrid of the two preceding varieties. "Forastero" is the most commonly grown variety in West and Central Africa, but its flavour is not as good, as that of the other two varieties (Kokou Edoh Adabe and Lionelle Ngo-Samnick, 2014). Cocoa is a major source of income for about 5 million small-scale farmers (Poelmans and Swinnen 2016). Cocoa is produced within 10º N and 10º S of the equator where the climate is suitable for growing cocoa trees. West Africa has been the centre of cocoa cultivation for many decades, as two-thirds of the world's cocoa is produced in West Africa. Approximately 74% of the global production originates from four countries in West and Central Africa: Côte d'Ivoire, Ghana, Cameroon and Nigeria (ICCO 2020), where the cocoa plantations are among the least productive in the world (Oomes *et al.,* 2016). This is less than one-tenth of the potential yield of cocoa in West Africa (Zuidema *et al*., 2005).

A considerable part of the cocoa in the world is produced by smallholders, and the International Cocoa Organization (ICCO) estimates that approximately 14 million people are directly involved in cocoa production. Cocoa ranked first amongst agricultural export crops in its contribution to foreign earnings (Tijani *et al*. 2001). It is a crop of economic importance with more than 650,000 ha being cultivated in Nigeria (Sanusi and Oluyole 2005) Cocoa has generally enhanced the economy of Nigeria over the years. It is exported either as raw cocoa beans or cocoa products. Some 70% of Nigeria's annual cocoa exports are to Europe with a further 10% to the United States of America and up to 15% to Eastern Europe. Nigeria is currently the 4th largest producer of cocoa in the world. However, the gross production of cocoa has decreased since 2010 because of declining yields per hectare that started in the early 1990s (FAOSTAT, 2020). Because of the limited availability of land, productivity per hectare will need to increase if Nigeria is to contribute to the increasing global demand for cocoa.

In Nigeria, most of the Cocoa plantations are old and less productive (Ayoola 2000). Most soils under Cocoa plantations and adaptable areas in Nigeria are marginal to moderately suitable in fertility status. The soils are well drained, thoroughly leached and deeply weathered. Cocoa is exceptionally demanding in its soil requirement (Smith 1975). Wessel (1971) showed steady decline in almost all nutrients with length of cultivation. Omotoso (1975) reported that a crop of 1000 kg dry Cocoa beans removed about 20 kg N, 41 kg P and 10 kg K from the soil. It has been reported by Ogunlade *et al*. (2009) that most Nigerian Cocoa farmers don't use fertilizers on their farm. Soil fertility often deteriorates on cocoa farms (Adeniyi *et al*., 2017). Typically, cocoa trees planted on a freshly cleared forest initially benefit from high fertility due to high organic matter levels and well-developed soil structure. However, the subsequent removal of the harvested pods and beans can reduce nutrient levels (Boyer, 1973; Fassbender *et al.,* 1988; Hartemink, 2005; Thong & Ng, 1978; van Vliet *et al.,* 2015), and soil fertility declines if they are not replenished with organic or mineral/inorganic fertilizers (Aikpokpodion, 2010; Hartemink, 2005). Degradation can also occur due to the acidification of the soil from the use of acidifying fertilizers, like urea, organic matter decay, the removal and leaching of basic cations (Goulding, 2016), and an increased availability of toxic elements (Lal *et al*., 1989).

To maintain soil fertility, farmers typically apply amendments and fertilizers to replenish nutrients stocks and correct soil acidity. Few peer-reviewed studies have evaluated their effects both on cocoa productivity and soil properties, and where there is research, it often focuses on short-term effects on seedlings or young cocoa trees (Ahenkorah *et al.,* 1987; van Vliet *et al*., 2015; Wessel, 1971). Verlière (1981) reported that only a few fertilizer experiments with cocoa had provided significant results, and there was a need to determine the interactions between shade management, cocoa nutritional needs, and productivity. Low levels of adoption of good cocoa farming practices, pest and disease attacks, ageing plantations, and poor and decreasing soil fertility contribute to poor average yields (Wessel and Quist-Wessel 2015). Whereas reported yields at farm level vary from 300 400 kg ha^{-1} (Beg *et al*. 2017; Wessel and Quist-Wessel 2015) to 700–900 kg ha^{-1} (Jagoret *et al*. 2017; Jagoret *et al*. 2018), cocoa yields can reach >3000 kg ha^{-1} (van Vliet and Giller 2017; Yin 2004) in on-station trials. Crop simulation models suggest that the potential yield of cocoa exceeds 4000 kg ha^{-1} (Zuidema *et al*. 2005). Poor soil fertility is considered to be an important cause of the prevailing cocoa yield gap in Africa (van Vliet and Giller 2017). Soil fertility refers to the degree to which soils support plant growth. When forests are initially cleared for cocoa plantations, the soils are fertile and can sustain cocoa production for several years, referred to by Ruf and Zadi (1998) as the 'forest rent.' Continuous harvesting of cocoa with no additional fertilisers leads to a decline in soil fertility (Appiah *et al.* 2000; van Vliet and Giller 2017).

The decline of cocoa yields (WCF 2018) contributes to deforestation due to expansion of cocoa farming (Ruf and Zadi 1998). Maintenance and enhancement of soil fertility are essential to increase cocoa production with minimum negative environmental impact (Liniger *et al*. 2011; Vanlauwe *et al*. 2010; Vanlauwe *et al.* 2015). Several scholars cited by van Vliet and Giller (2017) have reported increased cocoa yields in response to fertilisation. For instance, in Ghana, the gross yield of fertilised plots was 61% to 116% higher compared with unfertilised plots (Appiah *et al*. 2000). During fertiliser experiments, yield response was stronger when cocoa was cultivated without shade (ibid.; van Vliet and Giller 2017). Besides mineral fertilisation, soil fertility enhancement can be achieved through the application of organic fertilisers or lime, and inclusion of legumes in the cropping system, or a combination of these (Hartemink 2006; MINADER 2018; Vos *et al*. 2003). The implementation of these practices requires farmers' recognition that declining soil fertility is a problem. Understanding the logic and rationale that underpin current farmers' management of soil fertility is essential for designing interventions to enhance yields. The paper reviewed nutritional conditions and fertility status of soils for cocoa production in Nigeria.

Soil and Land Requirements

Cocoa requires deep and well-drained soil for easy penetration of the roots. Poorly drained soil is inimical to this crop. It is predominantly grown on clay loam and sandy loam soils. It thrives well on wide range of soil types with pH ranging from 4.5-8 .0 with optimum being 6.5-7.0 (CPCRI, 2006). Soil nutrient content to achieve high productivity, cocoa requires a soil abundant in nutrients (Wessel 1971). The importance of other soil characteristics, such as pH, is largely due to their influence on the availability of nutrients. Cocoa needs a soil containing coarse particles and with a reasonable quantity of nutrients, to a depth of 1.5m to allow the development of a good root system. Below that level it is desirable not to have impermeable material, so that excess water can drain away. Cocoa will withstand waterlogging for short periods, but excess water should not linger. The cocoa tree is sensitive to a lack of water, so the soil must have both water retention properties and good drainage. The chemical properties of the topsoil are most important, as the plant has a large number of roots for absorbing nutrients. Cocoa can grow in soils with a pH in the range of 5.0-7.5. It can therefore cope with both acid and alkaline soil, but excessive acidity (pH 4.0 and below) or alkalinity (pH 8.0 and above) must be avoided. Cocoa is tolerant of acid soils, provided the nutrient content is high enough. The soil should also have a high content of organic matter: 3.5% in the top 15 centimetres of soil. Soils for cocoa must have certain anionic and cationic balances. Exchangeable bases in the soil should amount to at least 35% of the total cation exchange capacity (CEC), otherwise nutritional problems are likely. The optimum total nitrogen|total phosphorus ratio should be around 1.5 (International Cocoa Organization, 2020). In Nigeria, most of the Cocoa plantations are old and less productive (Ayoola 2000). Most soils under Cocoa plantations and adaptable areas in Nigeria are marginal to moderately suitable in fertility status. Cocoa can be grown in arecanut and coconut gardens as a mixed crop. It can also be planted in forest lands by thinning and regulating the shade suitably (Hamzat, 2005; Aroyeun, Olubamiwa, Adebowale, Adeogun and Ogunwolu, 2006).

Cocoa Nutrition

Cocoa plant requires adequate nutrients for optimum production. Both macro and micro nutrients are needed. Nitrogen (N), Phosphorus (P) and Potassium (K), Magnesium (Mg), Calcium (Ca), are required in large quantities while Zinc (Zn), Copper (Cu), Boron (B), Iron (Fe), Manganese (Mn), Molybdenum (Mo), Sulphur (S) and Chlorine (Cl) are required in small quantities. Quantities of these elements in the soil and plants are determined through soil and leaf sample analysis. Nutrients application is done to replenish those that are lost. Thus, fertilizers are needed to be applied in the necessary amount. UCDA, (2019) suggested that for proper and effective use of fertilizer, both soil and cocoa leaves should be sampled and analysed once in a year to determine the present status of nutrients and pH of such cocoa plantation. This would make for proper understanding of the nutrient recycling and management of fertilizer for optimum production of cocoa. Adejobi *et al.*, (2011) reported from a research carried out in Ibadan, Nigeria that the use of both chemical (NPK, Ca and Mg) and organic fertilizers significantly enhanced cocoa growth parameters, fresh, dry matter and dry cocoa bean yield.

The need to fertilize cacao (*Theobroma cacao* L.) emerged at the very beginning of the establishment of high-yielding commercial cacao plantations. Results of fertilizer trials were first published in a study conducted in Cameroon in 1910, quickly followed by Java, Trinidad and Ghana, among others (Verlière, 1981). The objective of these studies was to evaluate the effect of each nutrient supplied separately on cocoa yields. The results showed that phosphorus (P) and potassium (K) have always had positive effects on cacao yields. Although calcium (Ca) and magnesium (Mg) have also had positive effects on yields, the responses were much more variable and the quantities were dependent on the environmental condition. The variability of yield responses to nutrients pointed to the need to link the nutrients with each other or with other factors, in particular with soil, climate and topography. In the case of nitrogen (N), a significant effect on yields was rarely observed, except when the intensity of shading is reduced (Evans and Murray, 1953). There are three reasons for the contrasting effects of N (positive, neutral or negative) and its relationship to shading. First, due to the high vigor of the hybrid cacaos, the supply of nitrogen promotes vegetative growth at the expense of the production of pods (Alvim, 1977; Bastide *et al.*, 2003). Consequently, the positive effect of N on yields is only visible when the yield of pods is high and nutrient requirements are consequently high, which is more frequently the case when cacao is grown without shade.

Second, since cacao is cauliflorous, the fruits grow directly on the trunk and primary branches (at the base of the tree), while leaf production is concentrated in the apical branches (at the top of the tree). As N promotes vegetative growth, cacao uses the products of photosynthesis to produce more branches at the expense of flowering and fruiting. By increasing the amount of shade over the fruiting area, N can thus have a rather negative effect on production unless shading is controlled (Wessel, 1985).Third, when nitrogen deficiency occurs in the soil, the need for N may emerge and it becomes a limiting factor for other nutrients, which is quite a common phenomenon in soils with low organic matter content (Snoeck *et al.*, 2016). However, our study also showed that when cacao is grown under shade trees, recycling of organic matter increases soil N content, which improves soil quality with age, thus reducing the need for N in older plots. Nitrogen management should therefore aim for a balance between soil poverty and shade intensity. Based on the findings that P and K are always important and most often the only nutrients required, many governments recommend only one P–K–Ca–Mg-based fertilizer formula for their countries. The same formula may even be recommended in several other countries (e.g. Côte d'Ivoire, Ghana, Togo and Cameroon). Only a few countries (particularly, Brazil and Malaysia) have more specific recommendations, where fertilizer formulas are calculated based on critical N, P and K levels in the soil (Chepote *et al.,* 2013; Ling, 1984; Malavolta, 1997). This simplification, which consists in using very few formulations or even only one for a whole country, goes against the principle of nutrient management of the soil–plant system, which is based on two observations:

Each species has unique nutritional requirements and its own mechanisms underlying soil nutrient absorption. The specific nutrient requirements of cacao were deduced from the results of many trials conducted in many countries (Jadin and Snoeck, 1985).

• Each soil can only supply what it contains, and the availability of each nutrient in the soil varies with the type of soil in interaction and with the properties of the soil–root interface. In particular, pH may be a determining factor for P (retrograded forms) content and cations.

Thus, the objective of nutrition management is to correct the soil so that the cacao plant can find the nutrients it needs in optimal quantities and ratios. The fertilizer formula is determined by physical-chemical analyses of a sample of soil taken from each plot to be corrected. A plot corresponds to a map unit with the same soil and climatic conditions and homogeneous farming practices.

Fertilizer Management

Nigerian soils are generally low in quite a number of essential nutrients due to various factors such as erosion, leaching, bush burning, low activity clay, and among others, hence, these must be provided to foster good and optimum cocoa yield. Large quantities of human, agricultural, forestry and industrial wastes are produced annually which are not being effectively utilized. However, because of increasing costs of chemical fertilizers coupled with disposal problems posed by these wastes, their use as means of maintaining organic matter level and boosting agricultural productivity has become an economic proposition. Studies have shown that ash derived from wood, cocoa pod husk, saw dust, oil palm bunch and other plant sources increased availability of nutrients in the soil and crop respectively thereby causing a significant increase in yield of food crops such as vegetables, maize, yam, cassava e .t .c (Olomilua, *et al*., 2007; Ojeniyi *et al.*, 2007; 2010; Ezekiel *et al.,* 2009b and Ayeni *et al*., 2008a).

Akanbi *et al*., (2014) reported from there trail that Oil palm bunch ash (OPA) contained Ca, Mg and other essential micro nutrients in addition to N, P, K. Similarly, its addition enhanced cocoa seedling growth, dry matter accumulation and improved the soil nutrient status. Therefore, it could be recommended as soil amendment for a depleted soil.

Ogunlade *et al*. (2004) reported a superior performance of neem leaf, its availability all year round unlike the seasonal nature of neem seed production, neem leaf can be considered for organic fertilizer amendment towards the up-grading their N contents.

Ogunlade and Adeoye (2006) reported that the fortification of cocoa pod husk with neem is a release precursor for nitrogen and correction of soil acidification, which are critical factors in Soil fertility and plant nutrition evaluation in low acidity clay soils. They also report a higher soil pH of the amended soil which was probably due to supply of basic cations into the soil system by mineralization of the organic materials. Cocoa pod husk fortified or not fortified with neem seed or neem leaf and NPK gave similar values of height, number of leaves and stem diameter of cocoa seedlings. Fertilizer rates have significant effect on the growth and dry matter yield (DMY) of cocoa seedling. Both organic fertilizer and NPK applied at 10 kg N ha^{-1} significantly enhanced the height, number of leaves, stem diameter and dry matter of cocoa in Ibadan, South West Nigeria. Ipinmoroti *et al.* (2005) reported that manures were better nutrient sources than NPK fertilizers for cocoa seedlings, while formulated from urea + rock phosphate + mutilate of potash mixture was better than other NPK mixtures.

Available phosphorus in Nigeria cocoa soils is low and considered inadequate for good growth and production of cocoa, nutrient imbalance also exists. Low yield of cocoa in Nigeria can be attributed to soil fertility problems among others as clearly shown in an experiment carried out by Ogunlade and Aikpokpodion (2006). The main achievement of the third Nigerian breeding programme are the selection of 10 Nanay and 4 Parinary hybrids and the subsequent development and testing of the new CRIN varieties, all from among the Trinidad introduction population (Ojo and Sanwo, 1981). Amazon cultivars have been shown to respond very favourably to boron fertilizer and foliar applications, increasing the yield by about 30% (Ojeniyi, Egbe and Omotoso, 1981; Olaiya, 2005a). Ojeniyi (1981) reported a response to N (31-35 kg ha^{-1}) and P (36-207 kg ha^{-1}) in a N^4, P^2, K^2, B^2 fertilizer trial on 12-year Amazon cocoa. This result confirmed that phosphorus is the most limiting of all nutrient elements for cocoa production in Nigeria. The micronutrients requirements of cocoa have received considerable attention and of various micronutrients, boron, zinc and copper deficiencies have been found in both cocoa nurseries as well as in matured plantations (Olatoye, Egbe and Chude, 1987). Chude and Obigbesan (1983) detected that 5 ppm B applied, as solubor, was required to raise the leaf B level of six-month-old cocoa seedlings from deficiency to sufficiency level. Foliar application of boron was also recommended to reduce cherelle wilt in old cocoa plantation (Olaiya, 2005a).

Ogunlade *et al*. (2008) reported that the soil pH of their selected site (Ikoromaja cocoa farming community, Osun State was 5.8 fell within the ideal pH range of cocoa. While available P and exchangeable K, Ca and Mg were below the critical values of 10 mg kg ha^{-1}, 0.3, 5.0 and 0.9 cmol kg ha^{-1} soil respectively required by cocoa, the nitrogen, phosphorus and potassium contents of the organic materials indicated similar nitrogen content for both neem leaf and *Chromolena odorata*. All the fertilizers used in the experiment increased dry bean yield compared with control, pod yield was highest (though not significantly) under NPK fertilizer treatment probably due to higher rate of nutrient release compared to other fertilizers (cocoa pod husk based organic fertilizer and organ mineral fertilizer). In another study it was reported that cocoa pod husk compared favourably with the inorganic fertilizer (NPK) on growth parameter such as plant height at 3 and 4 months after transplanting (MAT). This could be an indication that cocoa pod husk could serve as an alternative nutrient source for cocoa seedlings.

Soils of moribund cocoa plantation or previously cropped lands with low soil available phosphorus 16 kg P (37 kgP_20_5) ha^{-1} could be applied. The use of Sokoto rock phosphate could be beneficial for longer period on the field for tree crops such as cocoa (Iloyanomon, 2008).

A trial was conducted at the experimental plot of cocoa research institute of Nigeria Ibadan to study the comparative effect of organically sourced cocoa pod husk ash (CPHA) and urea fertilizer application on soil properties and growth performance of cocoa seedlings in 2010 where the final results of the trial indicated that 25 t ha^{-1}, 30 t $ha^{-1}$and 20 t ha^{-1} of CPHA applications increased the soil, leaf N,P,K,Ca, Mg, Soil pH, organic matter and also plant height, stem diameter, number of leaves, leaf area, fresh and dry shoot weights of cocoa seedlings. It was concluded from the experiment that CPHA could serve as a good fertilizer and liming material for the cocoa seedlings (Adejobi *et al*., 2010).

Adejobi *et al.,* (2011) reported that the different combinations of organo-mineral fertilizer and cocoa pod husk ash are effective sources of organic matter, N, P, K, Mg and Ca for cocoa seedlings. Their application to soil increased growth or cocoa seedlings and uptake of nutrients. Cocoa pod husk can therefore be utilized to the maximum as organic fertilizer supplement and its combination with organo-mineral fertilizer enhance its performance to increase the growth of cocoa seedlings and nutrient uptake. Having reviewed the beneficial effects of applying the different sources of organic and inorganic fertilizers in the cultivation of cocoa in Nigeria. Agbeniyi *et al*., (2010) reported a Lacuna on the usage of fertilizers in cocoa production where they found out from there study that majority of cocoa farmers are not using fertilizer for cocoa production in the study area. They are doing this with the view that their soil is rich enough forgetting that there is a need to replenish the lost nutrients due to pod harvest from time to time.

CONCLUSION AND RECOMMENDATIONS

They study reviewed nutritional conditions and fertility status of soils for cocoa production in Nigeria. It was revealed that Nigerian soils are moderate to marginally suitable for cocoa production and will require good management practices to obtain optimum productivity. Therefore, deficient nutrients should be supplied through the use of appropriate organic and inorganic fertilizers which has been reported to increase cocoa productivity. In another twist, majority of cocoa farmers are not using fertilizer for cocoa production in Nigeria. They are doing this with a view that their soil is rich enough forgetting that there is a need to replenish the lost nutrients due to pod harvest from time to time. Due to this problem, the following recommendations were made:

a) Farmers should be trained on the relevance of soil test to know the fertility status of their cocoa farms. This is very important in view of the fact that some farmers were claiming that their farms were fertile enough and did not require fertilizers application.

b) Government and other stakeholders should encourage the production of cocoa pod husk fertilizer in as much that cocoa farmers are ready to use it to grow their crops. Apart from the fact that the fertilizer will boost cocoa production, it will also reduce the disease infestation that is likely to result due to compilation of cocoa pod husk constituting nuisance on farms.

c) Farmers should be encouraged to improve their level of education. This is quite imperative in as much that level of education was found to have affected the use of fertilizer for cocoa production. Illiterate farmers could be encouraged to undergo adult literacy programme.

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EFFECT OF VARYING LEVELS OF ACHICHI (*Cannabis sativum* l.) SEED OIL EXTRACT IN THE INHIBITION OF BACTERIA SPOT DISEASE OF SCOTCH PEPPER (*Capsicum annumm* l.)

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ABSTRACT

Negative food safety reports over the use of synthetic pesticides in controlling bacteria disease of pepper caused by Xanthomonas campestris pv is increasing in Nigeria, hence the need for friendly options. This research sought to test the inhibitory potential of Achichi Seed Oil (ASO) extract at varying levels on bacteria spot diseases of pepper under field conditions with synthetic bactericide powder (Ridomil Gold) used as a positive control while distilled water constituted negative control. Result showed that application of ASO had bactericidal inhibition potential against the bacteria spot diseases comparable to the synthetic ridomil powder. Application of between 2 – 4 ml / 1liter of water of ASO was found to significantly influence the general performance of sprayed pepper in the study area. Further investigation should be carried out to determine the right volume between the ranges of 2 – 4ml of ASO that can effectively control the bacteria spot disease.

Keyword: *Achichi seed oil (ASO), bacteria spot disease, scotch pepper, inhibition potential, yield*

INTRODUCTION

Pepper cultivation in Nigeria has intensified in recent years with a total production of about 410,033 tons of pepper fruits for both processing and fresh market (Willis *et al.,* 2019) and for commercial and home consumption [Lengai *et al*., 2017; Tijjani et al., 2014]. It constitutes 7% of the total horticultural produce and 14% of the total vegetables grown in Nigeria [Willis *et al.,* 2019]. The fruit is always in high demand since it is consumed by nearly all the households. It is rich in capsaicin which is [Tijjani *et al.,* 2014] and also minerals and vitamins A, C, and E [Asante *et al*., 2013]. The largest percentage of peppers produced in Nigeria is under open field where they are vulnerable to diseases and pests [Wachira *et al.,* 2014]. Diseases such as bacteria leaf spot caused by *Xanthomonas campestris pv. vesicatoria* affect the quality, quantity, and profitability of pepper [Lengai *et al.,* 2017], more importantly when environmental conditions are conducive [Mizubuti *et al*., 2007] and losses can be close to 100% [Mugao et al., 2020]. The symptoms appear as spot lesions on leaves, stems and fruit, and occur on all stages of plant growth (Langston, 2009).

Farmers rely on synthetic fungicides in the control of disease on the field but, there are reported cases of toxicity and residue retention in the food products [Stangarlin *et al.,* 2011] and to beneficial and non-target pollinators [Naing *et al*., 2013] as a result of synthetic chemical misuse.

The worldwide trend to explore organic/biological pesticides as alternative options to synthetic ones is gaining popularity [Zaker, 2016] mainly because of its biodegradable, nonpoisonous, and safe to non-target pollinators and without harmful residues in the food products [Kimani, 2014]. Several plant compounds have been reported to control bacterial and fungal pathogens under vitro and in vivo domain [Nashwa, 2011]. The plant compounds contain essential oils (aromatic and volatile liquids) which have abundant bioactive compounds with antibacterial activity [Mugao *et al.,* 2020; Taghavi *et al,* 2018; Rasheed and Rasheed, 2017] that can replace toxic synthetic bactericide. The current study is therefore aimed at investigating the antimicrobial activity of varying levels of Achichi (*Canabis sativa* L.) seed oil (ASO) extract against pepper bacterial spot diseases under field conditions.

MATERIALS AND METHODS

Location of the study

The study was carried out at the Teaching and Research Horticultural Production Garden, Rufus Giwa Polytechnic, Owo, Ondo state, Latitude 7^0 12^N and Longitude 5^0 35^E, at 300m above sea level. Owo falls under guinea savannah transition zone with bimodal rainfall pattern which varies from 1200mm to 2000mm and spread from April to July, attaining the first peak in July and September to November with noticeable peak in September. The maximum and minimum temperatures of the area average are 29^0C and 15^0C and is also even throughout the year. The relative humidity is 60% during dry season but increase to 80% in rainy season

Collection of diseased pepper plant materials

Sampling was done in Horticultural Production Garden, Rufus Giwa Polytechnic, Owo. Pepper leaves with bacteria spot symptoms were randomly collected inside cool boxes by physical examination to the laboratory and refrigerated at 4^0C for processing and further analysis.

Isolation of the pathogens

V8 and Potato Dextrose Agar (PDA) (Naik *et al*., 2010) were the standard media used for isolation of *Xanthomonas campestris pv. vesicatoria* from the diseased pepper samples. The pepper leaves bearing bacteria spot symptoms were first washed under clean running tap water and then surface sterilized in 1% sodium hypochlorite for three minutes. They were rinsed in three changes of sterilized distilled water and blotted dry using sterilized blotting paper. A sterilized scalpel was used to cut infected leaf tissues of 3 × 3 mm size towards the healthy tissues where the pathogens were suspected to be more active.

The surface sterilized tissues were directly plated on the sterilized PDA and V8 agar for bacteria spot and then incubated in the laboratory at room temperature (27^0C) for three days. The colonies were then subjected to single spore isolation and sub-cultured on the media to obtain pure strains for identification. The isolates were identified using morphological microscopic and macroscopic features and comparing with established identification keys like gram stain, oxygen requirement, spore formation and shape. The isolates were then maintained on plates awaiting their inoculation on pepper plants in the field.

Extraction of achichi seed oils (ASO).

Clean seeds were poured inside a blender (industrial types XL Kenwood Chef Product) and were blended into powder. The powder was then poured inside a rubber container filled with hexane and allowed to stay for 36 hours, so as to get the desired liquid. The achichi seed powder and hexane were poured into a muslin cloth and squeezed with hand to get the extraction of achihi oil needed and the remaining residue left inside the muslin cloth was dispose. The liquid was allowed to settle for 22 hours and then separated. Retort stand was use to hold the soxhlet, condenser was connected to the soxhlet to cover it, boiling flask was connected to the soxhlet to cover it, mantle machine was plugged for heating. The achichi oil was poured inside the boiling flask and put on top of the mantle machine for boiling. It was made to boil for 25 minutes while connected to run through condenser with running water for cooling the hexane pressure. The soxhlet annexed the drops of hexane from the condenser and the extracted achichi oil remains in the boiling flask. The oil was later poured inside a beaker, put inside the oven for 45 minutes in order to drain out remnants of hexane inside the extract. The oil was later bottled and stored in the refrigerator till application in the experiment.

Experimental Design and Layout

The experiment was laid out in a Randomized Complete Block Design (RCBD) with four treatments replicated four times. There were six main plots in a block representing the plants inoculated by the pathogens (*Xanthomonas campestris pv*. vesicatoria). The three treatments comprised ‘control, achichi seed oils at 2 and 4 ml concentration, the positive control (Ridomil Gold synthetic fungicide), and the negative control (distilled water). Ridomil Gold is a curative fungicide manufactured by Syngenta (https://www.syngenta.co.ke/ product/crop-protection/ridomil-gold-mz-68-wg) and comprises Metalaxyl-

M 40 g/Kg and Mancozeb 640 g/Kg formulated as wettable granules. The test pepper variety was Scotch bunnet pepper (Rodo) bought from local market in Owo. It was not specified as being resistant to bacteria spot of pepper.

Prior to planting, the land was tilled, using hand hoe and well decomposed manure was worked into the soil. The land was irrigated to improve the moisture status of the soil. One-month-old pepper seedlings were transplanted in the field

Preparation of Inoculum

Fourteen-day-old cultures of Bacteria spot disease was used as source of the spores. Spore suspension was prepared by adding 5 ml of sterile distilled water to a pure 14-day-old culture in a Petri dish. Dislodging of spores was done with a glass rod and the content sieved using a three-layer cheese cloth to remove the mycelia. The hemocytometer slide was used under a microscope to ascertain the spore suspension concentration and then standardized to 1 × 106 spores per millimeter with sterile water. The inoculum was stored in the refrigerator, at 4^0C, awaiting inoculation.

Inoculation and application of treatments

Inoculation was done on actively growing pepper plants two weeks after transplanting by spraying every plant with the 20 ml of the inoculum using a hand sprayer. Symptoms of disease development began to appear on the 7th day after inoculation. In the preparation for spraying, 2 and 4 ml of achichi seed oil were first mixed separately with sterile distilled water to up to 500 ml thoroughly. Ridomil Gold solution was prepared following the manufacturer's instructions of 2.5 g per liter of water.

Subsequent applications were done after every ten days up to harvesting stage of pepper fruits.

Data Collection and Analysis

Disease severity was scored per treatment after every ten days using a 0–5 scale [Latha *et al.,* 2009] based on the size and number of lesions on the infected leaves as follows:

(i) 0 = healthy (no visible lesions on the leaf)

(ii) 1 = up to 10% of the infected leaf area

(iii) 2 =11%–25% of the infected leaf area

(iv) 3 = 26–50% of the infected leaf area

(v) 4 = 51–75% of the infected leaf area

(vi) 5 = more than 75% of the infected leaf area

The disease scales were converted into percentage for each plant using the formula described by Chaerani and Voorrips (2006) as provided in the equation.

$$\text{Disease severity} = \frac{\text{Sum of all ratings} \times 100}{\text{No. of leaves sampled} \times \text{maximum disease scale}}$$

The disease severity on each plant was determined according to the average of all leaves of a plant counted based on visual assessment [Derbalah *et al*., 2011].

Data was also collected on growth and yield parameters including plant height, number of branches / plant, number of leaf / plant, days to 50% flowering, and number and weight of marketable fruits.

All the data was subjected to Analysis of Variance (ANOVA) using SPSS version 2019 and separation of means was done, using LSD (Least Significant Difference) at 95% level of confidence.

RESULTS AND DISCUSSION

Severity of bacteria spot disease on inoculated pepper plant

Severity of bacteria spot disease on pepper plants inoculated with *Xanthomonas campestris* kept increasing throughout the period of experiment (Table 1). At 2 WAT, the severity of the disease reduced significantly (p > 0.05) with application of achichi seed oil. The achichi seed oils at 4 ml concentration gave similar results to the synthetic fungicide (Ridomil Gold®) used as positive control. The two concentrations (2 ml and 4 ml) varied significantly with the negative control (distilled water). For both concentrations, disease severity was significantly reduced. At low concentration of achichi seed oil (2 ml.) resumption of inhibition commenced late, while the severity continued to increase in negative control treatment.

Effects of achichi seed oils on number of leaf, plant height, and number of branches of pepper inoculated with bacteria spot disease at 2,4,6,8 and 10 WAT

Result showed that there was no significant ($p > 0.05$) difference across all treatments in number of leaf at 2 and 4 WAT. At 6, 8 and 10 WAT, significant difference ($p < 0.05$) were observed under different treatment levels. Control treatment recorded least number of leaves while positive control and two levels of achichi seed oil treatments recorded significantly high values. There was no significant difference in number of leaf at positive control and the two levels of ASO at 6, 8 and 10 WAT. Achichi seed oil at 4 ml (19.58) > 2 ml (18.15) > Ridomil gold (18.11) and > control (12.58) (Table 2).

The pepper plants inoculated with bacteria spot disease did not show significantly variation in height across all treatments at 2 WAT. At 4 WAT the pepper plants under control treatment showed significantly ($p < 0.05$) low plant height (3.41 cm) than all the other treatments. Positive control, 4 ml and 2 ml of achichi oil treatments did not show significant variation in plant height. At 6 WAT the plant height varied significantly ($p < 0.05$) among the treatments with plants in the control treatment being shortest in relation to the plants treated with 4 ml, 2 ml and Ridomil gold (control). Pepper plants sprayed with 2 ml achichi seed oil and positive control (Rindomil g) did not vary significantly in plant height, but 4 ml was significantly higher from both the positive control and 2 ml treatments (Table 3).

There was significant influence of treatments on bacteria spot disease on number of branches of pepper plant across all stages of measurement ($p < 0.05$). Among treatments, the negative control recorded the lowest number of branches while pepper plants sprayed with 4 ml of achichi seed oil showed increased number of branches. There was no significant difference in number of branches on plants treated with 2 ml of achichi seed oil and positive control treatments (Table 4).

Effects of achichi seed oils on days to 50% flowering of pepper inoculated with bacteria spot disease

The treatments significantly ($p < 0.05$) influenced the number of days to 50% flowering on the pepper inoculated with bacteria spot disease. Treatment at 4 ml of achichi seed oil had significantly shorter days to attain 50% flowering date followed by the positive control, then 2 ml. The negative control treatments took longest time to attain 50% flowering date in relation to the other treatments (table 4).

Effects of achichi seed oil on number of fruit and fruit weight per plant of pepper inoculated with bacteria spot disease.

The number of pepper fruits produced varied significantly ($p < 0.05$) among the treatments (Table 4). Among pepper plants inoculated with bacteria spot disease the negative control recorded the lowest number of fruits per plant. The number of fruits per plant increased with application of positive control (Rindomin G =5.88) and achichi seed oil extracts (4 ml =5.99) and (2 ml =5.86). there was no significant ($p > 0.05$) difference among treatments. Also**,** application of achichi seed oil at 2, 4ml and positive control (ridomil gold) on pepper plants significantly influenced fruit weight of pepper than the negative control. Application of achichi seed oil at 4 ml increased fruit weight more significantly than positive control (Ridomil Gold) and 2 ml. Values of positive control and 2 ml were not significantly ($p > 0.05$) different levels (Table 4).

Table 1: Effect of achichi seed oil on disease severity of inoculated pepper plant

Age	Control	Rindomin G	ASO 2ml	ASO 4ml	LSD
2 WAT	19.87*	10.06ns	10.02ns	10.11ns	0.45
4 WAT	40.52**	9.27*ns	9.45*	9.02ns	0.28
6 WAT	57.27*	7.75ns	7.82ns	7.38ns	1.18
8 WAT	62.69*	7.23ns	7.55ns	7.22ns	1.02
10 WAT	70.06*	7.07ns	7.26ns	7.10ns	0.98

NOTE: ** = Very significant, * = Significant, ASO = Achichi Seed Oil, LSD = Least Significant Difference, WAT= Week After Transplanting.

Table 2: Effect of achichi seed oil on disease severity on number of leaf of inoculated pepper plant

Age	Control	Rindomin G	ASO 2ml	ASO 4ml	LSD
2 WAT	4.16ns	4.16ns	4.17ns	4.15ns	0.52
4 WAT	7.23ns	7.55ns	7.45ns	7.56ns	0.42
6 WAT	10.65ns	16.02*	15.86*	16.03*	1.00
8 WAT	12.00ns	17.16*	17.12*	17.21*	0.63
10 WAT	12.58ns	18.11*	18.15*	19.58*	1.00

NOTE: ** = very significant, * = significant, ASO = Achichi Seed Oil, LSD = Least Significant Difference, WAT= Week After Transplanting.

Table 3: Effect of achichi seed oil on disease severity on plant height of inoculated pepper plant

Age	Control	Rindomin G	ASO 2ml	ASO 4ml	LSD
2 WAT	3.41ns	5.09*	4.98*	5.10*	0.66
4 WAT	5.00ns	8.62*	7.76*	8.64*	0.82
6 WAT	10.55ns	14.36*	13.84*	14.73*	1.02
8 WAT	13.18ns	15.00*	14.98ns*	15.25*	0.78
10 WAT	17.56ns	19.93*	20.02*	20.06*	1.28

NOTE: ** = very significant, * = significant, ASO = Achichi Seed Oil, LSD = Least Significant Difference, WAT= Week After Transplanting.

Table 4: Effect of achichi seed oil on disease severity on growth and yield of inoculated pepper plant at 50% flowering stage and harvest

Parameters	Control	Rindomin G	ASO 2ml	ASO 4ml	LSD
No of branches	2.63ns	3.31*	3.28*	3.53*	0.50
DTO 50% Flowering	62.00ns	56.17*	56.05*	57.23*	2.15
No of fruit	3.68ns	5.88*	5.86*	5.99*	0.66
Weight of fruit (g)	28.65ns	35.63*	34.96*	36.21**	1.03

NOTE: ** = very significant, * = significant, ASO = Achichi Seed Oil, DTO =Days to Flowering, LSD = Least Significant Difference, WAT= Week After Transplanting.

DISCUSSION

Disease severity was not significant on the number of leaf at 2 – 4 WAT. The reason could be attributed to inherent genetic resistant of the pepper plant against the disease during the formative stage of the pathogen and also that the environment may not compromise with quick establishment of the pathogen at the time of inoculation (Chatfield, 2000). At 6 – 10 WAT disease severity was high on pepper plants inoculated with bacteria spot under negative control, reducing the plant vegetative growth (number of leaf, plant height and number of branches). Pepper plants inoculated with bacteria spot under positive control (Rindomil gold) and the two levels of achichi seed oil (2 and 4 ml) had low severity of disease infection, hence increase vegetative growth (number of leaf, plant height and number of branches), showing that the disease suppression mechanism, though varied with application level of the treatments, were effective. Kagale *et al*., (2004) pointed out that the mechanism of diseases suppression may be either by active antimicrobial compounds acting on the pathogen directly by destroying their membranes thus lowering disease development. This study showed that the antibacterial effects of achichi seed oil (ASO) reduced the chance of the pathogen developing resistant traces after application (Rasheed and Rasheed, 2017) and was comparable to that of Ridomil Gold synthetic fungicide (Lengai *et al*., 2017; Nashwa and Abo-Elyousr, 2012).

Flowering accounted for fruiting and yield of crops. This study showed that ASO efficacy was reflected in the attainment of Days to 50% flowering stage, fruit and yield of pepper when compared with the untreated control. Late resumption of days to 50% flowering stage of pepper plant under negative control was indication that the pathogen had implicated the physiological and biological processes of growth of the plant thereby affecting flowering formation. On the other hand, plants under positive control (Rindomil gold) and the two levels of ASO assumed 50% flowering stage early which led to production of more flowers that eventually increased fruits and yield of pepper, which showed the capacity of ASO in controlling bacteria spot disease of pepper. Essential oil, according to Din *et al*., [2016], contains secondary metabolites such as organosulfur, phenols, and alkaloids which are antimicrobial which reduce the chance of pathogens to cause disease in plant. This corroborated the theory of Naing *et al*. [2013] that some organic pesticides induce disease resistance systems of the plant which lead to healthy growth of the plants and thus better production. Nashwa and Abo-Elyousr, [2012]; Ahmad *et al*., [2017] also showed that the Eucalyptus camaldulensis (eucalyptus), Ocimum basilicum (sweat basil), Allium sativum (garlic), Nerium oleander (oleander), Datura stramonium (jimsonweed), and *Azadirachta indica* (neem) plant extracts boosted the yield of tomato as compared to the control.

CONCLUSION

The study showed that the essential oils from Achichi seed (*Canabis sativum* L. seed) is as effective as the Ridomil Gold ® synthetic fungicide in managing the bacteria spot of pepper. The treatments significantly boosted the growth and yields of pepper plants. The essential oil can therefore be incorporated in the bacteria spot management as eco-friendly option to synthetic pesticides. This will lower the chemical residue levels in fruits of pepper thus improving the fruit quality and reducing the risks and hazards of toxic fungicides.

RECOMMENDATION

Further research should be conducted to determine the right volume between 2 – 4ml of ASO (achichi seed oil) extract that will effectively control or inhibit the severity of bacteria spot disease on pepper that will not lead to waste of material and resources.

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EFFECTS OF PRETREATMENTS ON CAROTENOID CONTENT IN PULP OF PUMPKIN VARIETIES (*Cucurbita pepo L.*).

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ABSTRACT

The prevalence of micronutrients deficiency especially vitamin A is on the increase due to poor dietary intake. Hence, there is need to address this problem with pro-vitamin rich foods. Pumpkin which has high carotenoid content is a good candidate for alleviating vitamin A deficiency. The effects of boiling and steaming on the carotenoid contents in the pulp of two pumpkin varieties (Orangetti and Connecticut field) obtained from National Horticultural Research Institute farm around July 2023 was modeled and optimized. The pumpkin pulp was steamed and boiled for varying time between 0 to 6 minutes, and total carotenoid content was determined on it. The result showed that the carotenoid content decreased for variety 1 (Orangetti) after treatment from 13.79 to 9.40 µg/g. while the second variety increased after treatment from 8.96 to 29.40 µg/g. Central composite design of response surface methodology was used as statistical indicator with boiling and steaming time (0-6 minutes) serving as independent variables. As indicated by p-values that of 0.01 and 0.02, both boiling and variety had a significant impact on the carotenoid content of pumpkin pulp. However, steaming had no significant impact on the carotenoid content. The optimization result revealed that Connecticut field was the most desirable with 28.511 % of carotenoid by steaming at 2.6 minutes and boiling for 6 minutes. This study deduced that application of heat to pumpkin improved the carotenoid content compared to the raw form.

INTRODUCTION

Micronutrients malnutrition, particularly vitamin A deficiency, affects about three billion people worldwide (Pritwani and Mathur, 2017). Vitamin A Deficiency (VAD) has afflicted around 5.2 million preschool-aged children and 9.8 million pregnant women, primarily in sub-Saharan Africa , according to the World Health Organization (WHO) (Ohanenye *et al.*, 2021). Vitamin A is required for adequate vision, epithelial tissue integrity, and a wide range of other metabolic processes (Pritwani and Mathur, 2017). According to studies from developing countries, pro-vitamin A-rich foods account for up to 80% of dietary vitamin A intake (Cardoso *et al.* (2009);Van den Berg *et al.* (2000). Vitamin A is available in the form of pro-vitamin A carotenoids, which are pigments generated by many plants and found in green, orange, and yellow plant tissues. Most fruits and vegetables contain carotenoids and encouraging their injection daily can serve as a good potential in tackling VAD. According to the report of Pritwani and Mathur (2017), vegetables that are excellent sources of carotenoids include but not limited to carrots, green pepper, spinach, sweet potato, and pumpkin.

Pumpkin also referred to as squash exist in the family of Cucurbitaceae, genus Cucurbita (Shamsuri and Ahmad, 2019). It is widely grown throughout the tropical and subtropical countries. The most common species of pumpkin are C. maxima, C. pepo, and C. moschata (Lucia Maria Jaeger *et al.*, 2012). The flesh of the fruit is distinguished by its hard outer cover with characteristic yellow to orange colour which indicates the presence of carotenoids, with firm texture and flavour (Chuwa *et al.*, 2022). Rodriguez *et al.*

(2018) reported that the fruit is abundant in minerals such as potassium, calcium, phosphorus, ß-carotene (which can be converted to vitamin A), dietary fibre, and lycopene. Vegetables are eaten in either raw or cooked form. Research has shown that most nutrients in fresh vegetables are preserved in the raw condition, however any degree of cooking leads in partial loss of nutrients and significant changes in its sensory properties. Some researchers have conducted studies on the effects of different cooking methods on pumpkin (Shamsuri and Ahmad (2019);Lotfy *et al.* (2017). However, studies focused on modeling and optimization of cooking methods on the total carotenoid content of pumpkin is very hard to come by. Therefore, this study modeled and optimized the effects of boiling and steaming on the total carotenoid content of two varieties of pumpkin using response surface methodology (RSM).

Variety 1 (Orangetti)

Variety 2 (Connecticut field)

MATERIALS AND METHODS

Sample preparation

Two pumpkin varieties (Orangetii and Connecticut field) cultivated and harvested at the same time were obtained from the Research Farm of National Horticultural Research Institute, Ibadan, Oyo State. Fresh samples were washed and peeled to remove the outer skin. The seeds were removed and the pulp was cut into smaller sizes and divided into eight portions to increase the surface area in order to facilitate the treatment process i.e. boiling and steaming. For boiling, 20 g of the sample was randomly selected from the lot and was immersed in boiling water at 100°C for 0 to 6 minutes based on the experimental design while steaming was conducted by placing 20 g of the sample above boiling water in a steamer with lid for varying time between 0 to 6 minutes.

Determination of total carotenoid

The total carotenoid content of the pumpkin was determined according to the method oLucia Maria Jaeger *et al.* (2012) with little modification. This was done by weighing 0.5 g of the mashed sample into a 20 ml test tube and 5 ml of cold acetone was added and mixed to form a paste, and the mixture was continuously shaken until it became colourless. The extract was then transferred into a 100 ml separating funnel containing 8 ml of n-hexane, and the acetone was separated by slowly adding water to avoid the development of an emulsion, and the aqueous phase was discarded. The technique was repeated until there was no more remaining solvent. The procedure was repeated until no residual solvent remained. Then the extract was transferred to a 50 ml volumetric flask containing 3 g of anhydrous sodium sulfate and the volume was made up to its full volume by adding n-hexane and read at 450 nm with a UV-visible spectrophotometer (T80 series UV-visible double beam spectrophotometer).

$$\text{Carotenoid content } (\mu g/g) = \frac{A \times V(ml) \times 10^4}{A^{\%}\ 1cm \times P}$$

Where A= Absorbance; V=Total extract volume; P= sample weight; $A^{\%}{}_{1cm}$ =2560 (ß-carotene Extinction Coefficient in n-hexane).

Experimental design and statistical analysis

The experimental design used in this study was the central composite design of response surface methodology; with three independent variables; in which two are numeric (boiling (0-6 minutes) and steaming (0-6 minutes), and one categorical factor (varieties). A total of 18 experimental runs was generated using Windows design expert version 13. Table 1 below gives the details of the experimental runs and the treatment combinations considered for each of the run. The data obtained for the corresponding carotenoid content responses for each of the runs was then subjected to multiple regression analysis. This was done by fitting the data into polynomial models whose fitness was verified using R^2 (coefficient of determination) and the corresponding p-value.

RESULTS AND DISCUSSION

The carotenoid content of the pumpkin pulp decreased after steaming and boiling for Orangetti from 13.79 % to 9.40%. While for Connecticut field, the carotenoid content increased upon steaming and boiling from 8.96 % to 29.40% as shown in table 1 below.

Table 1: Experimental runs, treatment combinations, and carotenoid content of the two varieties of pumpkin pulp.

Runs Variety 1	Factor 1 A: Steaming (minutes)	Factor 2 B: Boiling (minutes)	Carotenoid content (µg/g) Mean ±S.D	Runs Variety 2	Factor 1 A: Steaming (minutes)	Factor 2 B: Boiling (minutes)	Carotenoid content (µg/g) Mean ±S.D
1	0	0	**13.79**±0.51	**10**	0	0	8.79±0.16
2	6	0	**10.38**±0.92	**11**	6	0	21.29±0.10
3	0	6	**8.92**±0.75	**12**	0	6	24.06±0.13
4	6	6	**12.86**±0.80	**13**	6	6	22.34±0.13
5	0	3	**10.00**±0.47	**14**	0	3	17.17±0.57
6	6	3	**11.46**±0.67	**15**	6	3	19.25±0.06
7	3	0	**7.94**±0.13	**16**	3	0	8.96±0.24
8	3	6	**10.60**±0.82	**17**	3	6	29.40±0.41
9	3	3	**9.40**±0.35	**18**	3	3	20.23±0.25

As shown in the table below, the p-value of the model is 0.0215 which is less than 0.005, indicating that the model is significant. Due to the p-values above 0.05, steaming (A) is not a significant factor while boiling (B) and variety (C) is a significant factor. However, the interaction between AB and AC are not significant, while BC and ABC are significant. This implies that both boiling and variety affects the carotenoid content no matter the treatment time of exposure while steaming does not influence the carotenoid content. The model's F-value of 5.76 obtained implies that the model is significant, and it is a good fit for predicting the responses. An R^2 value of 0.91 indicates that the model is a good predictor for the data.

Table 2: Analysis of variance table for carotenoid responses.

Source	F-value	p-value
Model	5.76	0.0215
A-Steaming	1.79	0.2292
B-Boiling	11.16	0.0156
C-Variety	9.42	0.0220
AB	0.5769	0.4763
AC	0.9630	0.3643
BC	10.83	0.0166
ABC	5.69	0.0544

Model equation for carotenoid content of the pumpkin

$12.85130-1.78426S-0.905741B+0.204259SB+0.213580S^2+0.051358B^2$ …….Equation 1

$7.07889+2.37426S+3.05500B-0.395185SB-0.079074S^2+0.028704B^2$ ……......Equation 2

The model equation above can be used to predict the value of carotenoid content in the pumpkin as steaming and boiling time varies.

The Figure 1 below shows the interaction of steaming (A) and boiling (B) time with the varieties on the carotenoid content of pumpkin respectively. The two undotted lines denotes the first (Orangetti) and second variety (Connecticut field) respectively. It can be observed that for the first variety (Orangetti), between 0-6 minutes the carotenoid content is constant and falls around 10 for both steaming and boiling i.e., the carotenoid content remains constant between that time range. While for the second variety (Connecticut field), the carotenoid content shows an increasing trend for steaming and boiling from 0-6 minutes. Though, boiling exhibited a more increasing trend than steaming. It can also be observed that the second variety has better carotenoid content than the first variety. According to Hwang *et al.* (2012), thermal treatment improves carotenoid availability. Similar findings were reported by Shamsuri and Ahmad (2019). Cooking methods degrade food matrices and loosen carotene-binding fibers. This may result in nutritional loss, but it may also improve bioavailability and enhance carotene content (Fernández-García *et al.*, 2012).

A B

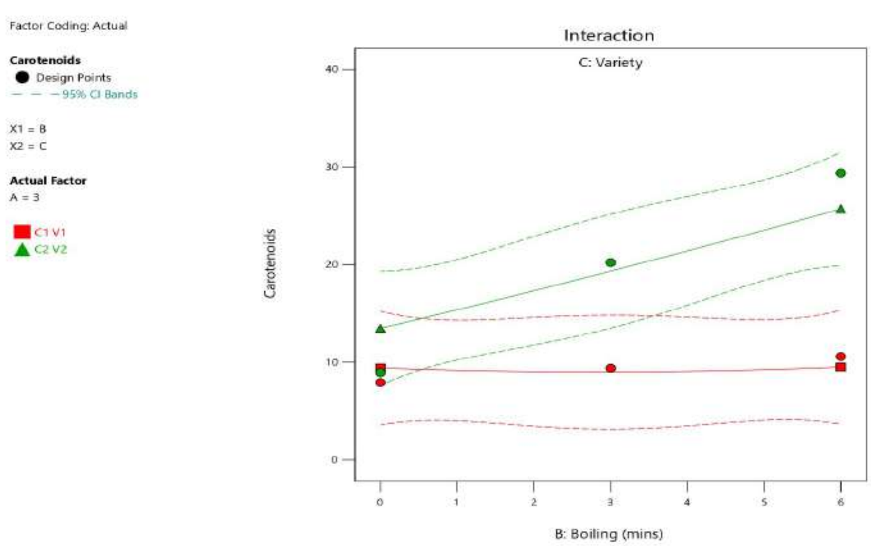

Figure 1: graph illustrating the interaction of steaming (A) and boiling (B) on the carotenoid content of pumpkin.

Optimization of the carotenoid content of pumpkin based on varied treatments

The optimization result generated 19 outputs and only 5 of the optimum desirable output were considered. The most desirable output to obtain 28.511 % of carotenoid was in second variety (Connecticut field) by steaming at 2.6 minutes and boiling for 6 minutes.

CONCLUSION

In conclusion, boiling, and time used has a substantial influence on the carotenoid content of the pumpkin varieties. However, streaming has no significant impact. The second variety (Connecticut field) was the best in terms of availability of carotene, steaming and boiling within 6 minutes can be used to enhance carotenoid bioavailability. Therefore, the inclusion of pumpkin in the diets of both children and elderly ones is recommended.

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EFFECT OF FEEDING DIET CONTAINING GRADED LEVELS OF BOILED COFFEE PULPS MEAL ON HAEMATOLOGICAL PARAMETERS OF WEANER RABBITS.

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ABSTRACT
The effects of feeding diet containing boiled coffee pulp meal on haematological parameters in rabbit were studied. A total of thirty-six (36) mixed breed weaner rabbits (average weight, 550 g) were randomly allocated to four dietary treatments containing 0, 4, 8 and 12% boiled coffee pulp meal (BCPM). Diet 1 (0% BCPM)) served as the control diet. Each of the four treatments was replicated thrice and each replicate had three rabbits arranged in a Completely Randomized Design. The rabbits were fed with the experimental diets for 12 weeks. The results showed that pack cell volume, haemoglobin, mean corpuscular haemoglobin, mean cell volume and red blood cell were significantly affected by the treatments while white blood cell count, neutrophil, lymphocytes, eusnophils, basophils and monocytes showed no significant difference. It was concluded that inclusion of boiled coffee pulp meal in rabbit diets was well tolerated by weaner rabbits without any adverse health condition.
***Keyword**: coffee pulp meal, rabbits, anti-nutritional factors, boiling, haemoglobin*

INTRODUCTION

The inability of livestock farmers to supply their animals with high quality feed has been recognized as one of the technical constraints limiting livestock production in the developing countries (Okoruwa, 2015). The livestock are exposed to severe nutritional stress especially in recent time that the prices of conventional feedstuffs such as soybeans, maize and groundnut have been increasing at the same time that the availability is often a problem (Babayemi *et al*., 2006). The case has been worsened during the dry season when fodders are rare and of low nutritive value. To salvage this problem, it is necessary for the livestock farmers to explore the cheapest and readily available agricultural waste products that have high nutritive value as feed ingredient in the diet of their animals. Typical among such feed ingredients is coffee pulp. The presence of essential nutrients such as proteins, carbohydrates fibre and some minerals especially potassium in coffee pulp suggest that it could be used as livestock feed ingredient (Barcelos *et al*., 2001), nonetheless high content of anti-nutritional factors in this by-product has restricted its use as an animal feed to a large extent (Padmapriya *et al*., 2013). Therefore, total elimination or reduction of anti-nutritional factors in coffee pulp through physical, chemical or biological processing technique is of paramount important. The major limitations of these anti-nutrients are related to its physiological effects on the central nervous system and its influence can alter the constituents of the animal blood (Mazzafera 2002). The aim of this study was to determine the effect of feeding boiled coffee pulps meal on the haematological parameters of weaner rabbits.

MATERIALS AND METHODS

About 25kg of coffee pulps were collected from the coffee pulping centre, Cocoa Research Institute of Nigeria, Ibadan. The pulps were subjected to boiling process. The process involves putting sterilized coffee pulp into heat water at 100^{0}C at a pulp: water of 1:5 for 30 minutes. At this temperature, majority of hard pulps were expected to be softened, After which the boiled pulps were removed, put into sieve to drain the water, later sun dried and stored in jute bags until it was used.
Thirty-six (36) mixed breed weaner rabbits were purchased from Adeeko Farm, Ibadan, Oyo State. Before the commencement of the experiment, the rabbits were acclimatized for seven days. During this

period, rabbits were all fed control diets and were also treated against endo and ecto-parasites using sodex (dewormer) and ivomectin respectively. The animals were randomly divided into four treatment groups andach group comprised of nine rabbits. Each group was further sub-divided into three, such that replicate groups of three rabbits were obtained for each sub-group with three rabbits per replicate. The boiled coffee pulp was mixed into rabbits ration at 0, 4, 8 and 12% inclusion level designated T_1, T_2, T_3 and T_4 respectively (Table 1). All diets were formulated to meet the nutritional requirements of weaner rabbits based on NRC (2007) recommendations and the experimental diets were offered to rabbits twice in a day at about 7:00 am and 4:30 pm. The animals were allowed *ad libitum* access to feed and water throughout the trial. On the last day of the feeding trial, two sets of blood samples were collected from each rabbit via jugular vein puncture using a 5 ml needle fitted syringe. About 5 ml blood sample each was collected into labeled sterile bottles containing anticoagulant for the determination of hematological parameters while the blood samples for serum analysis were taken with sterile bottles without anticoagulant, so as to allow the blood to coagulate at room temperature. The supernatant was then collected and stored in a freezer for subsequent biochemical analysis. The blood samples were analyzed using the procedure described by AOAC (2001). Data collected from this study were subjected to statistical analysis (SAS, 2008 version 9.2) and significant means were separated using Duncan multiple range test (Duncan, 1955). The trial lasted for 84 days.

Table 1: Feed composition and calculated nutrient values of the experimental diets

Parameters	**T_1 (0%CPM)**	**T_2 (4%CPM)**	**T_3(8%CPM)**	**T_4 (12%CPM)**
Maize	38.00	37.00	36.00	36.00
Soybean meal	27.00	26.55	25.85	25.00
Fish meal	3.35	2.80	2.50	2.50
CPM	0.00	4.00	8.00	12.00
Rice bran	28.00	26.00	24.00	20.85
Bone meal	2.50	2.50	2.50	2.50
Premix	0.25	0.25	0.25	0.25
Salt	0.50	0.50	0.50	0.50
Methionine	0.20	0.20	0.20	0.20
Lysine	0.20	0.20	0.20	0.20
Total	100.00	100.00	100.00	100.00
Calculated analysis				
Crude protein	18.06	18.03	18.05	18.01
Gross energy	3003.05	3001.00	3000.55	2999.85
Crude fibre	10.95	11.05	11.10	11.25

CPM: Coffee Pulp Meal

Table 2: Effect of Feeding Diet Containing Graded Levels of Boiled Coffee Pulps Meal on Haematological Parameters of Weaner Rabbits.

Parameters	**T_1**	**T_2**	**T_3**	**T_4**	**SEM**
Pack cell volume (PCV)	24.06^c	26.05^b	28.72^a	28.84^a	0.87
Haemoglobin	7.04^b	8.65^a	8.70^a	8.50^a	0.76
Mean corpuscular haemoglobin	30.36^b	34.25^a	34.82^a	34.85^a	0.82
Mean cell volume	86.47^b	88.35^a	90.11^a	92.77^a	2.15
Red blood cell	5.50^b	5.62^b	7.00^a	7.55^a	0.77
White blood cell	5.97^a	6.05^a	6.12^a	5.95^a	0.89
Neutrophils	63.11^a	60.68^{ab}	64.75a	58.00^b	3.05
Lymphocytes	48.20^a	43.86^{ab}	46.10^a	38.25^b	0.81
Eusnophils	3.80^a	3.61^a	3.50^a	3.10^{ab}	0.28
Basophils	2.25^a	2.00^a	1.85^{ab}	1.70^b	0.34
Monocytes	$1,85^a$	1.70^a	1.62^{ab}	1.50^b	0.41

^{abc}= mean with different superscripts on the same column are significantly different (P<0.05), SEM= Standard error of mean

RESULTS AND DISCUSSION

The results of haematological parameters of rabbits fed graded levels boiled coffee pulp are presented in Table 2. The results showed significant (P<0.05) differences in most of the haematological parameters investigated. The least packed cell volume (PCV) was recorded in rabbits fed control diet which increase progressively as the level of boiled coffee pulp increase in the diets. The increase in the PCV concentration in the blood of rabbits in this experiment indicated the good health status as low PCV values are taken as an index of anaemia. This is in agreement with the finding of (Abdelati *et al*., 2008) who reported reduction in the PVC of broiler chickens fed roasted *Leucaena leucocephala* at various levels and attributed it to toxic factor (anti-nutritional factor) in the diet. PCV is a symbol of toxicity (Ahamefule *et al*., 2008). Haemoglobin (Hb), mean corpuscular haemoglobin (MCH), mean cell volume (MCV) and red blood cell (RBC) counts were also significantly (P<0.05) affected by the dietary inclusion of boiled coffee pulp which increase progressively as the level of inclusion is increased in the diet. The increase in Hb, MCH, MCV and RBC denotes that coffee pulp meal positively contributed to the synthesis of blood forming metabolites such as copper, iron and magnesium which augments effective transportation of oxygen and other nutrients in the body of animals (Oyebode, 2015). The white blood cell were not significantly (P>0.05) different. This shows that boiled coffee pulp meal neither enhanced nor impaired the ability of rabbit to ward off infection. There was also no significant (P>0.05) difference in the neutrophil, lymphocytes, eusnophils, basophils and monocytes, and their values fell within the normal range established by Research Animal Resource (2009) for growing rabbits.

CONCLUSION

It was concluded that inclusion of boiled coffee pulp meal in the rabbits diet was well tolerated by weaner rabbits without any adverse health condition.

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EFFECT OF DIFFERENT PLANTING DATES ON THE GROWTH AND YIELD OF SESAME (*Sesamum indicum L.*) IN OWO, ONDO STATE, NIGERIA

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ABSTRACT
Sesame (Sesamum indicum L.) is an important oil spice grown in Nigeria with good yield obtained from savannah zone with low rainfall, hence the need for its trial in Owo, a guinea savannah transition zone. Field experiment was conducted during rainy season of 2022 at Rufus Giwa Polytechnic Teaching and Research Farm Owo, Ondo State. Three different planting dates (August 16th, August 30th and September 13th) were fitted into a Randomized Complete Block Design (RCBD) to evaluate the growth, yield and yield components of Sesame at three replications. Data were collected on vegetative and yield parameters. The results showed that August 16th planting date influenced stand count, plant height, number of leaf per plant, number of capsule per plant, number of seed per capsule, moisture content and yield as against August 30th and September 13th planting dates. Therefore, August 16th is recommended for Sesame cultivation in the study area.
Keyword: *Sesame cultivation, planting date, agro-ecology, climatic variable, yield*

INTRODUCTION

Sesame (*Sesamum indicum* L) is one of the oldest sp oil crops in the world, grown mainly for its seed that contains approximately 50% oil and 25% protein (Olowe 2007). It belongs to the family *Pedaliaceae,* which contains about 16 genera and 60 species (Olowe, 2007). Nigeria currently produces 400,000 - 500,000 tons of Sesame seed with the largest producing states being Jigawa, Nasarawa, Benue, Bauchi, Taraba, Niger, Kano, Katsina, Gombe, Kogi, Kwara, Yobe and Plateau, unfortunately, average yield of Sesame is still low at 0.4 ton/ha (FAO, 2018). Climate is one of the important factors affecting Sesame cultivation in most agro ecological zone. Commercial variety requires 90 - 120 frost-free days. Day time temperature of 20°C to 27°C is optimal, below 20°C, growth is reduced, and at 10°C germination and growth are inhibited. Rainfall requirement for Sesame ranges between 500 – 800 mm per annum (Ogbonna and Umar-shaba, 2012). It requires adequate moisture for germination, early growth and for reasonable yields (Olowe, 2007, Abdel Rahman *et al.,* 2007). It tolerates many soil types, but it thrives best on well drained fertile soils of medium texture and neutral pH.

Planting date affect the growth and yield of Sesame in different agro ecology, particularly in derived savannah zone (Olowe, 2007, Abdel Rahman *et al.,* 2007). Farmers growing Sesame in some part of south western savannah transition zone of the country have not been adequately informed on the best planting period that can give them high and quality yields. It is therefore essential to find out the best planting date for Sesame in the study zone in order to encourage its cultivation and increase the crop yield.

MATERIALS AND METHODS

The experiment was conducted at the Teaching and Research Farm, Rufus Giwa Polytechnic Owo, Ondo, (Latitude 7° 05^{N}; 5° 15^{E} Longitude), at 350m above sea level. Ondo falls under swamp forest and longtime raining season. The annual rainfall varies from 1200mm to 1420mm decreasing southwards. The maximum and minimum temperatures of the area average are 28.8°C and 15°C. The treatments consisted of three (3) planting dates; August 16, August 30 and September 13, laid out in a Randomized Complete Block Design (RCBD replicated three (3) using balloting method on 168m² area of land). The land was cleared, ploughed and harrow mechanically, using tractor and hand hoeing during weeding. The experimental plot consist of nine (9) plots measuring 4m x 1.5m (6 m²) each with 0.5m pathway between plots and 1m between replicates. *Jigida*, Hausa variety of 90 to 95days maturity was obtained from National Cereal Research Institute (NCRI), Badeggi, Niger state. Sowing was done at spacing of 20 ×50 cm intra / inter row spacing. Weeding was done twice by hand at 3 and 6 weeks after sowing (WAS). The crop was harvest when the leaves begin to turn yellow and shed. The capsules turn from green to yellow and lowest capsule on the stem were about to split open. The operation was done by cutting the stem using sickle and the harvest materials from each net plot was tied in bundle, followed by threshing, winnowing and then drying. Yield from each net plot area was measure after threshing and winnowing. The weight of threshed seeds was express as kg/net plot area and also extrapolated to t/ha. Data collected include; Stands establishment count, plant height, number of leaves per plant at 6 and 8 weeks after planting, number of capsules per plant, number of seed per capsule, The fresh weight of capsule, dry weight of capsules, percentage moisture content of capsules and total yield per hectare (t/ha)

Data Analysis

The data generated was subjected to analysis of variance (ANOVA) using procedure of Statistical Analysis System (SAS). Significant differences were separated by Duncan's Multiple Range Test (DMRT) at 5% level of significance.

RESULTS

Effect of different planting dates on the vegetative growth of Sesame at 6 and 8 WAS

Planting dates significantly influenced stand count establishment, with the 1st planting date (August 16th) having the highest count (65925.89), followed by 3rd (September 13th) with 49629.59 count and the least stand count establishment value (46481.46) recorded at 2nd planting date (August 30th). Same trend was observed for plant height. Plant height recorded significant ($p<0.05$) difference at 6 and 8 WAS in favour of 3rd planting date. There was no significant difference observed in 3rd and 1st planting dates, nevertheless 3rd planting dates was statistically different from 2nd planting date. While, 1st and 2nd planting dates were not statistically different. Number of leaf at 6 and 8 WAS were significantly ($p<0.05$) higher in 1st planting dates (41 and 49.97), followed by 2nd planting date (27 and 36.34) and the least value at 3rd planting date (22.23 and 27.96) respectively. Data obtained for stem girth at 8 WAS were statistically similar at 2nd and 1st planting dates (Table 1).

Effect of different planting dates on the yield and yield components of Sesame at harvest

Significant increase was recorded for number of capsules per plant at 3rd planting date and the least value at 1st planting date. Length of capsule, number of seed per capsule were significantly ($p<0.05$) influenced by 1st planting dates. Moisture content significantly increased at 2nd planting date while fresh weight of capsule per plant and dry weight of capsule per plant were statistically similar across all treatments (Table 2).

DISCUSSION

Planting date had a significant influence on some vegetative parameters of sesame. The significant difference in stand establishment count of sesame could be attributed to potential ability of the seed to resume active growth, based on seed physiological maturity which varies among seed lots, in the presence of germination factors prevalent at the sowing date. These factors as enumerated by Kingra and Kaur (2012) include temperature, day length, relative humidity, rainfall, wind velocity and biotic factor. This study showed that the climatic factors in the study area varies with different planting dates (Figure 1). Plant height, number of leaf and stem girth at various stages of growth, in this study showed variation that could be attributed to climatic influence of the growing period. The variation in temperature, humidity and moisture could influence root temperature which in turn affect root and shoot elongation. Meena et al. (2015) reported the effect of temperature variation on the growth and yield of groundnut agreeing with this work on the influence of abiotic factor of plant growth and development. Also, Ogbonna and Umar-Shaba (2012) recorded lower plant growth in case of delayed sowing in cucumber, noting that maximum number of leaf was obtained from August sowing to first week of September.

Mean capsule length was significantly influenced by planting date. this might be due, in part, to early sowing which enhanced availability of extended photoperiod for good vegetative growth to produce maximum capsule length. This result aligned Naoki et al., (2011) on the growth and sesamic content of sesame. Number of capsules per plant, number of seed per capsule, increased moisture content of capsule and yield per hectare of capsule were positively influenced by first planting date. Similar result reported by Ogbonna and Umar-Shaba (2012); Naoki et al., (2011) and Lei Deng et al., (2016) agreed with this study that adequate soil moisture content complementing the evaporative demand of the atmosphere and moisture replenishing potential of the first planting date translated to moisture distribution to the vegetative parts and significantly influenced capsules (fruit) formation of sesame.

CONCLUSION

Early planting (first planting date), during which growth resources are well distributed, in addition to conducive abiotic factor (Temperature, moisture, sunlight, humidity and sunlight quality) favour good growth, capsule formation and eventually seed yield of sesame in the study area. For optimum growth and yield, farmers in the study area are encouraged to adopt the first planting date for the cultivation of sesame.

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Table 2: Effect of different planting dates on the vegetative growth of Sesame in 2022 rainy season

Parameters	Planting Dates			
	August 16	August 30	September 13	LSD
Stand count	65925.89a	46481.46c	49629.59b	0.39
Plant height(cm)@ 6WAS	78.96c	91.40b	106.38a	1.00
Plant height(cm)@ 8WAS	107.60ab	96.13b	110.67a	0.58
Number of leaf (@ 6WAS	41.00a	27.00b	22.23c	1.00
Number of leaf @ 8WAS	49.97a	36.34b	27.96c	1.00
Stem girth(cm)@8WAS	1.91a	1.96a	1.78ab	0.45

Means bearing the same letter(s) within the same row do not differ significantly at 5% level according to DMRT ,WAS =week after sowing

Table 3: Effect of different planting methods on the yield and yield components of Sesame in 2022 rainy season

	Planting Dates			
Parameters	August 16	August 30	September 13	LSD
Number of capsule per plant	26.56c	27.56b	29.36a	0.97
Length of capsule (cm)	84.89a	9.11b	64.78	0.52
Fresh weight of capsule per plant (g)	4.86a	4.59a	4.71a	0.46
Dry weight of capsule per plant (g)	0.75a	0.77a	0.74a	0.71
Number of seed per capsule	84.46a	83.22b	84.24a	0.22
Moisture content percentage (%)	0.72b	1.21a	0.88b	0.30
Total yield (t/ha)	3.28a	3.17b	3.24ab	0.30

Means bearing the same letter(s) within the same row do not differ significantly at 5% level according to DMRT, @= at,WAS =Week after sowing.

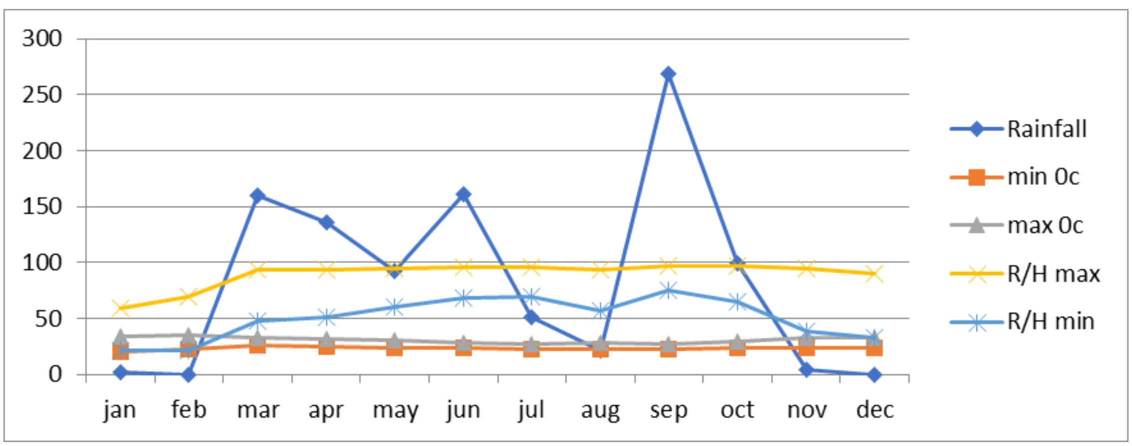

Figure 1: Annual monthly mean weather parameters for year of experiment (Rainfall, Max. and Min, Temperature, Max. and Min. Relative humidity %)

Note: Monthly Rainfall(cm), Min T^0C-Minimum Temperature, Max T^0C-Maximum Temperature, RH (min)-Relative Humidity Minimum, RH (max)- Relative Humidity Maximum.

EFFECT OF FERTILIZER SOURCES, INTRA-ROW SPACING AND VARIETIES ON GROWTH OF CUCUMBER (*Cucumis Sativus* L.) IN IBADAN, SOUTHWESTERN NIGERIA

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ABSTRACT
Cucumbers (Cucumis sativus L.) is an important vegetable crop of Cucurbitaceae family. Yield of cucumber have increased over time with increase in application of inorganic fertilizer, but little considerations are given to consumers' health and preservation of natural environment, and this has necessitated the use of organic fertilizer as substitute for chemical fertilizers. Despite the benefits of organic fertilizers its application has not been easy because of the bulkiness, slow nutrient release and low nutrient composition. Therefore, this experiment was conducted at the Vegetable programme research field of National Horticultural Research Institute, (NIHORT), Ibadan. The treatments included three fertilizer sources (Organic Liquid fertilizer, NPK fertilizer and Control) applied at the recommended rates on three varieties of cucumber; (Greengo F1, Malvarino F1 and Marketmore) at four spacings of 75cmx15cm, 75cmx25cm, 75cmx40cm and 75cmx50cm. Results shows that application of inorganic fertilizer (NPK 20:10:10) followed by the liquid organic fertilizer can improve cucumber yield per hectare at the highest spacing of (75cmx15cm). Also, the highest yield was obtained from Malvarino F1 followed by Marketmore variety.
Keywords: *Cucumbers, Fertilizers, spacings, varieties, yield*

INTRODUCTION

Cucumber is an important vegetable crop (Eifediyi and Remison 2010). Cucumber is widely cultivated in temperate and tropical regions throughout the world (Vora, 2014). The plant is a coarse prostrate annual deep-rooted crop cultivated for its fruits which can either be eaten raw or with little processing in accompaniment with other vegetables (Eifediyi and Remison, 2010). In addition to providing valuable nutrients, cucumber add variety, taste, color, and texture to diets. Since cucumber fruits contain about 95% water, they are often recommended as natural diuretics and useful for body building. Nigeria soils are typically low in organic matter and supply through chemical fertilizers is becoming increasingly important. Fertilizer practices that maintain or increase production levels and simultaneously decrease ground water pollution potentials should be encouraged, since excessive application of chemical fertilizers can result in high soil nitrate levels after crop harvest (Gordon et al., 1993; Akintoye et al., 2002). Thus, the use of organic fertilizer needs to be encouraged in place of chemical fertilizers for health and environmental benefits. Although its use has not been easy because of bulkiness, slow nutrient release and low nutrient composition. However, the production of handy liquid and concentrated organic fertilizer is a relief to the problems, but its effectiveness must be compared with inorganic fertilizers at different intra row spacing to meet with cucumbers demand despite the reduction in agricultural land.

MATERIALS AND METHODS

Experimental Location and period

The experiment was carried out in National Horticultural Research Institute (NIHORT), Idi-Ishin, Oyo State, Southwestern Nigeria with coordinates Latitude 7^0 40' N; Longitude 3^0 85'. The zone is also characterized with mean annual rainfall between 1800mm-2500mm per annum (April-November) with temperature ranging from 24^0C to 32^0C. The experiment comprised of three varieties (Marketmore, Greengo F1 and Malvarino F1), three fertilizer sources (control, inorganic and organic) and four intra rows spacing (15cm, 25cm, 40cm and 50cm) at constant inter row spacing of 75cm. The total land area used for the experiment was 500 square meters. The field was sectioned into 72 plots of 6 square meters ($6m^2$) dimension each with one squared meter ($1m^2$) spacing in between them.

The experiment was designed as a 3 X 4 X 3 factorial experiment arranged in split split block design with three replicates. The main plots consisted of the fertilizer treatment, the sub plots were made up of the intra row and sub-sub plots contained the varieties.

The land was tilled mechanically by ploughing in all existing vegetation twice before harrowing.72 beds of dimension 3m x2m x 1m was made on the experimental site. Each bed represents one experimental plot. Each plot was marked according to the intended row spacing with pegs. The intra-row spacings are 15cm, 25cm, 40cm and 50cm at constant inter row spacing of 75cm to give plant density of 88,889, 52,632, 33,333 and 26,667 plants per hectare respectively. The seeds were sown directly into the soil on 23rd September 2021 at the rate of 3 seeds/hole. There was rainfall immediately after the seeds were sown hence make watering not necessary. About 55% of the seeds germinated about 7 days after sowing. The ungerminated seeds were supplied and the excess seedling thinned to one per stand a week after sowing. The N-P-K 20:10:10 fertilizer and the liquid organic fertilizer were applied at split dose in 2,4 and 6 weeks after planting to satisfy the recommended rate of 400kgN/ha.

The data collected were subjected to analysis of variance (ANOVA) using the general linear models (GLM) procedure of Statistical Analysis Systems (SAS, 2003).at 5% level of probability with LSD test to separate the means.

RESULTS

Influence of treatments on growth parameters of cucumber

Table 1 showed that application of inorganic N.P.K (20:10:10) fertilizer resulted in an outstanding performance in canopy development such as vine length and leaf area but the effects of liquid organic fertilizer on the vine length was not significantly different. This may be due to the absorption rate of the fertilizers and the immediate response of the plant to the fertilizer. Though the NPK 20:10:10 was easily available to the plants at steady level. The organic liquid fertilizer was readily dissolved with the soil water and may not be easily available to the plant due to run off by rain and leaching by soil water. Table 1 also indicated that all the variety responded to NPK 20:10:10 fertilizer but Marketmore had the best vine length.

Table 1: Vine length and leaf area of cucumber as influenced by fertilizer sources, spacing and variety at 2, 4 and 6 weeks after sowing.

		Vine length			Leaf area (cm3)	
Treatments	2	4	6	2	4	6
Fertilizer						
Control	10.48a	27.66c	75.66c	316.62a	1073.16c	271.41c
Inorganic	10.27a	41.02a	136.49	312.86a	1688.14a	562.24a
Organic	10.32a	37.45b	80.48b	311.34a	1593.75b	428.63b
Mean	10.35	35.38	97.54	313.61	1451.67	2987.43
LSD	0.12	1.39	4.14	NS	19.73	21.13
Spacing (plants ha^{1})						
88,888	10.76a	37.83a	105.85a	321.32a	1343.82d	892.22d
53,333	10.51b	36.51a	98.70b	308.15b	1636.17b	488.26c
33,333	10.18c	33.74b	92.92c	312.03b	1624.55c	502.42b
26,666	9.96d	33.38b	92.71c	319.94a	1687.02a	554.44a
Mean	10.35	35.38	97.54	315.47	1572.8	3359.34
LSD	0.14	1.61	2.17	8.11	11.60	13.83
Varieties						
Marketmore	10.47a	39.86a	96.43a	317.06a	1657.61a	133.46b
Greego F1	10.20b	31.56c	97.76a	316.93b	1566.67c	084.54c

Malvarino F1	10.40a	34.72b	98.44a	308.95c	1653.67b	588.06a
Mean	10.36	35.68	97.55	3314.27	1859.20	3501.96
LSD	0.12	1.39	4.15	4.36	4.36	62.51

LSD: Least significant difference at 5% level of probability
Means with the same letter in the same treatment are not significantly different.

Throughout the time of data collection i.e., 2, 4 and 6 Weeks After sowing, closer intra row spacing resulted in longer vine length but other parameters are significantly higher at 53,333 followed by 33,333 as compared to the widest plant spacing of 26,666 as shown in Table 1. The greatest leaf area was recorded in 33,333 which is not significantly different from that observed at 53,333 and 26,666 which are all significantly higher than the one recorded at 88,888 intra row spacing.

Influence of Treatments on Yield Component and Yield Parameters of Cucumber

As shown in table 2, cucumber with inorganic fertilizer application had the highest days to 50% fruiting but lowest number of fruits initiated per plant. but not significantly different from that of organic fertilizer application. The differences among number of fruits per plant for all the treatment is not significant. The table also show that fertilizer had the greatest influence on days to 50% fruiting. Table 2 it is shown that wider spacing of 33,333 produces the highest number of fruits initiated per plant and fruit weight per plant which is not significantly different from 53,333 and 26,666 but significantly different from closest spacing of 88,888. Spacing has no significant influence on number of non-marketable fruit and weight per plant but closest spacing produce the highest non-marketable fruit yield per hectare. Widest spacing 26,666 resulted in longest fruit which is not significantly higher than intra row spacing of 40cm but had a significantly higher fruit girth (Table 2).

Table 2: Yield and yield component of cucumber plant as influenced by fertilizer, spacing and variety.

Treatments	Days to 50% fruiting	No. of fruits initiated/plant	Marketable yield	Non-Marketable yield
Fertilizer				
Control	41.45c	20.77a	25074c	117000a
Inorganic	45.20a	20.75a	132860a	9640a
Organic	43.50b	20.77a	94091b	12056a
Mean	43.72	20.76	84008	11139
LSD	1.27	1.66	6602.3	4882.4
Spacing (plants ha^{-1})				
88,888	42.94a	21.17a	177766a	18232a
53,333	41.83a	20.71a	107053b	9415b
33,333	41.33b	20.36a	96457c	8169b
26,666	40.77b	20.08a	50757d	8712b
Mean	41.72	20.58	50757d	8712b
LSD	1.46	1.86	7623.7	5637.7
Varieties				
Marketmore	42.60a	31.56a	74408b	12914a
Greego F1	39.66b	15.21b	89944a	7885c
Malvarino F1	42.83a	14.87b	87673a	12597a
Mean	41.72	20.55	84008	11131.99
LSD	1.27	1.62	6602.3	4882.4

LSD: Least significant difference at 5% level of probability
Means with the same letter in the same treatment are not significantly different.

DISCUSSION

The results of NPK Fertilizer on both the vegetative and yield parameters of cucumber was significantly higher followed by organic liquid fertilizer. Though, it is expected that NPK fertilizer should improve the growth of cucumber as reported on other nitrogen loving crop. However, the application of NPK fertilizer resulted in excessive foliage growth that delayed reproductive stage of cucumber. The slow release of N from the organic fertilizer source resulted in the slow pace of development but it did not have negative effect on yield parameters. NPK fertilizer effect on fruits' parameters was higher than that of liquid fertilizer. This implied that NPK fertilizer seems to improve the fruit length, girth, weight, and the number of fruits produced. This conforms with the findings of IwaIewa *et al.,* (2019) who reported that NPK fertilizer perform best in enhancing cucumber production when compared with other fertilizer sources. It is also in line with the findings of Akintoye and Olaniyan., (2023), who reported that sweet corn yields with applied inorganic fertilizer were greater than those receiving organic sources of fertilizer. Vikash Kumar et al. (2016) who attributed the vigorous growth and increased fruit yield of cucurbits to higher supply of nutrient elements also supported this outcome.

The Mean Square table showed that spacing also significantly produced variations in the vegetative values observed. Widest spacing 26,666 plants ha^{-1} and 33,333 plants ha^{-1} contributed significantly to the highest canopy cover. This is in line with Vinkash *et. al*., (2016) who observed that closer spacing resulted in significantly lower total above-ground plant dry weights, growth rates, and total leaf areas for cucumber cultivars. Widest spacing 26,666 plants ha^{-1} resulted in longest fruit which is not significantly higher than wider intra row spacing 33,333 plants ha^{-1} but had a significantly higher fruit girth. However, closest spacing 26,666 plants ha^{-1} produced the highest fruit yield per hectares while widest spacing produced the least which is not significantly different from that of wider spacing 75cmx40cm. Similar result supported this in the work done by Sanni and Adenubi (2019). The effects of intra row spacing observed on the cucumber plant may be attributed to varying level of intra specific competition caused by the four-plant spacing. Makinde and Macarthy: (2014) reported that this competition effects may be completely absent until a threshold at which resources becomes limited is reached. These findings are in line with Streck et al, (2014) who reported that final leaf size and lateral shoot growth of cassava increased as the spacing increased (i.e., decreased planting density). It also corroborates results reported by Enujeke (2013).

CONCLUSIONS

The results suggests that the use of NPK 20:10:10 inorganic fertilizer is best for commercial cucumber production in Southwestern Nigeria. This is because N-P-K 20:10:10 increases vegetative growth and canopy formation hence can produce more assimilates which later converts to useful biomass. Although closest spacing of 88,888 plants ha^{-1} had the highest yield per hectare, wider spacing of 33,333 plants ha^{-1} performed better in many other attributes such as fruit length, fruit girth, number of fruits per plant and fruit weight per plant probably because spacing is necessary for widening of leaves and thickening of vine.

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IMPACT OF NITROGEN RATES ON THE SEED QUALITY OF OKRA (Abelmoschus esculentus L. Moench) VARIETIES AT DIFFERENT FRUIT POSITION

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ABSTRACT
The experiment was conducted at the Teaching and Research Farm of the Federal University of Technology Minna, during the 2019 and 2020 cropping seasons. The treatments consisted of 2x5x6 factorial combinations of two okra cultivars (NHAe47-4 and LD 88), five nitrogen rates (0, 30, 60, 90, and 120 kg ha-1) and six fruit positions on the mother-plant (1, 2, 3, 4, 5 and 6th) arranged in a Completely Randomized Design (CRD) and replicated four times. Parameters measured includes number of seeds, seed weight and germination percentage. Data collected were subjected to analysis of variance (ANOVA) using SAS Statistical package 9.2. At 5% level of probability means were separated using Least Significant Difference (LSD) Test. Application of 120 kg N ha-1 produced the highest number of seeds and seed weight of okra. Harvested fruits from the lower positions (1-2) gave best results in all the parameters. While seed germination was greater at the lower positions prior to storage and after storage.
Keywords: *Okra, Seed size, Fruit position*

INTRODUCTION

Okra (Abelmoschus esculentus (L.) Moench), an economically important vegetable crop grown in tropical and sub-tropical parts of the world, also known as Ladies' Finger, originated from Ethiopia (Pandey et al., 2017) and was then propagated in North Africa, in the Mediterranean, Arabia and India by the 12th century BC (Nimona, 2019). It is one of the most widely known and utilized species of the family Malvaceae (Dantas et al., 2021). Okra grows best on well-drained sandy loam soil; it prefers slightly acidic soils with a pH between 6.0 and 6.8 (Nisar et al., 2021). The minimum and maximum soil temperatures for growth are 20°C and 30 °C, respectively and relative humidity of 21% – 30% (Makinde, 2022).

Good seed nutrition of the mother-plant during growth is important as it has been reported (Yakubu and Abubakar, 2017) to result in rapid seedling emergence in okra varieties. The mother-plant has a significant influence over seed traits, including seed size, dormancy, germination and storage. In many species, factors such as age of the mother-plant and position of the seed in the fruit, inflorescence, or canopy can affect seed properties (Lu et al., 2017). Seed quality is also affected by several factors and seed germination, vigour and health assessment play an important role in determination of seed quality (Ndinya et al., 2020). Seed vigour is an important factor that affects seedling establishment and crop growth and ultimately production rate. The seed lot may differ in size, number and weight which may be affected by growing conditions and cultural practices (Adebisi et al., 2021). Adebisi et al. (2011) reported that seed size, number and weight are components of seed quality which affects the performance of crop. The study was carried out to determine the impacts of nitrogen rates on seed quality of okra at different fruit positions.

MATERIALS AND METHODS

A Field experiment was conducted at the Teaching and Research Farm of the Federal University of Technology, Minna (latitude 90 51 1N and longitude 60 44 1E) during the 2019 and 2020 cropping seasons (May-Sept). Before land preparation, soil samples were collected from surface (0-15cm) with an auger from 10 points along four diagonal transects, each bulked together to give four composite samples. The soil samples were air dried and sieved through 2mm and 0.5mm sieve. They were analyzed for particle size distribution, pH 1:2 (H_2O and $CaCl_2$), Organic carbon, total nitrogen, available phosphorus, exchangeable bases (Ca^{2+}, Mg^{2+}, K^+, Na^+), exchangeable acidity (Al^{3+} + H^+) and effective cation exchange capacity following the procedures as described by Agbenin (1995). Seeds of NHAe47-4 and LD 88 variety of okra were sourced from the National Horticultural Research Institute (NIHORT) Ibadan, Oyo State Nigeria.

The land was manually cleared and ploughed with a tractor and ridges were constructed manually at 75 cm apart each measuring 2 m long. Plots were measuring 2×5.25 m (10.5m2) comprising of 8 ridges. The treatments consisted of factorial combinations of two okra cultivars (NHAe47-4 and LD 88) five nitrogen rates (0, 30, 60, 90, and 120 kg ha-1) and six fruit positions on the mother-plant (1, 2, 3, 4, 5 and 6th) arranged in a Completely Randomized Design (CRD) and replicated four times. Three seeds were manually sown per hole at 0.5m apart and later thinned to one vigorous seedling per stand (2WAP). Basal application of Phosphorus using single super phosphate and muriate of potash as sources and split application of varying rates of urea as a source of N fertilizer at 50 kg ha-1 each was applied in all the plots 2 week after planting (WAP) respectively. . The first application was at 2 WAP and second application was at 4 WAP (before flowering). Weeding was carried out at two weeks intervals manually.

Incidence of insect pests was suppressed from 2WAS till harvesting stage with the application of Zap® a.i (Lambda Cyhalothrin 25g/L), at 0.005kg a.i/ha. . Plants were date tagged at flowering daily on the field. The tagged fruits were harvested at different positions on the mother-plant (1, 2, 3, 4, 5 and 6) at 42 DAA (Days after anthesis). Following each harvest, the fruits were broken to extract the seeds. The seeds were left to dry further at ambient temperature for about two weeks before storage. Samples of seeds from each treatment combinations were put in small open plastic plates measuring 300 ml and then placed in an incubator at 35 ºC and relative humidity of 90 %. This was aimed at accelerating the ageing of the seeds to determine the relative longevity of the seeds of the different lots (Delouche and Baskin, 1973). The okra seed samples were drawn from the containers in storage for conducting germination test at 0, 2, and 4 weeks after storage. This was done by counting four replicates of 30 seeds of the seven harvesting stages which was placed on filter paper moistened with distill water in plastic Petri-dishes. Germination counts was taken every-other-day and results were expressed in percentages. Parameters measured included Number of seeds, seed weight and germination percentage

The data collected were subjected to analysis of variance (ANOVA) using SAS Statistical package 9.2. At 5% level of probability means were separated using Least Significant Difference (LSD) Test.

RESULTS

The results of the chemical and physical properties of the soil at the experimental sites before the two cropping years 2019 and 2020 are presented in the Table 1. The particle size distribution showed that the soil of the site is loamy sand in texture with a moderate pH indicating the soil to be slightly acidic (H_2O) 6.7, 6.8 and (CaCl) 5.5, 6.1 respectively. Soil organic carbon (SOC) of 4.50(g kg-1), 4.51(g kg-1) and Soil Total N of 1.21 (g kg-1), 1.23(g kg-1) was found to be low. The available phosphorus 8.25, 8.50 (mg kg-1) and ECEC 8.2, 7.69 (cmol+ kg-1) respectively of the soil were also found to be low. The Exchangeable bases (Cmol+ kg-1) Ca^{2+} 3.75, 3.85, K^+ 0.07, 0.03 and Na^+ 0.17, 1.55 respectively were considered to be moderate. The exchangeable Mg^{2+} 3.0, 2.90 was considered sufficient to support plant growth.

The effect of nitrogen rates on number of seed of two okra varieties at different harvesting positions in 2019 and 2020 is shown in Table 2. Number of seed was significantly different among the okra varieties at harvesting position 1 in 2020 only, such that LD 88 produced the highest number of seed (72.47) than NHAe47 – 4 which produced the lowest number of seed (68.0). Nitrogen rates had a significant effect on number of seed throughout the sampling positions in 2019 and 2020 respectively. At position 1, the application of 120 kg N ha-1 produced the highest number of seed in both years (88.33 and 87.50) than the other rates compared with zero application in 2019 (39.88), 0 and 30 kg N ha-1 in 2020 (51.83 and

58.00) which produced the lowest number of seeds. At position 2 in 2019, the application of 60, 90 and 120 kg N ha-1 produced significantly similar highest number of seeds (62.50, 67.67 and 65.33) than zero application which had the lowest number of seed (38.83). In 2020, the application of 90 and 120 kg N ha-1 produced statistically similar highest number of seed (69.17 and 75.33) than the application of 60 kg N ha-1 (62.17) compared with 0 and 30 kg N ha-1 which recorded similar lowest number of seed (44.17 and 50.17). At position 3 in 2019, the application of 90 and 120 kg N ha-1 produced similar highest number of seed (69.17 and 75.33) compared with 0 and 30 kg N ha-1 which had similar lowest number of seed (44.2 and 50.2).

The effect of nitrogen rates on seed weight of two okra varieties at different harvesting positions in 2019 and 2020 are shown in Table 3. Seed weight differed significantly across the positions and years except at position 1 in 2019, position 4 and 5 in both years and position 6 in 2020 which showed no significant difference among the varieties. The variety LD 88 consistently produced the heaviest seeds between (3 g – 5 g) than NHAe47 – 4 which consistently produced the lightest seeds between (3 g – 4 g) across the years. Nitrogen rates affected seed weight significantly throughout the sampling periods in 2019 and 2020 respectively. At position 1, the application of 120 kg N ha-1 produced significantly heavier seeds in both years (6.25 g and 6.07 g) than the other rates compared with zero application in 2019 (3.03 g), application of 0 and 30 kg N ha-1 in 2020 (4.09 g and 4.3 g) which produced the lightest seeds. At position 2 in 2019, the application of 60, 90 and 120 kg N ha-1 produced statistically similar heaviest seeds (4.45 g, 4.65 g and 4.59 g) than zero application which had the lightest (3.22 g). In 2020, the application of 120 kg N ha-1 produced significantly heavier seeds (5.11 g) similar with the application of 90 kg N ha-1 (4.18 g) compared with 0 and 30 kg N ha-1 which had similar lightest seeds (3.66 g and 3.88 g).

Table 4 showed variety significantly affected germination percentage of seeds at different storage periods at 0 weeks before storage (WAS). Seeds of NHAe47-4 germinated significantly higher 49.57% than LD88 43.50 % in 2019 while in 2020 LD88 recorded 54.25%) than seeds of NHAe47-4 51.61%. In 2019, at 2 WAS varieties significantly differed statistically in both years respectively. NHAe47-4 recorded higher germination 46.25% than LD88 39.02%. While in 2020 the reverse was recorded where LD88 germinated significantly higher with 35.92% than NHAe47-4 32.89%. The same trend affected the traits significantly at 4WAS. However, position affected germination percentages significantly across storage periods. Prior to storage, seeds extracted from fruits of positions 1 and 2 germinated significantly higher (61.50% and 58.85%) than those of positions 3-6 with values ranging between 50.40 and 27.90% in 2019. In 2020, seeds from positions 4 and 3 germinated significantly higher 77.47 and 76.03%.

DISCUSSION

Rao et al. (2017) advised that seeds should be harvested at appropriate time to ensure their quality in terms of germinability and vigour. However, Bortey et al. (2022) reported that fruits harvested even before physiological maturity and allowed some days of post-harvest ripening may produce good quality seeds since seed development continues in fleshy fruits owing to continuous supply of nutrients and food reserves from fruit to seed. Kortse and Oketa (2016) also observed that okra fruit size was affected by position on mother-plant under competition for assimilates. Seeds from the peduncular fruit segments were delayed in reaching maximum quality compared with seeds from other positions in cucumber (Hu et al., 2019). Bigger seeds in the earlier positions than in later ones (position 6) is due to the fact that less nutrients were made available to the developing fruits and seeds of later positions (Ibrahim and Oladiran, 2011). Position 1 fruits weighed the heaviest compared to those of the other positions (2, 4, 4, 5 and 6) on the mother-plant, this result agrees with the trend reported by Alan and Eser (2007) for pepper in which fruit weight gradually declined from position closest to the plant base to those at the upper layer.

CONCLUSION

Fruits formed at the lower positions (1-3) produced more and bigger seeds than those formed at the higher positions (4-6).

Position of fruits on the mother-plant

Table 1: Physical and chemical properties of the soil samples of the experimental field

Soil Properties	2019	2020
Particle Size distribution (g kg^{-1})		
Sand	815.5	8.17
Silt	109	110
Clay	78	77
Textural class	SL	SL
pH (1:2)		
H_2O	6.7	6.8
Kcl or $Cacl_2$	5.5	6.1
Total N (g kg^{-1})	1.21	1.23
Organic C (g kg^{-1})	4.50	4.51
Available P (mg kg^{-1})	8.25	8.50
Exchangeable bases ($Cmol^+$ kg^{-1})		
Ca^{2+}	3.75	3.85
Mg^{2+}	3.00	2.90
K^+	0.07	0.03
Na^+	0.17	1.55
Exchangeable acidity (Cmol kg^{-1})		
Al^{3+} H^+	0.8	0.70
ECEC	8.2	7.69

Table 2: Effect of nitrogen rate on number of seed of okra varieties at different plant positions

	Number of seed											
	Position 1		Position 2		Position 3		Position 4		Position 5		Position 6	
Variety (V)	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
NHAe47-4	63.13a	68.00b	56.53a	58.73a	58.73a	56.53a	40.67a	50.07a	63.13a	40.67a	45.87a	38.20a
LD 88	63.20a	72.47a	58.73a	61.67a	61.67a	58.73a	38.53a	51.53a	64.20a	38.53a	42.93a	39.33a
LSD (0.05)	3.41	3.99	4.78	4.41	4.41	4.78	5.03	5.44	3.41	5.03	6.17	5.52
N (kg ha^{-1})												
0	39.83e	51.83d	38.83c	44.17c	44.17c	38.83c	30.00c	33.00c	39.83e	30.00c	38.83a	30.33b
30	48.67d	58.00d	53.83b	50.17c	50.17c	53.83b	34.33bc	41.00c	48.67d	34.33bc	44.00a	36.17ab
60	60.33c	72.67c	62.50a	62.17b	62.17b	62.50a	41.50b	50.83b	60.33c	41.50b	45.67a	41.83a
90	81.17b	81.17b	67.67a	69.17a	69.17a	67.67a	41.83b	67.67a	81.17b	41.83b	47.67a	41.67a
120	88.33a	87.50a	65.33a	75.33a	75.33a	65.33a	50.33a	61.50a	88.33a	50.33a	45.83a	43.83a
LSD (0.05)	5.39	6.30	7.55	6.97	6.97	7.55	7.96	8.66	5.40	7.96	9.75	8.73
Interaction												
V x N	**	NS	NS	NS	NS	NS	NS	NS	**	NS	NS	NS

Means with the same letter(s) under the same column are not significantly different from each other at P≤ 0.05 by LSD.

Table 3: Effect of nitrogen rate on seed weight of okra varieties at different plant positions

	Seed weight (g)											
	Position 1		Position 2		Position 3		Position 4		Position 5		Position 6	
Variety (V)	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
NHAe47-4	4.63a	4.80b	4.05b	4.22b	4.22b	4.05b	3.05a	3.60a	3.09a	3.05a	4.05b	2.91a
LD 88	4.57a	5.21a	4.30a	4.53a	4.53a	4.30a	3.17a	3.88a	3.14a	3.18a	4.30a	2.91a
LSD (0.05)	0.28	0.22	0.24	0.28	0.28	0.24	0.30	0.30	0.46	0.29	0.24	0.31
N (kg ha^{-1})												
0	3.03e	4.09d	3.22c	3.66c	3.66c	3.22c	2.52c	2.62c	3.03ab	2.52c	3.22c	2.40c
30	3.79d	4.31d	3.97b	3.88c	3.88c	3.97b	2.83bc	3.43b	3.55a	2.83bc	3.97b	2.76c
60	4.29c	5.01c	4.45a	4.42b	4.42b	4.45a	3.35a	3.70b	2.95ab	3.36a	4.45a	2.93ab
90	5.64b	5.54b	4.65a	4.81ab	4.81ab	4.65a	3.23ab	4.63a	3.43a	3.23ab	4.65a	3.11ab
120	6.25a	6.07a	4.59a	5.11a	5.11a	4.59a	3.63a	4.33a	2.60b	3.63a	4.59a	3.35a
LSD (0.05)	0.44	0.35	0.38	0.44	0.44	0.38	0.47	0.48	0.73	0.47	0.38	0.49
Interaction												
V x N	**	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Means with the same letter(s) under the same column are not significantly different from each other at P≤ 0.05 by LSD.

Table 4: The effect of fruit position on mother-plant on the germination percentage of seeds of two okra varieties at different storage periods

	Week 0		Week2		Week 4	
Variety (V)	2019	2020	2019	2020	2019	2020
NHAe47-4	49.57a	51.61b	46.25a	32.89b	33.60a	34.54b
LD 88	43.50b	54.25a	39.02b	35.92a	32.12a	35.86a
LSD (0.05)	1.71	2.13	0.71	0.40	1.21	0.70
Positions (P)						
1	61.50a	59.25b	54.30a	50.25ab	5015a	40.23b
2	58.85a	54.93b	57.25a	59.34a	44.90b	41.32a
3	50.40b	76.03a	47.65b	41.21b	35.50c	30.59c
4	45.10c	77.47a	43.60c	39.05c	34.50c	29.23c
5	35.45d	39.80c	30.30d	22.23d	15.50d	20.99d
6	27.90e	25.53d	22.70e	20.53e	16.55d	14.35e
LSD (0.05)	2.22	2.24	1.22	3.64	1.02	1.11
Interaction						
V x P	NS	NS	*	NS	NS	NS

Means with the same letter(s) under the same column are not significantly different from each other at P≤ 0.05 by LSD.

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MONITORING SEED PROTEIN CONTENT (SPC) OF FOUR BELL PEPPER CULTIVARS HARVESTED AT DIFFERENT FRUIT AGES TO ASSESS THEIR VIABILITY

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ABSTRACT
To investigate the appropriate time of harvest for four cultivars of bell-pepper (Capsicum annuum), a mass transplanting of "Dan Datsa", "Dan Charkawa, "Dan Damaso", and "Dan Boko" cultivars of "tatashe" was carried out in the 2018 dry season at 75 × 50 cm inter-row and intra-row spacings respectively. Each cultivar was transplanted in dedicated blocks measured at 108 m^2. The flowers were tagged at full anthesis, and the fruits were harvested at 25, 30, 35, 40, 45, 50 and 60 days after anthesis (DAA). Seeds were extracted, processed, packaged, and stored in an incubator set at 35 °C and 75% relative humidity (RH) to accelerate the ageing process of the seeds. Samples were collected every week for viability test and monitoring of seed protein content. The seeds of "Dan Damaso" cultivar recorded significantly higher (36.57 - 1.57%) seed germination percentage (SGP) and significantly higher seed protein content (23.78 – 18.24%) which was across the storage period. While other cultivars recorded germination ranging between 0.50 - 31.71% germination and 16.31 – 21.34% SPC. Fruits harvested at 50 DAA recorded significantly higher SGP and SPC across the storage period. Across the storage period, irrespective of harvesting stages, SGP recorded increase in values within the first 2-3 weeks of storage while the SPC values reduces as the storage period progressed. From this study, we can conclude that studying the seed protein contend of bell-pepper seeds can be used to monitor the viability and vigour of bell pepper seeds during storage.
Keywords: *ageing process, full anthesis, seed protein content, storage period, viability test*

INTRODUCTION
Globally, pepper is a very important vegetable crop for both fresh and processed food markets (Airaki *et al.,* 2012). Over 200 million Nigerians irrespective of their socio-economic status use pepper extensively for either, colouring, flavouring, soup making, or stew thickening (Gates *et al.,* 2007). However, seed production in Nigeria has been undermined by the incidence of pests, diseases, high cost of inputs (pesticides, herbicide, and fertilizer), land over-utilization, and poor-quality seeds (Kudi *et al.,* 2008). Also, majority of seed companies in Nigeria place a high priority on the production and distribution of cereals and legumes leaving the small-holder vegetable farmers to source seeds by themselves. These small-holder farmers mostly collect seeds and fruits that have been left to weather on the field which are of poor quality (Ibrahim *et al*. 2017).
Oladiran and Kortse (2002) stated that the production of high-quality vegetable seeds is dependent on genotype and the appropriate time of harvest. During the fruit maturation process, seeds go through physical, biochemical, and physiological changes which are influenced by genetic (Makhaye *et al.,* 2021) and environmental (Kurukalasuliya *et al.,* 2013) factors. Ibrahim *et al.* (2017) reported that both mass and physiological maturity of seeds were attained in all four genotypes of pepper used at 52 days after anthesis (DAA). Vigidal *et al.* (2009) reported that the vigour of sweet pepper seeds extracted from fruits that were harvested at 60 or 70 days after anthesis was higher than those obtained from fruits harvested at 40 or 50 days after anthesis. A vigorous lot have both the high percentage of viable seeds in the sample and can also produce normal seedlings under in less than optimum or adverse conditions like what is obtainable on the field (ISTA, 2021). Using a vigorous seed not only results in fast and uniform

germination but also assists in competing with weeds on the field for water, light, and soil nutrients (Cheng *et al.,* 2015).

According to Vandamme *et al.* (2016), seed weight and seed nutrient content affect plant growth and seedling state. Previous research related seedling vigour to seed size and its protein concentration (Han *et al.,* 2014). Snider *et al.* (2016) listed seed mass, total oil, and protein calorie content to be associated with early seedling vigour of cotton. Wen *et al.* (2018) used the absolute protein content (APC) of wheat seed to evaluate the plant's dry matter and assess seed vigour. In this research, we assess the variation in seed protein content among four bell pepper cultivars and monitor the changes in protein content as the seed ages. Secondly, the relationship between fruit age, seed protein content and their influence on seed vigour was also monitored as the seed aged. Therefore, the objective of this research is to evaluate viability and vigour by measuring their seed protein content.

MATERIALS AND METHODS

Seeds from the four cultivars of bell-pepper used ("Dan Datsa", "Dan Charkawa", "Dan Damaso" and "Dan Boko") and harvested at seven different fruit maturation stage (25, 30, 35, 40, 45, 50 and 55 days after anthesis) in a factorial combination of 4 × 7 arranged in a completely randomized design (CRD) and replicated four times. Twenty-eight different seed lot of bell-pepper were placed in plastic containers with perforated lids which were stored in an incubator set at 35°C and 75% relative humidity to accelerate the ageing process of the seeds. Samples were taken every week, or every order week and the following was evaluated.

Seed germination percentage (SGP): The seed germination percentage was determined by counting 50 seeds from each lot and placing them on a moistened paper towel. They are observed for two weeks, and germination count is conducted every-order-week and expressed in percentage.

Seed protein content (SPC): About 0.5g of sample was taken and added into the digestion tube where also 20ml of concentrated sulphuric acid was added. One selenium tablet was added as catalyst. The content in the tube was heated at a temperature of 35^{o}C for 6 hours until a clear digest was achieved, that is a clear solution. This solution was poured into a standard flask and made up to 100ml (Wen *et al.,* 2018). The data collected on all the parameters were subjected to analysis of variance (ANOVA) using Statistical Analysis System (SAS) and where significant differences among the treatments are obtained, means were separated using the Duncan Multiple Range Test (DMRT) at 5% probability unless otherwise stated.

RESULTS AND DISCUSSION

Figure 1 shows that seeds extracted from "Dan Damaso" cultivar fruits did not only record significantly higher seed germination percentage (SGP) during storage but also broke its dormancy faster by attaining its highest SGP (36.57%) at an early 2 weeks after storage (WAS). Other cultivars, "Dan Datsa", "Dan Charkawa" and "Dan Boko" attained their highest SGP values (20.29, 18.5 and 17.0% germination) at a later 3 WAS respectively. Seeds extracted from the fruits of "Dan Charkawa" cultivar recorded significantly lower SGP values which ranged between 0.5 and 17% germination during the 8 weeks of storage although the values were statistically at par with those of "Dan Datsa" between 4 WAS up until the end of storage (8 WAS).

Dormancy has been reported to be present in freshly harvested seeds of *Solanum spp* (Yogeesha *et al.* 2008) and this dormancy was also reported by Oladiran and Kortse (2002) to vary among pepper types. Ibrahim et al. (2018) also observed variation in viability among pepper genotypes. The variation in SGP and dormancy levels among the four cultivars of bell pepper used could be ascribed to their genetic make-up. Ramirez-Rosales *et al*. (2004) also reported variations in germination percentages among tomato genotypes which they attributed to the low germination in some cultivars due to their high lycopene content. High lycopene content is also attributed to high ABA content (Seyed and Naser, 2012). Abscisic acid (ABA) and gibberellins (GA) are well-known phytohormones that are involved in regulating seed germination. The two hormones operate in opposite manners, as the ABA inhibits germination while the GA promotes the biological process of germination (Nambara *et al.,* 2010).

Figure 2 shows the effects of fruit harvesting stages on the SGP of bell pepper plants. Seed extracted from fruits that attained 50 days after anthesis (DAA) recorded significantly higher SGP values during storage with values ranging between 2.87 and 43.25% at 8 and 2 WAS respectively. Seeds extracted from fruits harvested at 25 DAA produced seeds with significantly lower SGP values during the periods of storage. These values ranged from 0.00 to 7.38 recorded at 8 and 3 WAS respectively. This suggests that at 50 DAA maximum seed filling, sufficient nutrient absorption of soil nutrient which is translocated into the seeds in the fruit has occurred. This process might have conferred superiority in the capacity of these seeds over those of other ages. This was similar to the findings of Demir and Samit (2001) who reported that harvesting tomato when they are fully red, and firm (70DAA) gave the maximum seed quality regardless of the seed extraction method used.

Figure 1: Effects of cultivar on seed germination percentage of bell pepper plants

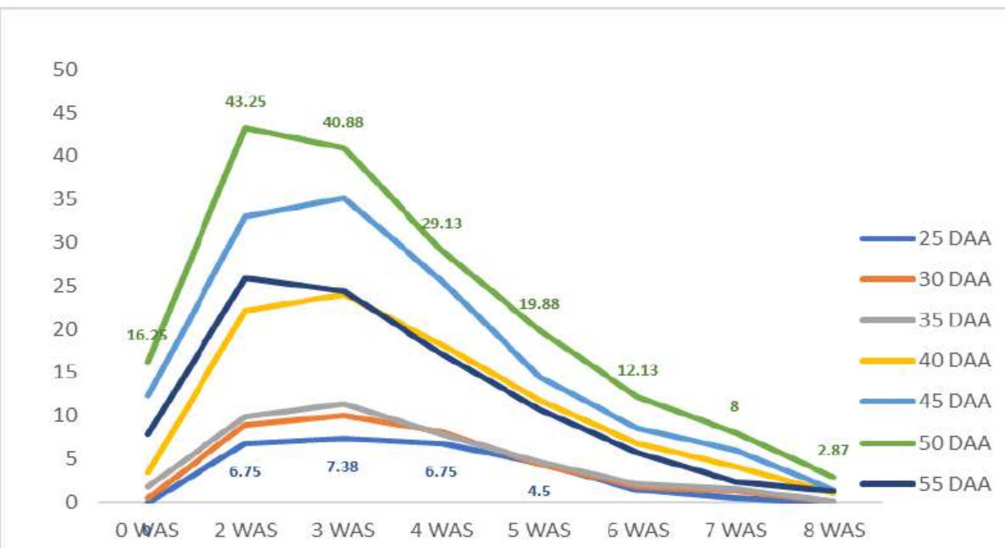

Figure 2: Effect of fruit age on seed germination percentage of bell pepper plants

Table 1 shows the interaction effects of cultivar and fruit age on the SGP of four bell pepper harvested at different fruit ages. Seeds extracted from the fruits of "Dan Damaso" cultivar and harvested when the fruits attained 50 days after anthesis produced seeds with significantly higher SGP values across the period of storage. These values ranged from 73.50% obtained at 2 WAS and 4.00% germination obtained at the end of storage (8 WAS). Irrespective of cultivar, seeds extracted from fruits that attained just 25 DAA recorded the lowest SGP values across the 8 weeks of storage.

Figure 3 shows the effects of cultivar on the seed protein contents (SPC) of four bell-pepper plants. "Dan Damaso" cultivar of bell-pepper produced seeds with significantly higher SPC during the storage period with values ranging between 23.78% recorded at the onset of storage (0 WAS) and 18.24% protein recorded at end of storage (8 WAS). Seeds extracted from the fruits of "Dan Boko" cultivar recorded the least SPC with values ranging from 19.13% protein at 0 WAS and 16.31% protein at 8 WAS. Adepoju *et al.* (2019) observed varying types of protein bands among "Ijosi" and "Sombo" varieties of pepper. According to Gao *et al.* (2016), the content of storage proteins is one of the main determinants of seed longevity. This statement is supported by the fact that the biggest differences between seeds with high and low quality are seen in their storage proteins (Sathish *et al.,* 2015). The superiority of "Dan Damaso" cultivar in seed protein content could be as a result of its ability to assimilate more nutrient required for protein production and also has the capacity to translocate more of this nutrient into the seed.

In figure 4, at 2 WAS, seeds extracted from fruits that attained 40 DAA recorded significantly high SPC value (21.58% protein), while at 0, 4, 6 and 8 WAS seeds extracted from fruits that attained 50 DAA recorded significantly higher SPC values with 25.51, 22.53, 21.75 and 20.08% protein. Fruits that attained 25 DAA before harvest produced seeds with significantly lower SPC values across the period of storage. These values ranged between 16.91 and 14.99% protein recorded at 0 and 8 WAS. The interaction between cultivar and fruit age on the seed protein content of bell-pepper plant is shown on Table 2. The table shows that fruits of "Dan Damaso" cultivar that attain 50 DAA produced seed that contains significantly higher SPC (27.28, 24.34 and 20.18% protein) recorded at 0, 2 and 6 WAS respectively. Fruits of "Dan Boko" cultivar that were harvested when the fruits that attained 25 DAA recorded the lowest SPC (15.26, 14.14 and 14.64% protein) across the storage period.

This could be tied to the fact that matured seeds have more storage reserves, desiccation, dormancy induction, better seed coat formation, and protective chemical synthesis (Naoto *et al.,*2016). Zhang, *et al.,* (2020) supported this claim by postulating that during the aging process in seeds, the changes include alterations in membrane, protein composition, disruption of the nuclear envelope, protein degradation, decreases in lipid content, oxidative stress, and decreases in mRNA translation and DNA replication capabilities.

Table 1: Interaction effects of cultivar and fruit harvesting stage on the seed germination percentage of bell pepper plants stored for eight weeks.

Interaction		Storage period (Weeks)								
Cultivar	Fruit Age (DAA)	0	1	2	3	4	5	6	7	8
Datsa	25	0.00 o	3.50 mno	8.00 op	7.00 op	4.00 p	1.00 l	0.00 n	0.00 j	0.00 f
Charkawa	25	0.00 o	2.50 op	6.00 q	4.50 op	3.50 p	3.50 k	1.00 m	0.00 j	0.00 f
Damaso	25	0.00 o	4.00 mn	10.00 n	10.00 no	9.50 lm	6.50 ghi	3.50 k	2.00 h	0.00 f
Boko	25	0.00 o	0.00 r	3.00 r	8.00 op	10.00 l	7.00 gh	1.00 m	0.00 j	0.00 f
Datsa	30	2.00 lm	6.00 l	13.00 m	8.00 op	5.50 o	3.00 k	0.00 n	0.00 j	0.00 f
Charkawa	30	0.00 o	3.00 no	7.50 p	9.00 no	5.50 o	5.00 j	3.00 k	2.50 h	0.50 ef
Damaso	30	0.00 o	4.50 m	10.00 n	14.00 k	13.00 j	6.50 ghi	3.00 k	2.00 h	0.00 f
Boko	30	0.00 o	1.00 qr	5.50 q	9.00 no	8.50 mn	3.00 k	1.50 lm	0.50 ij	0.00 f
Datsa	35	2.25 klm	7.75 k	15.00 l	9.00 no	5.50 o	3.50 k	1.00 m	0.50 ij	0.00 f
Charkawa	35	1.50 mn	3.75 mn	9.25 no	10.50 m	5.50 o	5.50 ij	3.00 k	2.50 h	0.50 ef
Damaso	35	1.00 kl	4.50 m	10.00 n	16.50 j	13.00 j	6.00 hij	3.00 k	2.00 h	0.00 f
Boko	35	1.10 n	1.50 pq	5.50 q	9.50 mn	7.50 n	3.50 k	1.50 lm	1.00 i	0.00 f
Datsa	40	3.50 j	8.50 jk	12.00 m	12.00 l	11.50 k	9.50 g	4.50 j	2.50 h	0.00 f
Charkawa	40	5.00 i	6.00 l	8.00op	30.00 f	10.00 l	7.00 gh	5.00 ij	3.50 g	0.50 ef
Damaso	40	3.00 jk	23.00 d	47.50 c	43.00 c	27.50 c	19.50 c	8.00 ef	5.00 de	2.00 bc
Boko	40	2.50 kl	9.00 ij	21.00 i	27.00 g	24.00 ef	15.00 d	9.00 de	5.50 d	1.50 cd
Datsa	45	5.00 i	12.50 g	23.00 h	27.00 g	19.50 h	10.50 f	5.00 ij	4.00 fg	1.50 cd
Charkawa	45	6.00 h	10.50 h	16.50 jk	21.50 i	21.50 g	13.50 e	6.50 g	4.50 ef	1.50 cd
Damaso	45	28.50 b	44.00 b	57.00 b	52.00 b	36.00b	17.50 c	11.50 c	9.00 b	2.50 b
Boko	45	10.00 e	20.00 f	35.00 e	31.50 e	25.50 d	16.50 c	11.00 c	6.50 c	1.50 cd
Datsa	50	11.00 d	20.00 f	30.50 f	37.00 d	25.00 de	15.00 d	8.50 ef	5.50 d	2.50 b
Charkawa	50	7.00 g	10.00 hi	26.50 g	10.00 no	23.00 f	14.00 de	8.00 f	5.00 de	0.50 ef
Damaso	50	38.00 a	58.00 a	73.50 a	61.00 a	42.50 a	29.00 a	16.50 a	12.00 a	4.00 a
Boko	50	9.00 f	21.50 e	42.50 d	36.00 d	26.00 d	21.50 b	15.00 b	9.50 b	4.50 a
Datsa	55	5.50 hi	12.50 g	22.50 h	29.50 f	20.00 h	10.50 f	6.00 gh	2.00 h	1.50 cd
Charkawa	55	2.00 lm	6.00 l	15.00 kl	14.00 k	13.50 j	5.50 ij	2.00 l	0.50 ij	0.00 f
Damaso	55	21.50 c	34.00 c	48.00 c	25.50 i	20.00 h	17.00 c	9.50 d	4.50 ef	2.50 b
Boko	55	2.50 kl	11.00 h	17.50 j	21.00 i	15.00 i	9.50 f	5.50 hi	2.50 h	1.00 de
±SE		0.74	1.08	1.14	1.31	1.17	1.18	0.78	0.71	0.42

Any two means within each column not sharing a letter differ significantly from each other by LSD at 5 % probability level.

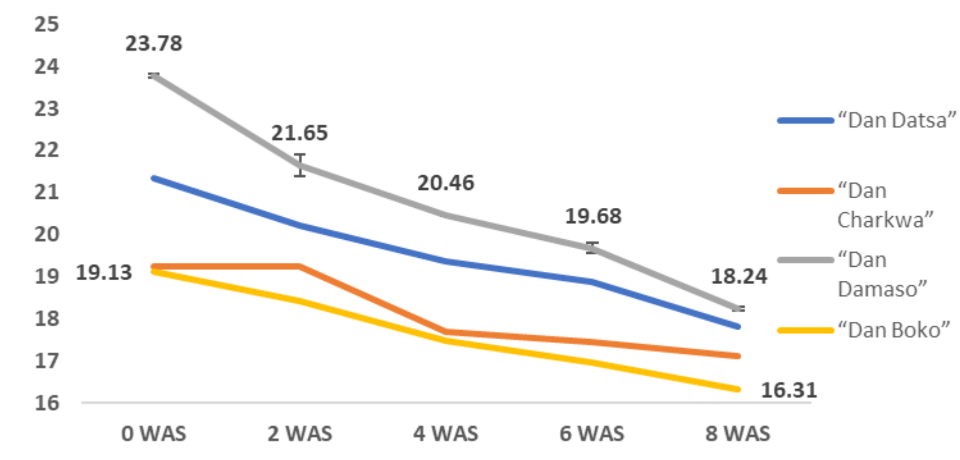

Figure 3: Effects of cultivar on seed protein contents of four bell-pepper plants

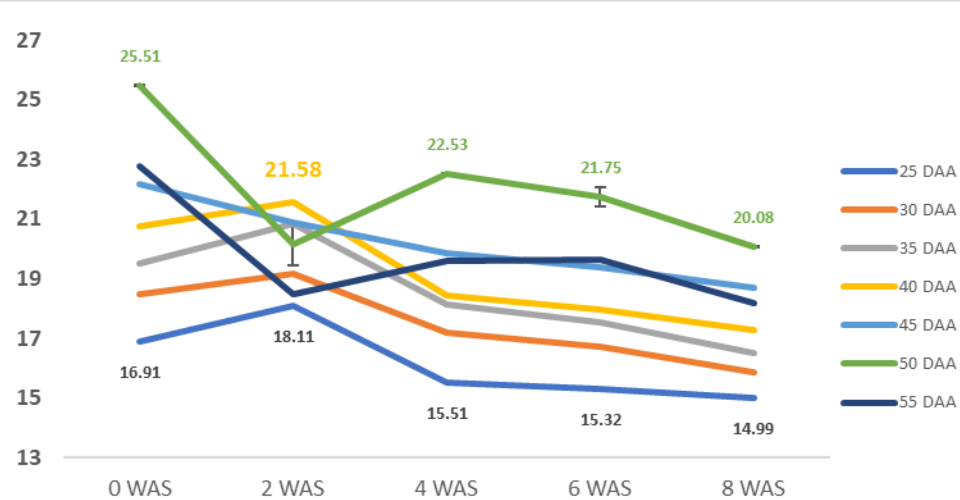

Figure 4: Effects of fruit age on seed protein content of bell-pepper plant

Table 2: Interaction effects of cultivar and fruit harvesting stages on the seed protein content of bell pepper plants

Interaction		Storage periods (weeks)		
Cultivar	Harvesting stages	0	4	6
Datsa	25	17.49 t	15.28 v	14.86 y
Charkawa	25	16.26 v	15.34 u	15.12 w
Damaso	25	18.64 r	17.29 r	16.28 s
Boko	25	15.26 w	14.14 x	13.64 z
Datsa	30	18.89 q	17.32 r	15.32 v
Charkawa	30	17.40 u	16.34 t	16.09 u
Damaso	30	21.41 h	19.88 i	17.69 j
Boko	30	16.25 v	15.19 w	14.29 z
Datsa	35	19.76 o	18.12 o	17.35 n
Charkawa	35	17.83 s	16.92 s	16.24 t
Damaso	35	22.62 g	18.63 l	17.49 l
Boko	35	17.79 s	18.92 j	14.93 x
Datsa	40	20.81 k	18.44 n	17.44 m
Charkawa	40	18.65 r	17.31 r	16.86 q
Damaso	40	24.26 f	20.66 d	18.27 g
Boko	40	19.23 p	17.53 q	16.58 r
Datsa	45	21.34 i	20.08 g	19.85 e
Charkawa	45	20.45 l	18.58 m	17.26 o
Damaso	45	26.84 b	21.85 b	19.93 c
Boko	45	20.08 m	18.84 k	17.67 k
Datsa	50	26.24 c	24.34 a	20.04 b
Charkawa	50	24.25 f	21.29 c	20.19 a
Damaso	50	27.28 a	24.34 a	20.18 a
Boko	50	24.25 f	20.15 f	19.89 d
Datsa	55	24.82 e	20.01 h	19.83 f
Charkawa	55	19.83 n	18.14 o	17.96 h
Damaso	55	25.93 d	20.55 e	17.83 i
Boko	55	21.04 j	17.65 p	17.17 p
±SE		0.04	0.03	0.01

Any two means within each column not sharing a letter differ significantly from each other by LSD at 5 % probability level.

CONCLUSION

The study further established that seed protein content has a direct correlation with seed viability, vigour and longevity. The cultivar "Dan Damaso" seeds extracted from fruit that attained 50 days after anthesis before harvest produced seeds that were more viable and contain higher percentages of seed protein content. Therefore, monitoring seed protein content during storage can be used to monitor bell pepper seed viability and vigour.

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EFFECT OF DIFFERENT GROWING MEDIA ON ROOTING AND SHOOT DEVELOPMENT OF *Ixora Duffi*

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ABSTRACT
Ixora duffi is a genus of flowering plants in the family Rubiaceae in which difficulty in rooting is often encountered during its propagation. To solve this problem, the current experiment was designed to investigates the effects of different growing media on rooting and shoot development of Ixora duffi at the Ornamental Horticulture Nursery Farm, Federal College of Agriculture, Akure, Ondo State, Nigeria between May 20, 2022 to September 23, 2022. Treatment consisted of eight treatments (Top soil (TS), Sawdust (SD), Poultry Manure (PM), River Sand (RS), Topsoil + Poultry Manure (Ts, Pm), Topsoil + Sawdust (Ts, Sd), Topsoil + River Sand (Ts, RS,), Topsoil + River Sand + Poultry Manure + Sawdust (Ts, Rs, Pm, Sd). Treatments were arranged in completely randomized design and replicated three times. Cuttings were raised in polythene pots filled with the different treatment. Data collected include; days to 50% bud break, plant height per plant, number of leaves per plant, numbers of branches per plant and were subjected to analysis of variance (ANOVA) and means were separated using Duncan multiple range test at 5% probability level. TS, PM, TS+PM, TS+SD, TS+RS were early in bud break by producing 50% bud break at 15days. TS+SD produced the highest plant height with mean value of 17.43. Number of branches and Number of leaves was high in RS compare to other growth media. The study therefore conclude that RS could be used to grow Ixora duffi while TS, TS+PM and PM, TS+SD as well as TS+RS can be considered when early bud break is of high priority.
***Keywords**: Ixora duffi, Propagation, adorable shrub, floral designs, bud break*

INTRODUCTION
Ixora duffi is a brightly coloured plant, a genus in the family Rubiaceae which happened to be the only genus in the tribe Ixoreae. The plants possess leathery leaves, ranging from 3 to 6 inches in length, and produce large clusters of tiny flowers in the summer. It is a suitable choice for bonsai, landscape beatification and floral arrangement. The Growers and flower nurserymen in most part of the world especially South Western Nigeria do encounter difficulty in propagation and rooting success of *I. duffi*. Larson (1980) mentioned that the best growing media must have a pH conducive to plant growth, a structure that will permit gaseous exchange to provide aeration for the root and permit water infiltration and movement. According to Kambooh (1984), organic matter content of the planting medium has a profound effect on its biological, chemical and physical properties. *Ixora duffi* plant is an acid-loving plant and grow best in acidic, rich, well-drained soil.

MATERIALS AND METHODS
The experiment was carried out at Ornamental Horticulture Nursery Farm, Federal College of Agriculture, Akure, Ondo State, Nigeria between May and September 2022. The experimental design used was a Completely Randomized Block (CRD) with three (3) replications, having eight (8) treatments

which include Top soil (TS), Sawdust (SD), Poultry Manure (PM), River Sand (RS), Topsoil + Poultry Manure 1:1 (Ts, Pm), Topsoil + Sawdust 1:1 (Ts, Sd), Topsoil + River Sand 1:1 (Ts, RS,), Topsoil + River Sand + Poultry Manure + Sawdust 1:1:1:1 (Ts, Rs, Pm, Sd). Poultry manure and topsoil were collected from the poultry unit of the Federal College of Agriculture, Akure. River sand were collected within Federal College of Agriculture, Akure. Sawdust was collected in Oba-Ile area, Akure in Ondo State. Data collected include; Days to 50% bud break, Number of leaves per plant, Plant height (cm) per plant, Number of branches per plant taken every 2weeks interval. Data collected were analysed using Gen Stat Discovery Edition 4 (version 2013) following analysis of variance procedures. The means were separated using Least Significant Difference at 5% probability level and ranked using Duncan Multiple Range Test (DMRT).

RESULTS

Effect of growth media on Days to 50% bud break

Growth media had significant effect on the cuttings of *Ixora duffi* (Table 1). The cuttings planted in TS, TS+PM, TS+SD, TS+RS were early in bud break (15 days) compare to RS, SD, PM and TS+PM+SD+RS. Late bud break was recorded in plants raised on SD+PM (23 days).

Effect of growth media on Plant Height (cm) per plant of *Ixora duffi*

Growth media produced significant ($P < 0.05$) difference on plant height with TS+SD having the highest mean plant height at 4 (17.43cm), 6 (16.37cm) and 8 WAP (13.27cm) respectively (Table 2). At 10 and 12 WAP, growth media produced significant ($P < 0.05$) difference on plant height with RS having the highest plant height with mean value 13.22cm and 11.12cm respectively while TS+PM had the least plant height (0.00cm) in both weeks. At 14, 16 and 18 WAP, there was no significant difference in the effect of growth media on plant height of *I. duffi*.

Effect of growth media on Number of Leaves per plant of *Ixora duffi*

Growth media produced significant ($P < 0.05$) difference on number of leaves of *I. duffi* with TS+RS having the highest number of leaves (6.67) while SD had the lowest number of leaves (1.89) at 4 WAP. At 8 WAP, growth media produced significant ($P < 0.05$) difference with TS+SD produced the highest number (4.67) of leaves (Table 3). At 10 WAP, growth media produced significant ($P < 0.05$) difference on number of leaves of *I. duffi* with PM having the highest number of leaves (5.89) while TS+PM had the lowest number of leaves (0.00). At 12 WAP, growth media produced significant ($P < 0.05$) difference on number of leaves with RS having the highest number of leaves (5.56) while TSPM had the lowest number of leaves (0.00). At 6, 14, 16 and 18 WAP, there was no significant difference in the effect of growth media on number of leaves of *I. duffi*.

Effects of growth media on Number of Branches of *Ixora duffi*

The growth media effects on number of branches of *I. duffi* was significantly ($P < 0.05$) different with TS having the highest number of branches (2.56) at 4WAP, while SD had the least (0.89) number of branches (Table 4). At 8, 10 and 12 WAP, growth media had significant ($P < 0.05$) effect on number of branches with RS having the highest plant height with mean value 1.89, 1.89 and 1.67 respectively while TS+PM had the least number of branches (0.00) in both weeks. At 14, 16 and 18 WAP, there was no significant difference in the effect of growth media on number of branches of *Ixora duffi*.

DISCUSSION

The result of this study depicted differential response of *I. duffi* plants to different growing media. This is related to the observation made by Adams *et al*. (2003) that a good soil medium is the basic resource in producing healthy and thriving plants. The differential response in number of leaves, plant height and number of branches of *I. duffi* plant based on the different growing media imposed may be due to the nature, type and composition of the growing media used in this study. In addition, the nutrient availability and release might have influenced the physiological processes taking place within the plants that brought about changes at different stages of plant growth and development. Similarly, number of leaves per plant produced on medium of TS+RS at 4 WAP, TS+SD at 8 WAP, PM at 10 WAP and RS at 12 WAP were significantly higher than TS alone, SD alone, TS+PM. +PM, TS+SD, TRRS+PMSD media. This trend may not be unconnected with the assertion made by Olosunde and Fawusi (2013) that the best medium for raising ornamental plants is the soil which has heterogeneity with regard to physical properties (i.e. texture, structure, colour, bulk density and water holding capacity) and chemical properties (i.e. PH and nutrient status).

The TS (loam) and the TS+SD proved to be more drained and more aerated thereby promoting rapid absorption of nutrients leading to growth as reported by Yusuf (2009). With regard to plant height per plant, TS+SD produced significantly higher plant height especially at 4 WAP. This may be due to presence of nutrient in both media for growth requirement which promoted growth and adequate aeration. This is in agreement with the findings of Beardsell and Nichols (1982) that the physical composition of the medium can have a profound effect on the supply of air and water to the growing medium. The mixture of TS with SD had better porosity and ability for to retain moisture and inherent nutrient contained in the TS which enhanced early leaf development. This result agrees with the findings of Okunlola and Oyedokun, (2016), who opined that the porosity of SD medium when mixed with an appropriate medium could have allowed water to be imbibed in seeds and adequate aeration for early plant development. Although, river sand has good aeration and drainage, but low water holding capacity and gave lower growth value in this study (Okunlola, 2016). The TS+SD medium produced significantly higher plant height than the other media types.
This could be attributed to availability of nutrients, adequate drainage, better aeration and low bulk density in the medium. Similar observation was made by Adams *et al*. (2003) who reported on the effect of different growing media on the growth of *Dieffenbachia maculata* that plants confined to a container needs a rich, porous medium for their growth and better seedling establishment. According to Adams *et al*. (2003) the TS+SD medium gave significantly higher plant height per plant throughout the sampling periods except in the wet season where there was no difference with TS medium. This is in accordance with the findings of Lamont and O'Connell (2007) who reported that the quality of container grown ornamental plants is in broad terms dependent on the physical and chemical composition of the medium and the growing environment among other things.

CONCLUSION

The suitability of the rooting medium depends on the species, type of cuttings, growing conditions, season of the year and the cost effectiveness of the medium components. A media which is light, rich, porous, well drained and free from pathogens is considered ideal for growing of ornamental plants. A good potting medium must be easy to supply, process and a cheap source.
The study was designed with the objective to determine the proper type of growing media for the propagation and nursery production of *Ixora duffi*. The result from the study revealed that growing media significantly influenced early bud break, plant height, root and shoot growth performance of the *Ixora duffi*. The study further shows that River sand had significant effects on shoot growth and development of *Ixora duffi.* Therefore, it can be concluded that River sand as a growing media is very important for the rooting, early sprouting and shoot growth of *Ixora duffi*, thus recommended for its propagation.
Further investigation should be carried out on preparation of mixture of growth media from locally available materials and more commercial mixtures should be researched on and be available for the end users.

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Table 1: Days to 50% Bud Break

Growth Media	Days to 50% bud break
TS	15
SD	23
PM	23
RS	20
TSPM	15
TSSD	15
TSRS	15
TSRSPMSD	16

Table 2: Effects of Growth media on Plant Height (cm)

Growth Media	WEEKS AFTER PLANTING						
	4 WAP	6 WAP	8 WAP	10 WAP	12 WAP	14 WAP	16 WAP
TS	15.54	15.34	6.98	7.30	7.50	7.70	7.80
SD	13.07	12.60	11.91	8.30	8.80	9.40	8.70
PM	13.39	9.49	8.89	9.00	5.50	5.80	6.10
RS	15.73	11.90	12.33	13.22	11.12	11.40	11.70
TSPM	15.27	6.92	0.00	0.00	0.00	2.10	2.10
TSSD	17.43	16.37	13.27	11.50	9.80	10.00	10.10
TSRS	15.76	14.93	5.52	5.60	5.70	5.90	6.00
TSRSPMSD	13.17	12.02	6.19	3.80	4.30	4.40	4.50
LSD ($P < 0.05$)	3.72	6.07	7.47	8.06	8.44	NS	NS

Table 3: Effects of sowing medium on Number of leaves

	WEEKS AFTER PLANTING							
Growth Media	4 WAP	6 WAP	8 WAP	10 WAP	12 WAP	14 WAP	16 WAP	18 WAP
TS	6.56	5.44	3.33	3.44	3.78	4.33	4.78	6.11
SD	1.89	3.67	3.11	2.44	2.89	3.89	4.67	1.89

PM	3.44	4.22	4.33	5.89	3.33	4.22	5.22	6.78
RS	2.33	3.44	4.22	5.33	5.56	6.33	6.11	7.67
TSPM	2.67	2.78	0.00	0.00	0.00	1.22	1.78	2.22
TSSD	5.89	6.11	4.67	4.56	4.11	4.33	4.44	5.56
TSRS	6.67	5.78	2.11	2.22	2.56	3.33	4.33	5.00
TSRSPMSD	4.22	5.78	2.56	1.89	2.44	2.56	2.78	3.67
LSD (P < 0.05)	2.29	NS	3.32	3.87	4.32	NS	NS	NS

Table 4: Effects of growth media on Number of Branches

Growth	WEEKS AFTER PLANTING							
Media	4 WAP	6 WAP	8 WAP	10 WAP	12 WAP	14 WAP	16 WAP	18 WAP
TS	2.56	2.11	0.89	0.89	0.78	0.89	0.89	0.89
SD	0.89	1.56	1.67	1.33	1.33	1.33	1.33	0.67
PM	1.67	1.44	1.44	1.67	1.22	1.33	1.33	1.33
RS	1.33	1.78	1.89	1.89	1.67	1.67	1.67	1.33
TSPM	1.56	1.00	0.00	0.00	0.00	0.89	0.89	0.89
TSSD	2.00	2.11	1.44	1.22	1.11	1.00	1.11	1.11
TSRS	2.44	2.22	0.67	0.89	1.00	1.11	1.11	1.11
TSRSPMSD	2.00	1.78	1.00	0.67	0.67	0.67	0.67	0.67
LSD (P < 0.05)	0.982	NS	1.16	1.26	1.30	NS	NS	NS

STORABILITY OF POTATO (*Solanum tuberosum* L.) AS INFLUENCED BY VARIETY, SEED FORM AND PLANTING DATE AT KAZAURE, JIGAWA STATE, NIGERIA

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ABSTRACT
In the low altitude, semi-arid tropics of Jigawa, northern Nigeria, potato production is constrained by a lot of production factors such as adaptable varieties, seed form, time of planting, and storage conditions among others. Research is therefore required to address these constraints. Consequently, a field trial was conducted at Kazaure, Jigawa State, Nigeria to evaluate the influence of variety, seed form, and planting date, on the storability of potato (Solanum tuberosum L.) tubers. Treatments consisted of four potato varieties (Nicola, Bertita, Diamant, and Agria), two seed tuber forms (whole tuber and cut setts), and three planting dates of four weeks intervals (November, December, and January) factorially combined and laid in a split- split plot design, replicated three times. Characters evaluated were tuber percentage weight loss, sprout, and rotting during storage at 4, 8 and 12 weeks after harvest. Thirty tuber samples of healthy and marketable sizes were randomly selected for each treatment and spread in clean disinfected wooden crates of 30 x 30 x 10 cm in length, wide, and depth dimensions stored in a well-ventilated room, under ambient conditions. The containers were arranged in a completely randomized pattern and inspected fortnightly, over a period of 3 months. Observations on mean weight loss, sprouting, and rotted tubers in percentage were taken and recorded at 4-week intervals. Results revealed that a significant influence was on percentage tuber weight loss at 12WAS, sprout at 8WAS, and rot at both 8 and 12WAS where variety Diamant consistently produced more tuber weight loss, sprout, and rot than other varieties. Between the two seed forms, a significant influence was on percentage weight loss at 12WAS only, where cut tuber produced significantly more weight loss than whole tuber. Variation in planting date on the other hand, resulted in a significant difference in percentage tuber weight loss and sprout where December and January plantings produced more tuber weight loss than November planting, while November planting produced more percentage tuber sprout than December and January plantings that were at par with each other. Likewise, seasonal variation resulted in a significant difference in percentage tuber weight loss, sprout, and rot whereas 2015/16 consistently resulted in more percentage tuber weight loss, sprout, and rot than the other two seasons. Based on this research, Nicola and Agria planted as a whole tuber in November and December is recommended for farmers in the study area
Keywords: *Variety, sprout, storability, rot, weight loss, treatments*

INTRODUCTION

Potato (*Solanum tuberosum* L.) is one of the most important vegetable crops, constituting the fourth most important food crop in the world (FAOSTAT, 2013). The potato crop is graded as a high potential food security and cash crop because of its ability to provide a high yield of high-quality product per unit input with a shorter crop cycle (mostly < 120 days) compared to major cereal crops like maize (Adane *et al.*, 2010). Nutritionally, potato has the highest and most favorable protein-calorie ratio among the same class

of roots and tuber crops (Nganga, 1982). Also, the biological value of potato protein is very high and is equal in quality to egg and milk protein (Sikka and Kanzikwera, 1993). However, in spite of this immense importance and contribution towards the reduction of nutritional deficiency as well as poverty alleviation in the country, production, yield and utilization is constrained for some reasons. A number of productions constrain that account for such low yields and utilization have been identified. The major ones are unavailability and high cost of seed tubers, lack of well adapted cultivars, inappropriate agronomic practices, diseases, insect pests and inadequate storage (Bereke, 1994). Hijmans (2003) predicted yield losses globally for potato in the range of 18 to 32% without adaptation in production methods, or 9 to 18% without adaptation in terms of planting time and use of heat tolerant cultivars.
The overall potato seed quality is affected by purity, genetic quality, health, size, physical damage and physiological age. Differences in variety characteristics determine the suitability for the cutting of seed potatoes. It includes rotting of some varieties compared to others, the number and position of eyes, especially limited to the apical part of the tuber (Fienie, 2016). Lenka *et al.*, (2013) in Plateau State for example, reported that the crop is mainly cultivated by whole seed tubers in which the continuous use of seed tubers has been found to bring about degeneration of tubers and also reduced the quantity of production. For economic consideration, in Nigeria quality of seed tubers is a serious challenge because of inadequate storage facilities and adaptable cultivars which resulted in farmers inability to break even. In view of the afore mentioned reasons, research was therefore undertaken to evaluate the influence of variety, seed form and planting date, on storability of potato tubers after harvest in the study area.

MATERIALS AND METHODS

Study area

Field experiment was conducted during three dry seasons (between 2015 and 2018) at Kazaure, Jigawa state, located at latitude 12º 38’ 54.46’’N and longititude 8º 24’ 42.41’’E and situated at an altitude of 635m above sea level. The climate of the area is semi-arid, with mean annual rainfall of 600mm. The relative humidity in the study area ranges from 21-47% during the dry seasons, with mean annual temperature of 25.9^0C. The area is controlled by two trade winds, northeasterly from October to March, which is dry and brings harmattan, and southwesterly, from April to September, hot and humid and brings rain. The bulk of agricultural activities are undertaken by small scale subsistence level farmers, involving family labour mostly using manual tools, associated with high level of risk caused by draught, flood, pests and diseases. The soil type is sandy loam of Chad basin formation, and the major crops cultivated are cereals (millet, sorghum, cowpea e t c) during wet season and vegetables (tomato, pepper and onions) in the dry season (Anon, 2009).

Experimental design, treatments, data collection and analysis

The treatments consist of four potato varieties (Nicola, Bertita, Diamant and Agria), two seed tuber forms (whole tuber and cut setts) and three planting dates of four weeks intervals (November, December and January). The treatments were factorially combined and laid out in a split-split plot design with three replications. In the design of the experiment, the varieties were allocated to the main plot, seed tuber forms to the subplot, while planting date was assigned to the sub-sub plot. Planting was carried out at three different dates starting from 14^{th} November to 15^{th} January as per the treatment, in each season. During planting, each plot consisted of five rows with ten seeds planted per row, giving a total of fifty stands per plot. Fertilizer was used at the recommended rate of NPK 120-60-60, applied using (NPK 15:15:15) in two split doses with half of N and all the P and K during planting, the second dose applied at 4 weeks after planting using Urea 46%N. Weeds were controlled manually using hoe at 2 to 3times during each trial, as determined by the weed status. Harvesting was carried out manually by uprooting tubers from the ground using hoe. Characters considered were tuber percentage weight loss, sprout and rotting during storage at 4, 8 and 12 weeks after harvest. Thirty tuber samples of healthy and marketable sizes were randomly selected for each treatment and spread in clean disinfected wooden crates of 30 x 30 x 10 cm in length, wide and depth dimensions stored in a well-ventilated room, under ambient condition. The containers were arranged in a completely randomized pattern and inspected fortnightly, over a period of 3 months. Observations on mean weight loss, sprouting and rotted tubers in percentage were taken and recorded at 4 weeks interval. The data generated was pooled and subjected to combine analysis of variance (ANOVA), using GenStat software, Seventeenth Edition. The treatment means however, were separated for significant F value, using Duncan Multiple Range Test (DMRT) at 5% probability level.

RESULTS

Table1 presents the influence of variety, seed form and planting date on percentage weight loss, sprout and rotting of potato at 4, 8 and 12 weeks after storage in the study area. The result indicated that variation in variety resulted in a significant ($P \leq 0.05$) influence of percentage tuber weight loss at 12WAS, sprout at 8WAS and rot at both 8 and 12WAS where Diamant variety consistently produced more tuber weight loss, sprout and rot than other varieties. Between the two seed forms, significant influence was on percentage weight loss at 12WAS only where cut tuber produced significantly more weight loss than whole tuber. Variation in planting date on the other hand, resulted in a significant difference of percentage tuber weight loss at all samplings and sprout at 4 and12WAS where December and January planting dates produced more percentage tuber weight loss than November planting while November planting on the other hand produced more percentage tuber sprout than December and January plantings that were at par with each other. Seasonal variation also resulted in a significant difference of tuber weight loss, sprout and rot at all sampling periods except tuber weight loss at 8 and 12WAS. During the investigation, 2015/16 season consistently produced more tuber weight loss, sprout and rot than other two seasons.

Table 1: Effect of variety, seed form and planting date of potato (*S. tuberosum* L.) on Percent Weight Loss, Sprout and Rot at Kazaure, Nigeria.

Treatments	Percent Weight Loss			Percent Sprout					
Percent Rot									
	4	8	12WAS	4	8	12WAS	4	8	12WAS
Variety (V)									
Nicola	19.5	33.7	44.6b	10.0	32.1b	47.4	7.5	22.6b	43.6b
Bertita	23.5	38.5	50.2ab	15.2	38.4a	55.8	12.8	28.7a	52.2a
Diamant	20.5	37.1	50.7a	18.0	37.2a	53.6	11.5	27.8a	51.1a
Agria	17.7	31.1	45.3ab	9.2	25.5c	41.3	7.7	20.3c	40.7b
SE	1.30	1.	1.00	2.	3.70	4.10	1.20	0.70	0.90
Seed form (S)									
Whole tuber	19.3	33.4	44.4b	14.7	36.7	52.1	10.4	24.8	47.1
Cut tuber	21.3	36.9	51.1a	11.5	29.7	46.9	9.7	24.9	46.7
SE	1.00	1.30	1.00	1.7	2.60	3.10	1.30	2.00	2.30
Planting date (D)									
Nov	16.8c	30.1b	43.0b	21.0a	37.3	54.8a	8.8	24.7	45.4
Dec	20.9b	36.9a	51.2a	8.4b	30.3	46.6b	10.4	26.6	48.1
Jan	23.2a	38.4a	49.0a	9.9b	31.9	47.3b	10.5	23.2	47.2
SE	1.30	1.50	1.80	1.40	2.30	2.30	1.20	1.60	2.20
Season									
2015/16	25.7a	42.3a	47.4	12.3	41.7a	56.9a	11.3a	31.7a	70.1a
2016/17	16,4c	29.0c	46.8	14.5	32.6b	51.1b	5.7b	14.7c	26.3c
2017/18	18.9b	34.1b	48.9	12.5	25.3c	40.6c	12.6a	28.1b	44.0b
SE	1.20	1.50	2.70	1.50	2.50	2.30	1.20	1.80	2.10
Interactions									
VxD	NS	NS	NS	**	NS	*	NS	NS	NS

VxSxD	NS	NS	NS	NS	NS	NS	NS	NS	NS
VxY	NS	NS	NS	NS	NS	NS	NS	NS	NS
SxY	NS	NS	NS	*	NS	NS	NS	NS	NS
DxY	**	**	NS	NS	*	NS	NS	NS	NS
SxDxY	*	*	NS	NS	NS	NS	NS	NS	NS

SE =Standard error, NS= Not significant,* and ** Significant at 0.05, WAS =Weeks after storage.
Means followed by different letters are statistically different following DMRT.

DISCUSSIONS

Varietal differences resulted in a significant ($P \leq 0.05$) influence of percentage tuber weight loss at 12WAS, sprout at 8WAS and rot at both 8 and 12WAS where Diamant variety consistently produced more tuber weight loss, sprout and rot than other varieties. This supports the findings of Vander Zaag *et al*., (1990), Gogapale, (2012) and Muhammad, (2014) who reported significant influence of these attributes with variation in variety, they observed that cultivar differ in their dormant period, some are short dormant period while others are long. They also attributed the variation in tuber quality like heat tolerance, storability, cooking and processing quality to cultivar differences. Seed form follows the same pattern with cultivar, where the significant difference was at 12WAS only, during which cut tuber produced significantly more weight loss than whole tuber. Tindal (1989) reported that cut sett resulted in the removal of apical dominance which ensures more sprout/tuber, but this does not however apply to tuber quality during storage.

This result further affirms that quality attributes are not affected by agronomic practices but by genetic and environmental factors. Planting date and seasonal difference on the other hand, significantly influence percentage sprout of potato tuber at 8 and 12WAS as well as tuber percentage rot at all sampling periods respectively. This is attributed to variation in climatic condition obtained during the growth period. The significant influence could also be as a result of variation in environmental factors during the period of storage, especially high temperature which hastened tuber degeneration and deterioration. Hassanpanah *et al*., (2009) working on plating date effect on yield components of potato cultivars under Ardabil's climate in Iran reported that planting date, is very essential, therefore tuberization and tuber bulking should not coincide with unsuitable environmental conditions (heat, drought and etc.) with special attention to the growth period of a cultivar. They asserted that, if planting date was not regarded, not, only crop quality decreases but the secondary growth would also be created in tubers.

CONCLUSION

The results of this study revealed that among the varieties studied, Nicola recorded less weight loss, while Agria had less rot and sprout percentage during storage. But whole tuber produced less tuber weight loss, while November planting produced less tuber weight loss, compared to December and January planting dates that together produced tubers with lesser rotting and sprouting percentage under storage. Therefore, Nicola and Agria varieties planted as whole tuber in November and December is recommended for farmers in the study area for good storability quality attribute and more economic benefit.

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SUSCEPTIBILITY AND ADAPTABILITY OF WEEVIL AND GRASSHOPPER AS IT IS INFLUENCED BY ORGANO-PESTICIDES (GOAT URINE – GINGER EXTRACT)

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ABSTRACT
Application of agro pesticides have significant impact on both beneficial and non-beneficial pests. It is important to develop organo pesticide with little or no side effect on the beneficial pest. Therefore, this study was carried in the year 2022 in Biotechnology Laboratory, Jigawa State Polytechnic to determine the influence of organo pesticide on the susceptibility and adaptability of weevil and grasshopper. Basic procedures were taken to produced organo- pesticide such as collection goat urine and ginger extract, sterilization, crushing, fermentation and storage at room temperature for 14 days. Each of the ten samples of bean weevil and grasshopper were subjected to the toxicity effect of organo-pesticide. Data collected were subjected to descriptive statistic such as percentage using Statistical Package for Social Sciences (SPSS). Results showed that bean weevils had 100% mortality rate followed by grasshopper with 60 percent. The extract had high effect to store pest (bean weevil) than field pest (grasshopper). Therefore, recommended that more studies should be carried out to with use of different plant and animal extracts for assessing the effectiveness of the bio-pesticide on several insects to reconfirmed the findings. ***Keywords:** Susceptibility, Adaptability, Weevil, Grasshopper, Influenced, Organopesticides*

INTRODUCTION

Human environment and Agricultural crops are under constant assault by insect pests, making the use of insecticides to have paramount importance to reduce losses (Wei *et al.,* 2018). Synthetic insecticides such as organophosphates are important and effective tools in modern crop management. However, they cause serious threats to the environment and to people. Humans come in contact with dangerous pesticides on food, in water and in the air near farms. Pesticide drift occurs when pesticide dust and spray travel through wind to places unexposed to pesticides. Almost 98 percent of sprayed pesticides do not reach their targets. They penetrate to groundwater, pollute streams and harm wildlife, including natural predators of the targeted pests. Older pesticides such as DDT killed bald eagle, birds, fish and even people (USEPA, 2023). Specialists representing various areas of the vast field of biology are contributing—entomologists, pathologists, geneticists, physiologists, biochemists, ecologists—all pouring their knowledge and their creative inspirations into the formation of a new science of biotic controls (USEPA, 2023). The perception that pesticides are harmful to human health and the environment has led to the implementation of more restrictive legislation dealing with allowable chemicals and residue levels. Other problems associated with excessive use of pesticides are the development of resistant strains (Cabanas *et al.,* 2009).

Exploring the potential to utilize the pesticidal properties of plants and animals has become a key focus of research in pest control. Some plants are known to contain bioactive metabolites, which show antifeedant, repellent and toxic effects on a wide range of insect pests (Kabrambam *et al.,* 2021). Many plants can protect themselves against insects by producing their own chemical defences that are toxic or repellent (Jessica Yactayo-Chang *et al.,* 2020). Bio-pesticides are naturally occurring substances from living organisms (natural enemies) or their products (microbial products, phyto-chemicals) or their by-products (semio-chemicals) that can control pest by nontoxic mechanisms (Salma and Jogen, 2011). Organization for Economic Co-operation and Development (2009), viewed bio-pesticides as manufactured mass produced agents derived from natural sources living micro-organisms and sold for use to control pests. According to Suman and Dikshit (2010), biopesticides encompass broad array of microbial pesticides, biochemicals obtained from micro-organisms and natural sources. Historically, biopesticides has been associated with the biological control and by implication, the manipulation of living organisms (Jitendra *et al.,* 2021). Biopesticides are usually inherently less harmful/toxic and cause less environmental load or pollutions. They are usually designed to only one specific pest or, in some cases, a few target pests as opposed to chemical that have a broad spectrum activity. Although the knockdown effect of biopesticide was proved to be delayed, and plus being costlier, it is reported that it reduced the number of application and are less prone to resistance. In recent decades, the focus on crop production have shift from yield to quality and safety produce.

Evidences suggest that biopesticide is an important component for promoting sustainable agriculture; hence it has gained lots of interest in the last decade particularly in view of the growing demands for organic foods (Emmanuel *et al.,* 2021). For a time in memorial, several biopesticide effect and efficiency have been assess by many scientist such as Salman *et al.* (2020) that tested the biological effects of a neem-based biopesticide on the repellency, mortality, oviposition, and development of Asian Citrus Psyllid (*Diaphorina citri*), Tang *et al.,* demonstrated that neem was effective in controlling the brown citrus aphid, *Toxoptera citricida* (Kirkaldy) and important vector of citrus tristeza virus (Halbert and Brown, 2023) used Garlic (*Zingiber officinale*) to produce a biopesticide that is naturally with fungicidal and pesticide properties that work effectively on controlling pests and makes an excellent economical, non-toxic biological pesticide for use in agriculture. Amuji *et al.,* (2012) investigated the effectiveness of ginger as a biocontrol method of controlling pests and insects on agricultural crops. Chemical made pesticides used in the farms are very toxic to the extent that the toxin tends to accumulate in the plant and translocated to different part of the plant such as seed which when consumed by human cause health effect. Constant damage to agricultural products is usually controlled by using chemicals that are toxic to even the insect which causes the damage. However, some biological agents are reported to possess certain pesticidal effects, hence this study aimed at determining pesticidal properties of crude garlic-goat urine extract crude on some selected insects.

MATERIALS AND METHOD

Description of the study area

The study was conducted in Dutse 11°42′04″ N, 9°20′31″ E. The rock city located in north western Nigeria. It is the capital city of Jigawa State and home to Federal University Dutse, Research Institute for Date Palm (Sub-Station) and State Polytechnic. The capital has an estimated population of 153,000 (2009), and total area of 7,382km^2 currently the largest city in Jigawa State. : Sulaiman *et al.,* 2018; Salami *et al.,* 2019). The climate of the city is classified as tropical and experiences two distinct seasons; the wet season which lasts from June to September with mean temperature of 31 °C but may linger until October, whereas the dry season extends from October to May (Zangina, 2015; Sulaiman *et al.,* 2018; Salami *et al.,* 2019). During the dry season, mean daily temperature ranges from 20 °C in the cooler months of October to February to 42°C during the hotter months of March to May. Annual rainfall ranges from 600 to 1 000 mm. Soil well known to be fertile ranging from sandy-loamy, pH ranges from 6.07-6.72, nitrogen content ranges from 0.63-1.64g/kg, phosphorus 6.25 to 12.04mg/kg and potassium ranges from 0.18-0.63cmol/kg respectively (Salami *et al.,* 2022; Aminu, 2021). The main vegetation type is Sudan savannah. As the state capital, during the last two decades, Dutse have faced a series of lands destruction in the name of urbanization including the construction of the first Airport in the state and other Estate. Raised in food and shelter needs in order to meet the demand of the increasing population of Dutse has also accelerated the used of herbicides in the farmlands, human settlements. Cash crops, such as potato, mango, peanut, bean, cotton, sugarcane, date and several types of vegetables, are produced in large quantities. Agricultural activities are not the major threat but the rate at which the farmers are using herbicides now in Dutse is highly alarming (Sulaiman *et al.,* 2018).

SAMPLE COLLECTION AND PREPARATION

The goat urine were collected from Jigawa State Polytechnic Bitanul garden and the ginger was bought from Dutse Ultra-Modern market. The plant was washed with clean water, blended and store in the clean container prior to use. Glass equipment's such as measuring cylinder, conical flask, and funnel were autoclaved at 121°C for 15min to achieve sterilization. About 50 ml of goat urine were measured using measuring cylinder and added into bottle container, 25gram of fresh ginger was weighed and grinded, then added into goat urine container and stored at room temperature for about 14days (2 weeks) for fermentation (Brooklyn Botanic Garden, 2000). The fermented mixture of goat urine and ginger were sieved to remove the residue. About 50ml of the biopesticide produced were then diluted with 50ml of water and carefully shake before spraying on insect/ pest of interest (Ellis *et al.,* 1992; Brooklyn Botanic Garden, 2000).

Biopesticide effect testing on the selected insect

Effect of the biopesticide produced were tested by spraying it on subject at the same concentration, and the mortality rate were observed. The biopesticide effect were found to be very effective due to the fact that, (goat urine and ginger) contain substances such as urea, sulphur and allicin that kill insects (Ellis *et al.*, 1992; Brooklyn Botanic Garden, 2000).

Data analysis

The data were analyzed using Statistical Package for Social Sciences (SPSS). Descriptive statistics such as: percentage.

RESULTS

Several steps, method and procedures were followed to obtain a compilation of the experiment by successful production of biopesticide from goat urine and ginger extract mixture which effectiveness were tested on various insects/ pest (Table 1). It was observed that, the mortality rate varies on the type of insect's pest tested. Total of 10 individuals of grasshopper and beans weevil were subjected to the test in order to determine the effectiveness of the produced biopesticide. The study found that, Beans weevils were more susceptible to the biopesticide with 100% mortality rate the followed grasshopper which had 60%.

Table 1: Showing the effect of Goat urine-ginger extract on selected insects

Type of insect		Total number	Mortality rate	Survivor	Percentage (%)
1,	Grasshopper	10	6	4	60%
2.	Beans weevil	10	10	0	100%

DISCUSSION

Biopesticides are now being recognized as growing components in the crop protection armoury. Key elements impacting future developments and acceptance include limited funding for research and development, limited shelf-life, high specificity (which can also be an advantage), limited persistence in the environment (in some instances also considered an advantage) and variable field performance (Leonard *et al.,* 2000). Many of these obstacles will be overcome as greater knowledge and experience of their use is incorporated into the selection and marketing of new products, thereby allowing companies to introduce improved products into global markets.

Results from this study proved that, goat urine-ginger extract possesses a high level of biopesticidal effect, based on the result in Table 1, it is enough to say that this is very good and working biopesticide. Results from the study are in agreement with the findings of some other literatures. The mortality rate of the insects treated with biopesticide could be due to toxic effects of the extract against the insects, this is in line with the Ellis *et al.* (1992); Brooklyn Botanic Garden (2000) that uses the extract as biopesticides.

No effect was reported from the use of prepared/produced biopesticide sample. The biopesticide was produced and tested effectively as required and has non-toxic and non-allergic effects to humans and other related animals. Environmentally, the production was pollution free and doesn't involve in any known toxic chemical reactions. The raw materials use for the production was entirely cheap and natural products. The study shows that, use of biopesticides is markedly safer for the environment and users, and more sustainable than the application of chemicals, their use as alternatives to chemical pesticides, especially as components in Integrated Pest Management (IPM) strategies, is of growing interest. The major advantage of the use of biopesticide for crop pest's management is environment safety along with their host specificity. Besides, the associated costs for the development and the registration of the biopesticide are comparatively lesser than that of the chemical pesticides.

CONCLUSION AND RECOMMENDATIONS

The biopesticide were successfully produced from goat urine-ginger extract; its effectiveness was determined on different pests. The results of the study have shown a promising pesticidal/insecticidal activity of goat urine-ginger extract in controlling pest/insects on both storage and treatment. The study believed that goat urine-ginger extract could replace the use of conventional synthetic chemical pesticide containing harmful chemicals as well as residue that may affect human and the environment. The study recommended the use of goat urine-ginger extract as biopesticides for the control of insect’s pests to both small scale and large scale farmers as an alternative to the issue of synthetic chemical looking at the fact that it’s environmentally friendly and healthier for both humans and animals. It can be used to protect several agricultural products from pest since it contains pesticidal properties, readily available, cheaper and less toxic to the immediate consumers. It is further recommended that; more researches should be carried out on assess the effectiveness of the biopesticide on several insects to reconfirmed the findings. Different other plant and animal parts should be used and produce more biopesticide of various kind to determine the most effective one in order to minimize the use of chemical pesticides.

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EFFECTS OF SEED TREATMENT ON SPROUTING AND EARLY SHOOT DEVELOPMENT OF QUEEN'S PALM *(Syagrus Romanzoffiana)*

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ABSTRACT
The study was carried to determine the effect of seed treatment in sprouting and early seed shoot development of Queen palm (Syagrus romanzofiana). The experiment was carried out in Horticultural Technology Departmental project site of Federal College of Agriculture, Akure, Nigeria. Sixty seeds each of Queens Palm were collected from International Institute of Tropical Agriculture (IITA) Ibadan. The study involved the use of four (4) treatments and three (3) replicates. Data collection includes; Days to 50% emergence of seedlings, number of leaves per plant at 2 weeks interval, and plant height per plant at 2 weeks interval. The treatment combinations are Popped (PD), Depoped (DPD), Depoped and Washed (DPDW), Depoped and Washed and soaked for 24hrs (DPDWS) seeds. The result shows that number of leaves was significantly (P < 0.05) higher in DPD (Deppoded) at 16 WAP with the mean score of 2.444. Plant height was not significant (P< 0.05) with the treatment except at 12 and 20 weeks after planting (WAP) where DPDW have highest mean score of 28.78cm and 35.37cm respectively. The findings also show that DPD (Depoded) seed was more viable in early germination, therefore this study suggested that dormancy in queen's palm might arise from the hardness of the seed coat and Depoped (DPD) method of seed treatment is recommended for the propagation of queen palm.
Keywords: *Sprouting, Shoot development, Percentage emergence, Poped, Depoped*

INTRODUCTION

The longevity or ability to preserve seed viability is essential for the formation of a persistent soil seed bank (Thompson, 1997), which plays a decisive role in the adaptation of species to different environments (Baskin and Baskin, 2014). Because of the peculiarities in different habitats, the most accurate method of assessing seed longevity is to bury them in the ground and remove samples at certain time intervals to determine their viability (Baskin, and Baskin, 2006; 2014). *Syagrus romanzoffiana* (Cham.) Glassman (Arecaceae), popularly known as "queen palm" is a palm native to South America, and widely used as an ornamental plant in several other countries (Lorenzi, 1996). The species has potential for biodiesel production due to the high lipid content of the seeds, which can exceed 50% (Moreira *et al*., 2013). Additionally, *S. romanzoffiana* is able to grow in dry environments (Falasca *et al*., 2012) and shows abundant fruiting throughout the year (Genini *et al*., 2009) which represents an important advantage over other perennial oleaginous species with seasonal fruit production. These characteristics have stimulated discussions about the deployment of the species as a commercial crop, as raw material for biodiesel production (Falasca *et al*., 2012). Sensitivity to dehydration and susceptibility to chemical or microbial deterioration in the seeds of many palm species are factors that cause decreased viability after harvest (Broschat, 1994; Orozco-Segovia *et al*., 2003). It is generally recommended to immediately plant seeds while still fresh. However, storage of diaspores may be important both for managing propagation and for *ex situ* conservation programmes. Studies on embryo viability and vigour (Ribeiro *et al*., 2012) in stored seeds may contribute to the development of technologies for the production of seedlings, the propagation of the species and the storage of *S. romanzoffiana* seeds.

MATERIALS AND METHODS

The experiment was carried out in Horticultural Technology Departmental project site of Federal College of Agriculture, Akure. The climate of the area is tropical savanna wet with high temperatures and high humidity. The maximum temperature is 35ºC while the minimum temperature is 23ºC. The climate is characterized by two distinct seasons namely; rainy and dry seasons with an annual rainfall of 1100mm-1500mm. The vegetation of the area has been described as Southern guinea savanna. Sixty seeds each of Queen Palm were collected from International Institute of Tropical Agriculture (IITA) Ibadan. The experimental field was cleared using cutlass, raked and the existing vegetation were removed. The experimental field was marked with pegs and ropes to determine the accurate plot size. Soil samples were collected from various spots on the experimental plot at 0.15cm depth and bulked for analysis to ascertain the physico-chemical parameters of the soil. The experimental field was fenced with nets, partial shaded and polythene bag was used with the size 8 by 4 inches. The experiment was laid out in Completely Randomized Design (CRD)with four (4) treatments and three (3) replicates. This treatments combination is as follow: (i) Popped Seed (PD), (ii) Seed Depoped (DPD), (iii) Seed Depoped and Washed (DPDW), (iv) Seeds Depoped and Washed and soaked for 24hrs (DPDWS). Data collection includes; Days to 50% sprouting, Number of leaves per plant, and Plant height per plant, at 2 weeks interval of collection. Data collected in this study was subjected to Analysis of Variance (ANOVA).

RESULTS

Effects of Seed Treatment on Number of Leaves

Seed treatment had significant ($P < 0.05$) effect on number of leaves of Queen palm (Table 1). Number of leaves was significantly ($P < 0.05$) higher in DPD at 16 WAP with the mean score of 2.444. Though at 12, 14, 18, 20, 22, 24, 26, 28 and 30 WAP, PD, DPD, DPDW and DPDWS were not significantly ($P< 0.05$) different in their effects on number of leaves of Queen palm, DPD slightly produced the highest number of leaves.

Effect of Treatment on Plant Height of Queen Palm

Plant height was not significant ($P< 0.05$) with the treatment except at 12 and 20 weeks after planting (WAP) where DPDW have highest mean score of 28.78 and 35.37cm respectively. In spite of the non-significant difference, At 10 weeks after planting, t DPDW recorded the tallest plant (26.37cm) at 10 WAP, same trend was observed at 14, 16, and 18 WAP where DPDW has the highest mean score of 28.56, 33.02, and 33.46 respectively. In a related development, at 22, 24, 26, and 28 WAP, the plant height was not significant ($P<0.05$) however, DPDW has the highest mean score of 39.57, 40.19, 42.84, and 46.91 respectively. Hile, at 30 WAP, the plant height was significant ($P<0.05$) with the treatment where PD has highest mean score of 53.12.

DISCUSSION

This study demonstrates the effectiveness of various methods of breaking dormancy on *S. romanzoffiana* seeds. It also shows how seeds responded to the different treatment combinations. Results indicated that seed dormancy in *S. romanzoffiana* arises from the hardiness of the seed coat. This finding is similar to that of Okunlola *et al.* (2011) who reported that seed dormancy in *Parkia biglobosa* was associated with the hardness of the seed coat. The increase in the germination rate of the Queens Palm seeds could be attributed to the removal of the cuticle and softening of the seed coat by the different methods tested for breaking seed dormancy of *S. romanzoffiana*. Treatment of seeds with Popped Seed was found to induce the highest germination rate compared to other treatments. This could largely be attributed to the influence of the acid that acted on the seed coat. This also may have penetrated the seed coat and inhibited the chemical compounds causing the dormancy. This observation concurs with other studies (Purohit, 2015). Similarly, in overall, this study suggests that the reason for the high germination rate in water might be as a result of the action of the hot water on the seed coat and also on the chemical constituents.
Further possible explanation for the high germination rate in hot water compared to the other treatments was likely due to the high temperature of the hot water. This observation is in line with (Dewir e*t al.*

(2011) who observed hot water increased the rate of germination by its action on the seed coat, consequently breaking down the bonds between the chemical compounds in the seed coat responsible for causing dormancy. The pronounced variation observed in the number of leaves revealed the genotypic differences among the accessions which were evident in the phenotypic expression. Hanane and Halima (2020) noted that traits related to vegetative and reproductive organs could be a useful tool to assess phenotypic diversity and are therefore, used as tools for characterisation of plant species. Salem *et al.* (2008), reported that morphological traits such as plant height, length of petiole, girth of plant, length and grouping of spines, fruit and leaves contain quantitative markers used for identification, description, differentiation and characterisation of queen's palm cultivars. Differences were observed among the accessions in all the morphological parameters observed in this study. This is in line with the report of Djerouni *et al.* (2015), who noted that vegetative characteristics could be used to differentiate queens palm varieties.

CONCLUSION

Queen's palm is one of the most popular palms for commercial and home landscape. This fast-growing palm is used to line street or sidewalks or is often planted in clusters for fast structure and interest. Queen palm is able to grow in dry environments and shows abundant fruiting throughout the year which represents an important advantage over other perennial oleaginous species with seasonal fruit production. The findings of this study indicated that dormancy in queen's palm arises from the hardness of the seed coat. Thus, the need to overcome it is critical to aid water and gas exchange to enhance the rate of germination of the queen's palm seed. It is recommended that Depoped (DPD) method of seed treatment is ideal for the propagation of queen's palm.

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Table 1: Effects of Seed Treatment on Number of leaves of Queen palm

Treatment	8 WAP	10 WAP	12 WAP	14 WAP	16 WAP	18 WAP	20 WAP	22 WAP	24 WAP	26 WAP	28 WAP	30 WAP
PD	1.000	1.222	1.889	1.889	2.111	2.667	2.889	3.000	3.22	3.889	3.889	4.000
DPD	1.000	1.444	2.000	2.000	**2.444**	2.778	3.000	3.000	3.56	3.889	3.889	4.000
DPDW	1.000	1.667	2.000	2.000	2.000	2.667	2.889	3.000	3.78	4.000	4.000	4.000
DPDWS	0.889	1.556	1.889	1.889	1.889	2.778	2.778	3.111	3.56	3.778	3.889	3.889
LSD **(P < 0.05)**	NS	NS	NS	NS	0.3626	NS	NS	NS	NS	NS	NS	NS

NOTE: The data in bold are significantly different from the other data in the same column

Table 2: Effects of Seed Treatment on Plant Height of Queens palm

Treatment	8 WAP	10 WAP	12 WAP	14 WAP	16 WAP	18 WAP	20 WAP	22 WAP	24 WAP	26 WAP	28 WAP	30 WAP
PD	15.49	24.33	27.14	27.81	30.61	33.16	34.42	35.97	40.94	44.18	48.39	**53.12**
DPD	18.07	25.12	27.31	28.03	31.00	32.68	34.38	38.21	41.81	44.09	48.41	51.63
DPDW	19.61	26.37	28.78	28.56	33.02	33.46	35.31	39.57	43.13	44.22	47.27	49.74
DPDWS	17.01	22.93	26.11	27.48	31.90	33.27	32.90	37.98	40.19	42.84	46.91	49.49
LSD (P < 0.05)	NS	NS	2.04	NS	NS	NS	2.04	NS	NS	NS	NS	3.10

NOTE: The data in bold are significantly different from the other data in the same column

EFFECT OF POULTRY MANURE RATES ON GROWTH, YIELD AND NUTRIENT COMPOSITION OF CARROT (*Daucus Carota*) IN KABBA

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ABSTRACT
The experiment conducted at the College of Agriculture, Kabba, during the 2022 cropping season aimed to assess the impact of varying poultry manure application rates on the growth, yield, and nutritional attributes of carrots. Employing a completely randomized design with five replicates, the study applied seven different rates of poultry manure, ranging from 0 to 12 t/ha. Observations encompassed various parameters such as plant height, leaf count, stem girth, root length, root diameter, fresh and dry root weight, root weight per plant, yield, and nutrient composition. The results of the analysis of variance revealed intriguing findings. At ten weeks after transplanting, the application of 12 t/ha of poultry manure resulted in the tallest plants, while 8 t/ha of PM fostered greater leaf production. The widest stems were observed in plants treated with 12 t/ha of PM, akin to those treated with 10 t/ha. The most extensive roots were recorded for the 6 t/ha treatment, on par with 2, 4, 8, 10, and 12 t/ha. Furthermore, the highest fresh root weight, dry root weight, root weight per plant, and yield were achieved with 10 t/ha of PM. Surprisingly, the application of poultry manure did not significantly affect the proximate traits assessed. In conclusion, the study recommends the use of 10 t/ha of poultry manure to optimise carrot yield for growers in the region.
***Keywords**: carrot, poultry manure, growth, yield.*

INTRODUCTION

Carrot (*Daucus carrota* L.) is one of the most important root vegetables classified under the family Apiaceae (Fikadu-Lebeta and Refisa-Jebessa, 2019). It ranked third among the succulent vegetables in world production (Yamaguchi, 1983). The edible roots of carrots contain water, protein, ash, vitamins,and minerals (Norman, 1992). Carrot is usually cultivated as an annual crop in the tropics, like Nigeria (De Lannoy, 2001). The crop requires a deep and well-drained loamy soil that is moderately acidic and high in organic matter (Yayock *et al*., 1988). Carrot contains carotene, thiamine, and riboflavin (Pant and Manandhar, 2007), as it enhances resistance against blood, eye, and other human diseases (Pant and Manandhar, 2007; Appiah *et al*., 2015). The crop is beneficial to resource-poor farmers because it is a short-duration crop and higher yields can be obtained per unit area (Ahmad *et al.,* 2005). However, low yields were reported in Nigeria by Sarkindiya and Yakubu (2006). The major reason for low yields is attributed to low soil fertility status. In order to obtain high and sustainable carrot yields, good soil fertility and constant growth are required to facilitate the production and translocation of carbohydrates from leaves to roots. The key limiting factors in crop growth, development, and yield are nitrogen, phosphorous, potassium, and water. In most cases, carrot growers use chemical fertilisers as the major supply of nutrients to attain higher growth and yield (Hochmuth *et al*., 1999; Amjad *et al*., 2005). Continuous application of synthetic fertiliser may lead to soil acidity, human health problems, and soil degradation because it releases nutrients at a faster rate. The increasing costs of synthetic fertilisers have made them generally unaffordable to most resource-poor, small-scale growers.
Organic manure can serve as an alternative to mineral fertilisers. Application of manure supplies the required nutrients, improves soil structure, water holding capacity, porosity, bulk density, moisture retention, increases microbial population, and maintains crop quality (Agbede *et al*., 2017). Poultry

manure (PM) is a good source of nutrients for plants such as carrots (Kankamet et *al*., 2014; Habimana et *al.,* 2014). There has been a continuous use of PM to fertilise crops by some farmers in Nigeria with no or limited documentation on performance. In Nigeria, proper disposal of poultry waste is a challenge for poultry farmers (Agbede and Adekiya, 2011), and its use in carrot production could be a solution. The objective of the study is to determine the effect of poultry manure rates on the growth, yield, and nutrient composition of carrots (*Daucuscarota*).

MATERIALS AND METHODS

The experiment was carried out in the College of Agriculture Kabba, located at a latitude of 7^0 51N and a longitude of 6^0 04E. It has an annual rainfall of 1,350 mm, an average annual temperature of 30^0 C, annual total number of sunshine hours of about 2,000 hours, a daily sunshine of about 5 hours, and a mean annual radiation of about 139Kcal/cm$^{2/}$year. The vegetation in the area is dominated by tall grasses and shrubs. The area is known for the production of arable crops such as maize, cassava, cowpea, yam, sorghum, and sesame. Nursery beds measuring 2m long and 1.2m wide were prepared. Seeds were sown thinly in rows. Seeds were nursed in March and transplanted in April 2022. The seed beds were watered and covered with mulching materials after sowing. After seed germination, the mulch materials were carefully removed and placed under shade, which was constructed with palm fronds to protect the young seedlings against harsh weather. The seedlings were watered until they reached the transplanting stage.

The experiment was laid out using a complete randomised design (CRD). Each treatment was replicated five times. Treatments included: T1 = 2 t/ha of poultry manure, T2 =4 t/ha of poultry manure, T3 = 6 t/ha of poultry manure, T4 = 8 t/ha of poultry manure, T5 = 10 t/ha of poultry manure, T6 = 12 t/ha of poultry manure, and T7 = no poultry manure (control). The soil was collected, air dried, and thoroughly mixed to ensure homogeneity. Therefore, 20kg of the soil sample was weighted into a polyethylene bag containing the pre-weighted animal manure, and both were thoroughly mixed to ensure uniformity of the treatment. Carrot seeds were obtained from the Research Institute (NIHORT) in Ibadan. The seeds were raised in the nursery before being transplanted to the pot five weeks after planting. The site was manually cleared with cutlass, and polyethylene bags were prepared and filled with appropriate substrates. Weeding was done manually at a 3-week interval.

A soil sample was taken from 0 to 15cm and bulked to have a composite sample, which was analysed for chemical and physical properties. The nutrient content of the poultry manure was analysed in the laboratory. Karate was used to control insect pests on the field. Data were collected on plant height (cm), number of leaves, stem girth (cm), root length (cm), root diameter (cm), fresh and dry root weight (g), root weight per plant (g), yield, and nutrient composition of carrot. All the data collected were subjected to analysis of variance (ANOVA) using the GenStat statistical package (GenStat, 2007). Means were separated using Duncan's multiple ranges at a 5% level of probability.

RESULTS AND DISCUSSION

The result of the properties of the soil is presented in Table 1a. The soil is rich in nutrients enough to support the growth of carrots. It has a high porosity, which suggests that the soil is free of iron concretions. The texture of the soil is sand clay loam and has a pH of 5.32 and a total nitrogen content of 0.27%. Table 1b indicates that the organic materials used contain enough nutrients for the growth and development of carrots. The result of different rates of poultry manure on the plant height of carrots is presented in Table 2. The result shows a significant ($p < 0.05$) difference in the plant height of carrots at 2, 4, 6, 8, and 10 weeks after transplanting. The results indicated that all plants grown in pots with poultry manure, irrespective of the rate of application, produced carrots taller than the control. This implies that the application of poultry manure is desirable in carrot production. Poultry manure, in particular, has been linked with a reduction in soil acidity apart from soil nutrient enrichment (Olatunji and Oboh, 2012; Sunassee, 2001). In a study by Parraga (1995), increased vegetative growth was attributed to the increased nitrogen content of the soil due to the addition of PM. This confirms White's (1992) report that organic manure improved soil structure and maintained uniform soil moisture and nutrient levels, which resulted

in root growth. An increase in poultry manure rates resulted in an increase in plant height. Among the organic manure-treated pots, the application of 12 t/ha of PM recorded the tallest plant at 10 weeks after transplanting. This was significantly better than all the other treated pots. The result obtained in this study may be linked to high nitrogen levels that facilitate the growth and development of foliage parts of the plant. This finding is in line with the findings of Mehediet et al. *(2001),* who stated that application of the highest rate of cow dung at 20 t/ha increased the growth parameters of carrot. Plants grown without poultry manure application (control) recorded the shortest plant at 10 weeks after transplanting.
Table 3 presents the effect of poultry manure rates on the number of carrot leaves at 2, 4, 6, 8, and 10 weeks after transplanting. Significant ($p < 0.05$) differences were observed in the number of carrot leaves at 2, 4, 6, 8, and 10 weeks after transplanting. The result indicated that all pots with poultry manure had more leaves compared to the plants that grew in the control. Application of 8 t/ha of poultry manure consistently produces more leaves than other rates used. At 10 weeks after transplanting, pots with 8 t/ha of PM produce 12 leaves. Leaves produced in pots with 4, 6, 10, and 12 t/ha of PM were similar. All these were significantly better than plants treated with 2 t/ha of PM. However, the least number of leaves was observed in the pot with the control (8.33 leaves). The decline in the number of leaves obtained above 8 t/ha of PM implies that a sufficient amount of nutrient elements was supplied by this rate. When optimum nutrients are supplied, it results in the production of high-quality and better-nutritional plants (Rice *et al.,* 1994; Baiyeri *et al.,* 2009). Adebayo *et al.* (2011) reported that when manure is available in adequate quantity, plants tend to grow to their optimal potential.
The effect of different rates of poultry manure on the stem girth of carrots is presented in Table 4. A significant ($p < 0.05$) difference occurred in the stem-girth carrots due to the different rate of poultry manure used, except at 2 weeks after transplanting. At 10 weeks after transplanting, the pot with 12 t/ha of PM recorded the thickest stem, followed by the pot with 10 t/ha of PM. The ability of 12 t/ha of PM to increase the stem girth of carrots could be attributed to the supply of adequate nutrients to the plant (Crosson, 1995). Pots with 2, 4, 6, and 8 t/ha of PM produced similar stem girth, which was significantly inferior to pots with 10 t/ha and 12 t/ha. The control pot recorded the thinnest plant in this experiment. The inability of 0 t/ha to produce the thickest stem may be attributed to a nutrient deficit in the soil.
The effect of different rates of poultry manure on the root character of carrots is presented in Table 5. Similar root length and root diameter occurred in all the pots with poultry manure, and all these were significantly better than the control. Root length and root diameter in the pot with poultry manure ranged between 18.80 and 21.09 and 4.74-6.41 cm, respectively. The result obtained in this current study can be linked to the release of nutrients that led to an increase in root length and root diameter. A similar result was reported by Kankam *et al.* (2014) in carrot.
The effect of different rates of poultry manure on the fresh weight, dry shoot weight,root weight, and root yield (t/ha) of carrots is presented in Tables 6 and 7. An increase in the rate of poultry manure resulted in a decrease in all the yield traits assessed. Plants in pots that received 10 t/ha of PM recorded the heaviest fresh and dry root weight and the highest root weight per plant and yield (t/ha) compared to others. The least was obtained in plants that grew in the control. The result obtained in this present study could be attributed to the enhancement of soil fertility status by 10 t/ha of PM, which improved carrot yield. Application of 10 t/ha of cattle manure improved the growth and yield of carrots, as reported by Daba*et al.* (2018), which was in agreement with our findings. Mazed*et al.* (2015) stated that the maximum root fresh weight of carrot was recorded from plants that received 25 t/ha of cow dung application, which contradicts our findings. Table 8 presents the effect of poultry manure rates on the nutrient composition of carrots. The result indicated that there was no significant ($p > 0.05$) difference in the nutrient composition of the carrot.

CONCLUSION

From the results obtained, it is evident that plants that received 10 t/ha (60g) had better performance in terms of growth and yield of carrot. Therefore, carrot growers should apply 10 t/ha of poultry manure for optimum production.

Table 1a: Pre-planting soil analysis manure utilised

Properties	Values
Sand (g/kg)	650
Clay (g/kg)	199
Silt (g/kg)	151
Soil texture	Sand clay and loam
pH	5.32
Bulk density (g/cm3)	1.37
Total porosity (%)	41.6
Organic matter (%)	3.46
Total N (%)	0.27
Available P (mg/kg)	3.56
Exchangeable K (cmol/kg)	0.14
Exchangeable Ca (cmol/kg)	2.55

Table 1b: Composition of poultry

Composition	Poultry manure
Organic C	47.6 (%)
Total N	4.8(%)
C:N	9.92
Phosphorus	1.53(%)
Potassium	3.26(%)
Calcium	1.78(%)
Magnesium	0.69(%)

Table 2: Effect of different rates of poultry manure on plant height of carrot at 2, 4, 6, 8 and 10 weeks after transplanting

Poultry manure (t/ha)	2	4	6	8	10
0	6.63^{c}	9.04^{c}	16.37^{c}	20.67^{c}	22.04^{d}
2	11.97^{b}	14.09^{b}	29.00^{b}	42.06^{ab}	44.04^{b}
4	13.37^{ab}	17.07^{b}	26.93^{b}	33.83^{b}	37.33^{c}
6	14.05^{ab}	18.57^{ab}	30.00^{ab}	41.43^{ab}	44.09^{b}
8	15.67^{a}	21.09^{a}	34.77^{a}	39.33^{ab}	43.04^{bc}
10	10.67^{b}	15.17^{b}	25.03^{b}	35.97^{ab}	40.57^{bc}
12	13.37^{ab}	18.37^{ab}	25.97^{b}	44.07^{a}	50.77^{a}
LSD	2.36	3.01	5.34	8.46	6.31

Table 3: Effect of different rates of poultry manure on number of carrot leaves at 2, 4, 6, 8 and 10 weeks after transplanting

Poultry manure (t/ha)	2	4	6	8	10
0	2.67^{c}	3.33^{c}	4.33^{b}	7.00^{c}	8.33^{c}
2	3.03^{bc}	4.67^{b}	7.00^{a}	9.33^{a}	11.00^{b}
4	3.00^{c}	4.33^{b}	7.00^{a}	9.67^{a}	11.67^{ab}
6	3.67^{b}	4.67^{b}	7.00^{a}	9.33^{a}	11.67^{ab}
8	4.33^{a}	6.00^{a}	7.33^{a}	9.33^{a}	12.00^{a}
10	3.67^{b}	5.00^{ab}	6.67^{a}	8.33^{b}	11.33^{ab}
12	3.67^{b}	6.00^{a}	7.00^{a}	9.00^{ab}	11.33^{ab}
LSD	0.64	1.06	1.11	0.69	0.91

Table 4: Effect of different rates of poultry manure on stem girth of carrot at 2, 4, 6, 8 and 10 weeks after transplanting

Poultry manure (t/ha)	2	4	6	8	10
0	3.01	3.03[c]	4.07[c]	5.07[d]	6.07[c]
2	2.93	4.02[b]	6.27[b]	8.09[b]	10.04[b]
4	3.03	4.33[b]	6.02[b]	7.09[c]	10.00[b]
6	3.01	5.02[ab]	5.87[b]	7.83[bc]	9.87[b]
8	3.07	5.06[ab]	6.23[b]	7.67[bc]	9.88[b]
10	3.07	5.17[a]	6.05[b]	8.93[ab]	11.0[a]
12	3.03	5.77[a]	7.23[a]	9.23[a]	11.02[a]
LSD	NS	0.76	0.58	0.93	0.81

Table 5: Effect of different rates of poultry manure on root characters of carrot

Poultry manure (t/ha)	Root length cm	Root diameter cm
0	15.16[b]	2.83[b]
2	20.22[a]	4.74[a]
4	20.93[a]	5.55 [a]
6	21.09[a]	5.32[a]
8	18.80[a]	6.41[a]
10	20.13[a]	6.09[a]
12	19.68[a]	6.00[a]
LSD	2.41	2.39

Table 6: Effect of different rates of poultry manure on fresh and dry shoot weight of carrot

Poultry manure (t/ha)	Fresh root weight	Dry root weight
0	8.54[d]	3.16[d]
2	16.08[c]	5.21[c]
4	19.08[c]	5.91[c]
6	15.93[c]	5.58[c]
8	28.91[b]	9.83[b]
10	36.35[a]	11.63[a]
12	25.17[b]	7.80[b]
LSD	5.69	1.43

Table 7: Effect of different rates of poultry manure on yield of carrot

Poultry manure (t/ha)	Root weight/plant (g)	Yield per hectare (t/ha)
0	10.05[e]	6.48[d]
2	16.63[d]	10.27[c]
4	18.09[cd]	11.67[bc]
6	19.39[c]	11.97[bc]
8	27.30[a]	16.86[ab]
10	29.17[a]	18.01[a]
12	22.26[b]	13.75[b]
LSD	2.31	3.47

Table 8: Effect of poultry manure rates on nutrient composition of carrot

Poultry manure (t/ha)	Water	Protein	Carbohydrate	Fat
0	88.24	0.09	10.1	0.22
2	88.23	0.10	10.1	0.21
4	87.91	0.09	09.8	0.23
6	88.33	0.11	09.8	0.26
8	88.14	0.10	09.6	0.21
10	88.06	0.11	09.9	0.22
12	87.93	0.11	10.0	0.23
LSD	NS	NS	NS	NS

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HORTICULTURAL CROP COMMERCIALIZATION: DETERMINANTS AND PERCEPTION TOWARDS MARKET ACCESS IN SOUTH EAST NIGERIA

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ABSTRACT

The study examined the perceptions of horticultural crop farmers towards access to market and commercialization. Data for the study were collected with a well-structured questionnaire from a cross-section of randomly selected 250 (125 maize farmers, and 125 okra farmers) respondents. The objective was achieved using Likert scale rating. Farmer's perception of market access and commercialization which was capture in five points Likert scale had a grand mean of 3.33 (maize), and 3.24 (okra) to imply that the farmers have a positive perception of market access and commercialization. The study recommends that governmental and financial institutions, especially the Agricultural Credit Schemes should be strengthened to provide soft loans to horticultural crops farmers at a very low interest rate.

Keywords: *Commercialization, determinants, horticulture, perception.*

INTRODUCTION

Due to the dependence of a large number of South-easterners on agriculture for their livelihood, the State Governments have made the development of the agricultural sector a top priority. One area identified for accelerated growth is the development of high-value crops such as horticultural crops (Ogbe, 2019). Commercialization of horticultural crops in South-East Nigeria is an essential pathway towards economic growth and sustainability (Enete & Ani 2020). However, adequate information on the perception of farmers on the marketing and commercialization of the business is lacking (Osuafor, Effiong & Ude, 2021). Most horticultural farmers in South-east are subsistence farmers who mainly produce for self-consumption; only selling the small surplus they have (Obi, Pote & Chianu, 2020).

Mayong et al. (2016) explained horticultural crop commercialization to mean the scaling up agricultural production from subsistence level to become market based. According to them, commercialization is characterized by expansion in sales of output which raises cash earnings of small-scale horticultural crop enterprises. To bring about commercialization, the unit of output can be increased, value addition can be raised, or both carried out, and there can be production for domestic and foreign markets. However, commercialization is dependent upon whether input and output markets are available. In Nigeria, the last one and a half decades have seen the government striving to encourage horticultural farmers to shift from subsistence to market-oriented production. Efforts have been put on intensification of the production systems, farmer cooperative promotion, and enhancement of farmers' access to markets (Komarek, 2020). As a result, increase in the commercialization and access to market for horticultural crops such as maize and okra is encouraged. Hence this study. The objective of the study was to examine the perceptions of horticultural crop farmers towards access to market and commercialization.

MATERIALS & METHODS

The study was carried out in South-East Nigeria. South-East Nigeria comprises of five states viz: Enugu State, Abia State, Ebonyi State, Imo State and Anambra State. Multistage, purposive and random sampling methods were used to select 3 States, 15 Local Government Areas (LGAs), 150 maize farmers and 150 okra farmers for the study. Data were collected from primary source using questionnaire administered to the respondents by personal interview. Out of the 300 filled questionnaires, 50 were wrongly filed and were dropped. Hence, 250 questionnaires were used for the analysis. The objective was actualized using Likert-scale rating techniques.

RESULTS AND DISCUSSIONS

Perceptions of Horticultural Crops Farmers towards Access to Market and Commercialization

The result of the horticultural crop farmers on their perception towards access to market and commercialization in Southeast Nigeria is presented in Table 1 (maize) and Table 2 (okra). The grand mean of 3.33 (maize), and 3.24 (okra) indicates that the farmers have a positive perception of market access and commercialization. Those in agreement with maize farmers are: there is a high competition in the market (3.82), access to market require more knowledge and competitiveness (3.82), value of agricultural inputs sourced from the market improved (3.92), gross agricultural product improved (3.92), and value adding to the agricultural produce has improved (3.85). On the other hand, those that agree with the okra farmers are: market access create conflict among participants (3.96), value of agriculture produce improve (3.73), value of agricultural sales to the market improved (4.02), value of agricultural inputs sourced from the market improved (4.19), gross agricultural product improved (4.11), and value adding to the agricultural produce has improved (4.20) among others.

Table 1: Perception of Commercialization of Maize Marketers

Perception on commercialization	Pooled		Anambra		Ebonyi		Enugu	
	Mean	S.D.	Mean	S.D.	Mean	S.D	Mean	S.D.
Not interested in the markets.	2.03	1.26	2.16	1.33	1.88	1.21	2.00	1.26
Market require a lot of time and planning.	3.07*	0.96	2.95	0.96	2.95	0.92	3.33	0.97
Market is very risky.	3.50*	1.07	3.58	1.04	3.49	1.12	3.43	1.06
There is a high competition in the market.	3.82*	1.38	3.68	1.36	3.83	1.48	3.93	1.31
Access to market require more knowledge and competitiveness.	3.82*	1.26	3.68	1.27	3.71	1.42	4.10	1.06
There are a lot of politics in the market.	3.03*	1.16	2.82	1.11	3.10	1.14	3.13	1.24
Market access create conflict among participants.	3.01*	1.31	2.95	1.23	3.02	1.39	3.05	1.34
Neighbouring farmers are not willing to share market information.	3.34*	1.18	3.50	1.27	3.32	1.23	3.23	1.05
Access to market can create employment in the community.	3.55*	1.32	3.76	1.42	3.49	1.29	3.38	1.25
Market access can reduce poverty in the community.	3.64*	1.30	3.63	1.27	3.56	1.30	3.80	1.32
Value of agriculture produce improve.	3.32*	1.34	3.24	1.22	3.22	1.46	3.53	1.34
Value of agricultural sales to the market improved.	3.40*	1.16	3.45	1.27	3.41	1.18	3.33	1.02
Value of agricultural inputs sourced from the market improved.	3.92*	1.13	4.16	1.05	3.93	1.06	3.65	1.25
Gross agricultural product improved.	3.92*	1.28	4.24	1.21	3.68	1.44	3.90	1.15
Value adding to the agricultural produce has improved.	3.85*	1.41	3.76	1.49	3.56	1.53	4.28	1.09
You have good knowledge of value chain or value adding.	2.52	1.12	2.61	1.14	2.54	1.12	2.40	1.10
Packaging of agricultural products is important and can improve wellbeing of your market.	2.86	1.41	3.00	1.39	2.90	1.37	2.65	1.48
Grand mean	**3.33***	0.38	3.36	0.35	3.27	0.42	3.36	0.36
t-value	**96.73*** **		**57.61*** **		**50.53*** **		**59.33*** **	
DF	119		38		40		39	
Obs.	120		39		41		40	

Source: Field Survey, 2021.

Table 2: Perception of Commercialization of Okra Marketers

Perception on commercialization	Pooled		Anambra		Ebonyi		Enugu	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Not interested in the markets.	1.22	0.41	1.22	0.42	1.21	0.41	1.21	0.42
Market require a lot of time and planning.	2.96	0.74	2.98	0.75	2.95	0.72	2.95	0.76
Market is very risky.	3.01*	1.02	3.02	1.03	3.05	1.00	2.95	1.06
There is a high competition in the market.	2.95	1.44	3.20	1.47	2.86	1.46	2.79	1.39
Access to market require more knowledge and competitiveness.	2.98	1.45	3.00	1.51	2.72	1.42	3.21	1.42
There are a lot of politics in the market.	2.96	1.43	3.04	1.35	2.72	1.45	3.12	1.50
Market access create conflict among participants.	3.96*	0.90	3.93	0.91	3.95	0.87	4.00	0.94
Neighbouring farmers are not willing to share market information.	2.92	1.40	2.89	1.40	3.14	1.46	2.74	1.33
Access to market can create employment in the community.	3.11*	1.39	3.02	1.34	3.23	1.38	3.07	1.49
Market access can reduce poverty in the community.	2.92	1.39	3.16	1.46	2.93	1.33	2.64	1.36
Value of agriculture produce improve.	3.73*	1.26	3.67	1.30	3.86	1.25	3.67	1.26
Value of agricultural sales to the market improved.	4.02*	0.75	4.00	0.77	4.14	0.74	3.93	0.75
Value of agricultural inputs sourced from the market improved.	4.19*	1.02	4.20	1.01	4.37	0.85	4.00	1.17
Gross agricultural product improved.	4.11*	0.97	4.11	1.01	4.09	0.97	4.12	0.97
Value adding to the agricultural produce has improved.	4.20*	0.90	4.24	0.88	4.12	0.98	4.24	0.85
You have good knowledge of value chain or value adding.	2.96	1.45	2.93	1.44	2.95	1.50	3.00	1.47
Packaging of agricultural products is important and can improve wellbeing of your market.	2.94	1.38	2.42	1.37	2.98	1.34	3.45	1.25
Grand mean	**3.24***	0.31	3.24	0.34	3.25	0.27	3.24	0.32
t-value	162.15***		63.12***		79.93***		65.31***	
Obs.	130		45		43		42	

Source: Field Survey, 2021

CONCLUSION

Horticultural crop farmers have a positive perception of market access and commercialization. Based on the findings, farmers should be encouraged to get involved in the production and marketing of the crops. Also, soft loans should be given to horticultural crops farmers at a very low interest rate.

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EFFECT OF POTASSIUM AND IRRIGATION INTERVAL ON THE GROWTH AND YIELD OF TOMATO (*Lycopersicon esculentus* L.) AT SAMARU, ZARIA

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ABSTRACT
A field experiment was carried out during the 2017/2018 dry season at Samaru College of Agriculture, Ahmadu Bello University, Zaria to study the effect of potassium and irrigation interval on the growth and yield of tomato (Lycopersicon esculentus L.). The treatment consisted four levels of potassium (0, 20, 40 and 60 kg K_20 ha^{-1}) and two levels of irrigation (3 and 5 days interval), eight treatments arranged in factorial combinations and laid out in a Randomized Complete Block Design (RCBD) replicated three times. The results showed that application of potassium had no significant effect on growth parameters except number of leaves at 9WAT, where 40kg K_20 ha^{-1} produced significantly more number of leaves though not statistically different from 0 and 60 kg K_20 ha^{-1}. Irrigation interval did not also result in a significant effect of growth parameters except number of leaves at 9WAT, where 3 days interval produced significantly a greater number of leaves than 5 days interval. The result also indicated that potassium had no significant effect on all yield parameters, but 0 kg K_20 ha^{-1} resulted in a slightly increased yield parameters of the crop. Irrigation had no significant yield components too, although irrigation at 3days interval resulted in a slightly higher yield of tomato. The interactions on growth parameters showed no significant effect. Also interaction on yield parameters showed no significant effect except on number of non marketable fruits and weight of non marketable fruits hectare^{-1}.
Keywords; *irrigation, potassium, treatment, growth, yield.*

INTRODUCTION

Tomato (*Lycopersicon lycopersicum* L. Krast) is one of the most important vegetable crops grown throughout the world field and greenhouse conditions (Kaloo, 1986). In terms of human health, tomato is a major component in the daily diet in many countries, and constitutes an important source of minerals, vitamins and antioxidant (Grierson and Kader, 1986). Tomato can be produced in both rainy and dry seasons. More importantly, it thrives well under irrigation in the northern part of Nigeria. This is because, the incidence of pest and diseases are low during this period. The commonly cultivated varieties in Nigeria are those with a determinate growth habit. Tomato belongs to the family *solanaceae* and it is believed to have originated in the coastal strip of western South America, from the equator to latitude of about 30^0 South. Indeterminate and determinate plant growth are characteristic of this family, where the former produce three nodes between each inflorescence with the later having fewer than three nodes on the stem, terminating in an inflorescence (Jones,1999). It possibly got to Asia in the 15th century from Spain. Tomato was taken across the Pacific Ocean to the Philippines and was found in the eastern Malaysia after 1650. It was introduced first to the Italy in the middle of the 16th century. Tomato was found in the united state towards the end of the 18th century. It must have spread to china, Japan, India and so on through their commercial activities with the Philippines.

Tomato got to Africa possibly through the British, Dutch, Greeks, Portuguese and French who colonized this part of the world. At this period, it was only cultivated on a small scale in the tropics except for Central America, until the end of the 19th century (Jones 1999). Tomato can grow on a wide range of climate conditions of both tropic and sub-tropics. It thrives well on a well drained fertile soil which is fairly deep and rich in organic matter especially, but not water-logged. The field should be free from nematodes and stubborn perennial weeds. The crop require abundant sunshine and cool weather of about 20 - 27˚C day temperature and 15 -21˚C night temperature. High humidity and temperature are intolerable especially at seedling stage (Kaur *et al,* 2005).

It is important to mention too, that, some cultivars show increased growth rate with alternating high day and low night temperature, while others do not. For instance, stem length increase with day temperature and leaf area increases with night temperature. Also, with low light and high temperature, fruit development is arrested. (Kaur *et al,* 2005). Tomato (*Lycopersicon esculentus* L.) is the second most important vegetable crop next to potato. Present world production is about 100million tons fresh produced on 3.7 million hectares. Tomato production has been reported for 144 countries (FAOSTAT, 2004), the major country being china in both hectares of harvested production (1,255,100 hectares) and weight of fruit produced (30,102,040 tons). The two leading countries in fruit, yield per hectare are the Netherland (4,961,539 kg ha^{-1}) and Belgium (4,166,667 kg ha^{-1}). The top five (5) leading fruit producing countries are the United State, China, Turkey, Italy and India (FAOSTAT, 2004). The crop is mainly cultivated under the rain in the tropic and sub-tropical regions but almost on the field in the temperate regions with the aid of irrigation. Tomato production in Africa, was estimated that about 9 million tons on 443,000 hectares of land are produced annually, while in Nigeria 680,000 tons on 22,000 hectares are produced yearly (FAOSTAT, 2004). In Nigeria, tomato is produced both in the rainy and dry season but it performs best under irrigation in the dry season (in the Northern part of the country), where pest and disease incidence is minimal.

Low yield in production of tomatoes in Nigeria has always been attributed to low level of fertilizer in the soil. Most of the Nigeria tomato farmers had the wrong perception that tomato crop does not require fertilizer and irrigation application during dry season for optimum performance. This is seriously affecting the crop yield per hectare as well as the farmer income. Also the country revenue on tomato production is negatively affected. It is therefore in view of the above mentioned problem that this study was proposed to investigate the effect of potassium and irrigation application in the study area. The objective of this study is to determine the effect of potassium and irrigation interval on the growth and yield of tomato production in Samaru, Zaria.

MATERIALS AND METHODS

Experimental site

The experiment was conducted in the field under irrigation during the 2017/2018 dry season at the agronomy section of Samaru College of Agriculture, Ahmadu Bello University, Zaria. Samaru is located at the northern guinea savanna ecological zone of Nigeria at latitude 11˚11'N and longitude 7˚38'E, 680 meter above sea level. Samaru experience a mean annual rainfall of 1080 mm and daily temperature range of 21˚C - 36˚C. The texture of soil after analysis was found to be sandy loam. The weather condition of the environment was fairly good at the beginning of the experiment but became harsh at the later phase of the crops life cycle.

Treatments and experimental design

The treatment consisted of four levels of potassium (0, 20, 40 or 60kgK_2O/ha-^{1}) and two levels of irrigation (3 or 5days interval) making a total of Eight treatments arranged in a factorial combinations and laid out in a randomized complete block design (RCBD) and replicated three times. Experimental area was 6.5m × 15m = 97.5m^2, consisting of 24 plots each plot size was 1.8m × 1.35m =2.43m^2. The land was ploughed and harrowed to a fine till on 23rd December, 2012 to improve the structure and water holding capacity, reduce soil borne pests and diseases by exposing the soil to hot sun and also to remove weeds. It further encourages root growth, breaking of clods and removing crop residues to level the land and a raised bed was constructed by making outer edge of the bed by a garden line to ensure that all side of beds are firmly beaten with the help of hoe to prevent side from being washed away by water. The tomato variety used was the determinate type with the line number UC 82 B obtained from genuine agrochemical dealer in Samaru, Zaria. Six weeks old tomato seedling were transplanted, one plant per hole on the 5th February, 2013.

Two levels of irrigation were imposed, with one set receiving water once every three days and the second, once every five days throughout the period of the experiment, beginning from one week after transplanting. Nitrogen (13.5kg/ha) were applied at two split dose to all the plots using urea (110%N), first at transplanting and at 4 weeks after transplanting at each application. Phosphorus and potassium was applied as single super phosphate (45% p_20_5) and muriate of potash (45% k_20) as shown: K_1 = 0.0g Mop Plot^{-1} = (0 kg k_20 ha^{-1}), K_2 = 4.86g Mop Plot^{-1} = (20 kg k_20 ha^{-1}), K_3 = 9.72g Mop Plot^{-1} = (40 kg k_20 ha^{-1}), K_4 = 14.58g Mop Plot^{-1} = (60 kg k_20 ha^{-1}). The phosphorus and potassium were applied along with nitrogen as basal application after transplanting. The fruits were harvested manually at maturity; that is, the period at which the fruits were almost reddish in color.

Data collection

Plant height (cm), number of branches plant^{-1}, number of leaves plant^{-1}, number of flower plant^{-1}, number of fruits plant^{-1}, fruit fresh weight plant^{-1} (kg). The data collected were subjected to statistical analysis of variance using Gen Stat. Significant differences between the treatment means were compared using Duncan Multiple Range Test (DMRT) in accordance with Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Effect of potassium and irrigation interval on growth parameters

Table 1 shows the effect of irrigation and potassium on plant height at 3, 6 and 9weeks after transplanting, respectively. There was no significant difference of irrigation on plant height among all the irrigation interval, however, at 3days of irrigation was slightly higher than 5days but, at 6WAT and 9WAT, 5days irrigation was higher. The non significant difference observed on plant height by varying irrigation period between 3 and 5days indicated that irrigating between 3-5days is adequate for normal plant growth, meaning that at 3 or 5days water was supplied at the right time. This contradicts the works of Fawusi (1980), who reported that irrigation has a positive effect on all growth components of tomato if sufficiently supplies in the right amount and time. This is probably because the gap was not wide enough for the effect to be manifested. There was no significant difference of potassium application on plant height among all the treatments, however, at 3WAT; 0 kg K_20 ha^{-1} gave taller plants while, and 40 kg K_20 ha^{-1} had the shortest plant height. At 9WAT, 60 kg K_20 ha^{-1} produced taller plants than 0 kg K_20 ha^{-1} and 40 kg K_20 ha^{-1}. The non significant difference on potassium at 0, 20, 40 and 60 kg K_20 ha^{-1} rates respectively in plant height supports the findings of Angelov (2002), who reported that potassium had no significant effect on the vegetative growth of the cultivar used. The interaction of potassium and irrigation frequency produced no significant effect on plant height.

Table 1 shows the effect of irrigation and potassium at different rates on number of leaves plant^{-1}. There was no significant difference of irrigation was observed except at 9 weeks after transplanting. Irrigating at 3days had the maximum number of leaves plant^{-1} than 5days of irrigation. At 9weeks after transplanting however, there was a significant difference between the two treatments. The significant difference observed at 9WAT between the two irrigation intervals was because at that period the plants matured enough and water requirement was more continent. This however supports the findings of Hernamdo and Orihuel (2004), who reported that number of leaves were significantly affected by irrigation regime, they however noted that the effect gradually decrease with decreasing irrigation rate. There was significant difference of potassium on number of leaves plant^{-1}, at all sampling periods but at 3 and 6WAS 0 kg K_20 ha^{-1} produced more number of leaves than other treatments, at 9WAT, though 40 kg K_20 ha^{-1} gave maximum result beyond which any additional potassium resulted in no increase on number of leaves. This result indicated that potassium is not a limiting factor on number of leaves especially at initial plant growth. The application of potassium was observed to have a significant effect on number of leaves plant^{-1} at 3 and 6WAT, though very inconsistent, at 3WAT the control was significantly higher, while at 6WAT, 40 kg K_20 ha^{-1} gave significantly higher number of leaves. The result showed that at 3WAT the plants were not mature enough. This closely agrees with Kaziev and Tursumetor (2006) who reported that growth and weight of tomato plant increased with increases in potassium application rate of 100 kg ha^{-1}

only in additional to N and P dressing, but a further rise to 150 kg K_20 ha^{-1} had no additional benefit. Interactions between irrigation and potassium rate were not significant at all the stages of growth.

Table 1 shows the effect irrigation and potassium on growth parameters on 50% flowering, fruiting and maturity of tomato. There was no significant difference on irrigation at 50% flowering, fruiting and maturity on tomato, however, 3 days of irrigation resulted in reduced days to 50% flowering and 50% fruiting however, 3days of irrigation resulted in delayed maturity. This result supports the works of Kwapata (1991), who reported that flower initiation and opening as well as number of fruit $plant^{-1}$ were significantly less in relatively wet soil moisture treatment. There was no significant difference of potassium at 50% flowering, fruiting and maturity. 0 kg K_20 ha^{-1} resulted in a slightly delayed 50% flowering, while 60 kg K_20 ha^{-1} resulted in delayed fruiting and maturity. This result follows the works of Sobuo *et al.* (1997),who reported that the effect of potassium on number of flowers $plant^{-1}$, fruit number $plant^{-1}$ were all observed at varying degrees by different workers depending on the soil nutrient status with respect to potassium in the soil. The interactions of potassium and irrigation did not result in a significant effect of 50% flowering, fruiting and maturity.

Effect of potassium and irrigation interval on yield parameters

Table 2 shows the effect of irrigation and potassium on number of fruits $plot^{-1}$, fruit yield $plot^{-1}$, weight of fruit $hectare^{-1}$ and fruit yield $hectare^{-1}$. Irrigation did not result in a significant difference of number of fruit $plot^{-1}$, yield of fruit $plot^{-1}$, fruit yield $hectare^{-1}$, and weight of fruit $hectare^{-1}$. Though, 3days of irrigation gave the higher yield compared to 5days of irrigation. This observations support the findings of Amico *et al*. (1985), who reported that the highest fruits $plant^{-1}$ was obtained with germination of 60% and fruiting at 80%, indicating that tomato is not very exigent on water but its productivity depends rather on water availability during certain stages of the crops' cycle. Irrigating at 3 and 5days indicated that water was supplied at the right time and amount which had positive effect on yield components of the crop. There was also no significant difference of potassium on number of fruit $plot^{-1}$, yield of fruit $plot^{-1}$, weight of fruit $hectare^{-1}$ and fruit yield $hectare^{-1}$. Though, 0 kg K_20 ha^{-1} had the maximum yield on number of fruits $plot^{-1}$, yield of fruits $plot^{-1}$ and weight per hectare while 40 kg k_20 ha^{-1} has the minimum yield on number of fruit per plot, yield per plot and weight $hectare^{-1}$. Potassium application did not show any significant effect on fruit yield and yield components. In this study, lack of significant effect could be due to its non significant effect on growth components or probably the low level of nitrogen in the soil (0.35) which normally complimented the uptake of other nutrients and could not trigger any significant response on yield. But, Matev (1995) reported that potassium had more significant effect at the later phase in the life cycle of tomato especially the reproductive phase.

Table 2 shows the marketable and non- marketable fruit $hectare^{-1}$ with the influence of irrigation and potassium at different application rates. There was no significant difference due to irrigation between 3 days and 5days on all the parameters presented, but 3days irrigation had slightly the highest number of marketable fruit and weight of marketable fruit $hectare^{-1}$ while, 5days of irrigation had the maximum number of non- marketable fruit and weight of non marketable fruit $hectare^{-1}$. This shows that more irrigation was required at fruiting. There was also no significant difference of potassium on all the parameters presented, but 0 kg K_20 ha^{-1} had the maximum number of fruit, while 40 kg k_20 ha^{-1} had minimum fruits. This shows that potassium did not affect fruiting. Interactions of potassium and irrigation had no significant effect on number of marketable fruit and weight of marketable fruits $hectare^{-1}$ but number of non marketable fruit and weight of non marketable fruits $hectare^{-1}$ were significantly affected.

CONCLUSION

The result showed that irrigation at 3days had significantly increased plant height, number of branches and number of leaves. Also on the yield parameters, 3days of irrigation significantly increased the yield of tomato. Application of potassium at 0 kg K_20 ha^{-1} had significantly increased growth and yield parameters in tomato. It was an established fact that the amount of potassium required for the production ripened fruits of tomato considerably exceeded those required for maximum yield (Matev, 1995).

RECOMMENDATION

From the experiment conducted, 3 days of irrigation was recommended for maximum growth and yield of tomato to farmers in Samaru, Zaria.

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Table 1: Effect of Potassium and Irrigation Interval on Growth Parameters of Tomato (*Lycopersicon esculentus* L.) at Samaru, Zaria.

Treatments	Plant height (cm)			Number of leaves plant^{-1}			Days to 50% flowering	Days to 50% fruiting	Days to 50% maturity
Irrigation (I) (days)	3WAT	6WAT	9WAT	3WAT	6WAT	9WAT			
3	28.30	47.00	53.80	89.40	182.10	228.00a	27.50	36.60	67.30
5	28.80	45.60	52.50	83.30	183.10	217.90b	27.90	38.30	65.20
Potassium rate (P) kg ha^{-1}									
0	30.80	46.40	52.80	94.80	183.10ab	221.30	29.30	37.70	65.70
20	28.50	46.30	53.10	84.60	177.70c	219.50	26.20	35.70	66.30
40	27.40	45.60	52.80	79.50	186.60a	226.40	27.00	37.20	66.30
60	27.70	46.90	54.00	86.60	183.10ab	224.90	28.00	39.20	66.70
SE±	**1.310**	**1.260**	**0.850**	**3.150**	**1.790**	**2.740**	**1.410**	**1.650**	**1.510**
IxP	**NS**	**NS**	**NS**	**NS**	*****	**NS**	**NS**	**NS**	**NS**

Means with the same letter (s) within a column are not significantly different at 5% level of probability, NS= Not Significant, *= Significant.

Table 1: Effect of Potassium and Irrigation Interval on Yield Parameters of Tomato (*Lycopersicon esculentus* L.) at Samaru, Zaria.

Treatments	Number of fruits plant^{-1}	Yield fruits plant^{-1} (kg)	Number of fruits hectare^{-1}	Yield of fruits hectare^{-1} (kg)	No of non marketable plant^{-1}	Non marketable plant^{-1} (kg)	No of marketable fruit hectare^{-1}	Marketable yield hectare^{-1} (kg)
Irrigation (days)								
3	100.60	4.10	413923.10	1700.9014	91.41	2.12	392611.69	17009.12
5	91.50	3.30	341044.21	13511.92	84.24	2.10	239192.97	13511.84
Sig	NS	NS	NS	NS	NS	NS	NS	NS
Potassium rate kg ha^{-1}								
0	106.30	4.00	366598.14	16461.15	84.16	1.92	352373.98	16461.14
20	93.00	4.00	382705.11	16392.12	83.27	1.86	367461.84	16392.11
40	86.20	3.10	354595.10	12963.16	71.38	1.83	341631.94	12963.26
60	98.70	3.70	406035.10	15226.18	67.91	1.77	390808.92	15226.29
SE±	**10.53**	**0.44**	**50674.080**	**1829.900**	**9.23**	**0.21**	**47659.540**	**1790.120**
Sig	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Means with the same letter (s) within a column are not significantly different at 5% level of probability, NS= Not Significant, *= Significant.

EFFECT OF ORANGE PEEL (*Citrus sinensis*) POWDER, LIME PEEL (*Citrus aurantifolia*) POWDER AND ALUMINIUM PHOSPHIDE IN THE MANAGEMENT OF STORED INSECT PESTS OF DIKA NUT (*Irvingia gabonensis*)

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ABSTRACT

Oryzaephius meccator commonly known as merchant grain beetle is often found infecting stored dika nut (Irvingia gabonensis). This study was conducted to proffer safe, environmentally friendly, cheap and affordable solution to the infestation. The objective of the study was therefore to: Determine and compare the effect of orange peel (Citrus sinensis), lime peel (Citrus aurantifolia) powders and aluminium phosphide on the storage parameters. Experiment was set up at the Faculty of Agriculture central laboratory, University of Ilorin, Ilorin, Kwara state. It was laid out in a Completely Randomized Design, each treatment was replicated three times and botanicals were applied at the rate of 2.5g, 5.0g, 7.5g, making a total of 24 experimental units, each involving 50g of dika nut and 10 adults of Oryzaephius meccator introduced to it each. Data was collected on the following parameters; adult mortality, oviposition, larval emergence and weight loss. Statistical analysis using ANOVA at a 5% significance level revels significant differences between the plant product treatments and the chemical control all through the 6 weeks experiment. It is concluded that the botanicals at the rate of 7.5g is more effective on adult morality at 6 weeks after infestation (1.33) and (0.33), oviposition at 6WAI (3.33) and (2.33), and larva emergence at 6WAI (0.67) and (0.00). It is recommended that the botanicals at high rate should be used in the management of insect pest of stored dika nut, for a more healthy, friendly environment and enhance food security.

Key words: *Orange Peel, Powder, Lime Peel, Aluminium Phosphide, Stored Insect Pests, Irvingia Gabonensis*

INTRODUCTION

Dika nut is an extract of wild mango (*Irvingia* spp.) which is grown for its fruits and kernels popularly known as ugiri and ogbono respectively in Nigeria. The edible fruit (*Irvingia gabonensis*) is eaten fresh or used to make juice and the kernel when ground is used to make ogbono soup but the no-edible (*Irvingia* spp) is solely grown for the production of ogbono from its kernels. The powder of the kernel is also used as ingredient in other sauces like tomatoes and groundnut for a sticky effect and taste (Achinewhu, 2019). Extracts of ogbono seed can be used to reduce obesity, cholesterol and chances of developing degenerative diseases such as diabetes, cancer, high blood pressure, kidney failure, heart attack and stroke (Agbor, 2017). The kernel composed about 62.8% lipids, 19.7% carbohydrates, 8.9% protein, 5.3% dietary fibre and 3.2% ash (Akusu and Kiin-Kabari, 2013).

One major insect pests is the merchant grain beetle (*Oryzaephilus mercator* Fauval), which lays its eggs between the testa and cotyledons of the seed or in cracks in the cotyledons, so that when the eggs hatch the larvae can feed on the cotyledons (Ejiofor and Okafor, 2017). Such insect infestation reduce the economic value of the kernel (Elah, 2020), thus the need for effective storage protection of the product. Usage of chemical insecticides offer effective protection to kernels.

MATERIALS AND METHODS

Study Location

The experiment was up at the faculty of agriculture central laboratory, University of Ilorin, Ilorin, Kwara State, Nigeria.

Source of Insects

The merchant grain bettles (*Oryzaephius meccator*) was obtained from existing culture at the insectanuim of the Nigeria stored products research institutes (NSPRI), Ilorin, Kwara State.

Preparation And Source Of Dika Nut

Dika nut was brought from Ipata market, Ilorin, Kwara State. After well picked, to separate the already dried ones, it was then stored in a covered plastic container and kept in the freezer for about 7 days. This was done to prevent the development of immature insects in the seeds. The seed were then spread after the eight-day set up for experiment.

Preparation of Plant Materials

Lime peel (*Citrus aurantifolia*) was brought from a local market in Ilorin, orange peel (*Citrus sinensis*) was sourced around Tanke area in Ilorin, Kwara State. The two plant materials were properly air-dried for two weeks, there after grounded with electric mill and sieved to obtain a fine powder.

Experimental Procedure

The experiment was laid out in a Completely Randomized Design (CRD). The treatment includes the powder of lime peel (*Citrus aurantifolia*) orange peel (*Citrus sinensis*) and the controls. Each treatment has three replicates.

For the experiment, 50% of dika nuts were weighed in to 24 plastic container (0.5mm) and the covered with Muslim cloth to allow aeration and also to prevent entry and exit of insects. First set of the experiment was treated with orange peel (*Citrus sinensis*) powder at different grams (2.5g, 5.0g, 7.5g). Each of the treatment at different levels of application has three replicates. Same procedure was repeated for the lime peel (*Citrus aurantifolia*) powder. The chemical which is the positive control was also replicated thrice but at just a single level of application. Also the untreated (negative control) was replicated thrice accordingly. Total number of 10 adults *Oryzaephius meccator* were introduced to each replicated. Keen observation was done, the treatments were added after a week of introducing the insect to the seeds. The effect of the treatments on *Oryzaephius meccator* was studied, counted and recorded on a week interval for 6 weeks. The seed weight loss as a result of the insect pest was recorded at the last week of the experiment.

Data Analysis

Data collected on adult insect mortality, larva emergence oviposition with the aid of microscope and weight loss caused by *Oryzaephius meccator* were subjected to one-way analysis of variance and where the differences were significant, the multiple comparisons of the treatment were done by using Tukey Honestly Significant Difference Test at P-value set at 5% level of significance. The statistical analysis was carried out using R Software (version 4.3.1)

Phytochemical Procedures

Determination of Total Phenolic Content

The amount of total phenolics in powders was determined with the Folin- Ciocalteu reagent. Gallic acid was used as a standard and the total phenolics were expressed as mg/g gallic acid equivalents (GAE). For this purpose, the calibration curve of gallic acid was drawn (Figure II). 1ml of standard solution of concentration 0.01, 0.02, 0.03, 0.04 and 0.05 mg/ml of gallic acid were prepared in methanol. Concentration of 0.1 and 1mg/ml of plant extract were also prepared in methanol and 0.5ml of each sample were introduced into test tubes and mixed with 2.5ml of a 10 fold dilute Folin- Ciocalteu reagent and 2ml of 7.5% sodium carbonate. The tubes were covered with parafilm and allowed to stand for 30 minutes at room temperature before and the absorbance was read at 760 nm spectrometrically

Determination of the Total Flavonoid

Aluminum chloride method was used for flavonoid determination. In this method Quercetin was used as standard and flavonoid contents were measured as quercetin equivalent. For this purpose, the calibration curve of quercetin was drawn (Figure II). 1ml of standard or extract solution (20, 40, 60, 80,100 mg/l) was taken into 10ml volumetric flask, containing 4ml of distill water. 0.3ml of 5%$NaNO_2$ added to the flask. After 5min, 0.3ml 10%$AlCl_3$ was added to the mixture. At the 6th min add 2ml of 1M NaOH was added and volume made up to 10ml with distills water. The absorbance was noted at 510nm using UV-Visible spectrophotometer

Determination Total Alkaloid Content

The total alkaloid content of the samples was measured using 1,10 - phenanthroline method described by Singh et al. (2004). 100mg sample powder was extracted in 10ml 80% ethanol. This was centrifuged at 5000rpm for 10 min. Supernatant obtained was used for the further estimation total alkaloids. The reaction mixture contained 1ml plant extract, 1ml of 0.025M $FeCl_3$ in 0.5M HCl and 1ml of 0.05M of 1, 10-phenanthroline in ethanol. The mixture was incubated for 30 minutes in hot water bath with maintained temperature of 70 ± 2^{o} C. The absorbance of red colored complex was measured at 510nm against reagent blank. Alkaloid contents were calculated with the help of standard curve of quinine (0.1mg/ml, i.e. 10mg dissolved in 10ml ethanol and diluted to 100ml with distilled water). The values were expressed as mg/g of dry weight

RESULT

Phytochemical Analysis

Tables 1: Phytochemical compounds in the orange peel (*Citrus sinensis*) and lime peel (*Citrus aurantifolia*) powders respectively.

SAMPLES	PHENOL Mg/l	FLAVANOIDS Mg/l	ALKALOIDS Mg/l
ORANGE PEEL POWDER	0.15	9.60	12.45
LIME PEEL	0.21	9.88	12.34

Table 1 revealed the phytochemical composition of the two *Citrus* spp consider in the present study. It was observed that phenol, flavonoids and alkaloids were all present in the *Citrus* spp. the present analysis indicated that both *Citrus spp* had a very low as compared to other constituents while alkaloids had higher quantity specifically in *Citrus sinesis* but lower flavonoids and phenols. The provided data presents a comprehensive analysis of different treatments' effects on infestation control, spanning various parameters such as adult mortality, larva emergence, percentage weight loss, and oviposition.

Effect of the *Citrus* spp. peel on Adult Mortality and Oviposition of *Oryzaephius meccator*

The effect of *Citrus* spp. powder on the adult mortality as shown in table 3. It was observed that the efficacy of the powder depends on the concentration level. The higher the inclusion level the higher the rate of adult mortality. Further observation revealed is the early adult mortality due to the quick action of the active chemical compound present in *Citrus* although it depends on the higher inclusion rate thereby with inclusion rate of 7.5g there was a less mortality observed at 6 weeks after infestation (WAI) since most of the insect had been controlled earlier as compared to the aluminum phosphide which eliminated all the insect pest at 1WAI and was left with no insect to controlled at week 2. The reason for this might be attributed to the presence of Limonene compound present in the peel of both *Citrus* spp. but at different concentrations.

Table 2: Effect of the Citrus *spp.* peel on Adult Mortality of *Oryzaephius meccator*

TREATMENT	Conc (g)	WEEKS AFTER INFESTATION (WAI) 1	2	3	4	5	6
Aluminum phosphide		10^{a}	0.00^{C}	0.00^{C}	0.00^{C}	0.00^{C}	0.00^{C}
Lime peel powder	2.5	0.33^{bc}	1.00^{b}	0.33^{bc}	1.00^{bc}	1.67^{a}	2.00^{b}
Lime peel powder	5.0	0.67^{bc}	2.00^{a}	1.33^{abc}	1.67^{ab}	2.00^{a}	2.00^{b}
Lime peel powder	7.5	1.33^{ab}	2.00^{a}	2.33^{a}	2.33^{a}	1.67^{a}	0.33^{c}
Orange peel powder	2.5	0.00^{c}	0.67^{bc}	1.00^{abc}	1.00^{bc}	1.33^{a}	2.0^{b}
Orange peel powder	5.0	0.33^{bc}	1.00^{b}	1.33^{abc}	1.67^{ab}	1.67^{a}	3.33a
Orange peel powder	7.5	1.00^{bc}	1.33^{ab}	1.67^{ab}	2.33^{a}	2.33^{a}	1.33^{b}
Control		0.00^{c}	0.00^{c}	0.33^{bc}	1.00^{bc}	2.00^{a}	3.33^{a}

Mean value in a column followed by the same lower-case letter(s) not significantly different at 5% level of significance according to Tukey's Honesty Significant Different Test (Tukeys' HSD)

The oviposition of the insect pest was observed with application of lime and orange peel powder at different inclusion rate which was presented in Table 3. There was significant difference observed with the inclusion of the powder of the two *Citrus* spp. when compared with control with no treatments.

Table 3: Effect of the Citrus *spp.* Peel on Oviposition of *Oryzaephius meccator*

TREATMENT	Conc (g)	WEEKS AFTER INFESTATION (WAI) 1	2	3	4	5	6
Aluminum phosphide		0.00^{C}	0.00^{e}	0.00^{f}	0.00^{d}	0.00^{f}	0.00^{f}
Lime peel powder	2.5	35.33^{ab}	31.33^{c}	27.00^{cd}	23.67^{b}	13.33^{c}	6.67^{bc}
Lime peel powder	5.0	34.67^{ab}	29.33^{cd}	24.00^{de}	15.00^{c}	9.00^{de}	4.67^{cde}
Lime peel powder	7.5	33.33^{ab}	5.67^{d}	22.67^{e}	12.33^{c}	7.33^{e}	2.33^{ef}
Orange peel powder	2.5	37.67^{a}	35.33^{ab}	31.33^{b}	20.67^{b}	17.00^{b}	8.33^{b}
Orange peel powder	5.0	35.33^{ab}	32.33^{bc}	29.33^{bc}	20.33^{b}	10.33^{d}	4.67^{cde}
Orange peel powder	7.5	34.67^{ab}	31.00^{c}	26.00^{cde}	14.67^{c}	7.67^{de}	3.33^{de}
Control		36.00^{ab}	36.33^{a}	37.67^{a}	39.33^{a}	41.67^{a}	44.67^{a}

Mean value in a column followed by the same lower case letter(s) not significantly different at 5% level of significance according to Tukey's Honesty Significant Different Test (Tukeys' HSD)

Effect of the *Citrus* spp. Peel on Larva Infestation of *Oryzaephius meccator*

The larvae infestation effect was observed with different inclusion rate of *Citrus* spp. and presented in Table 4. The result revealed that there was a significant difference observed for the all inclusion rate, synthetic insecticide and the control considering the larvae infestation in the dika nut. It was observed that dika nut treated with aluminum phosphides had no larvae infestation. It was observed that the inclusion rate affected the larvae infestation. The higher the inclusion rate the lower the larvae infestation. It was further observed that at 6 WAI there was no significant difference observed between the application of Lime peel powder at 7.5g and the aluminum phosphides, this might be attributed to the chemical compound limonene which has been reported to have higher toxicity (Khanikor et al., 2021). It has been reported that the chemical composition of C. *aurantifolia* peel is 77.5% limonene and palatinol-1C which was responsible for the insecticidal activities while *Citrus sinensis* peel has basically about 90% limonene and other little quantity of 32 compounds. *Citrus sinensis* was reported effective against the fourth instar larvae and adults of some insect pest (Salem et al., 2013). The peel essential oils of *Citrus aurantifolia* has been reported as insecticidal, repellent, and larvicidal against *Aedes aegypti*. In a previous study, it was observed that the ovicidal, larvicidal and adulticidal effects of leaf and peel essential oil of *Citrus aurantifolia* against *Aedes aegypti* (Sarma et al., 2019).

Table 4: Effect of the Citrus *spp.* Peel on Larva Infestation of *Oryzaephius meccator*

TREATMENT	Conc (g)	WEEKS AFTER INFESTATION (WAI)					
		1	2	3	4	5	6
Aluminum phosphide		0.00^{c}	0.00^{e}	0.00^{dC}	0.00^{e}	0.00^{c}	0.00^{d}
Lime peel powder	2.5	32.33^{b}	27.00^{cd}	22.67^{bc}	12.67^{c}	7.67^{c}	3.33^{b}
Lime peel powder	5.0	30.33^{b}	22.33^{d}	22.33^{bc}	10.67^{cd}	5.67^{c}	2.33^{bc}
Lime peel powder	7.5	31.00^{ab}	24.00^{cd}	19.67^{c}	9.33^{d}	4.00^{d}	0.00^{d}
Orange peel powder	2.5	34.67^{a}	33.67^{ab}	35.00^{b}	17.66^{b}	10.67^{d}	4.00^{b}
Orange peel powder	5.0	31.67^{ab}	29.00^{bc}	24.33^{bc}	13.00^{c}	5.67^{c}	2.67^{b}
Orange peel powder	7.5	29.33^{b}	28.33^{bc}	20.67^{c}	9.33^{d}	4.67^{d}	0.67^{cd}
Control		34.33^{a}	35.00^{a}	35.00^{a}	36.33^{a}	38.33^{a}	41.00^{a}

Mean value in a column followed by the same lower case letter(s) not significantly different at 5% level of significance according to Tukey's Honesty Significant Different Test (Tukeys' HSD)

Effect of *Citrus* spp. on the Percentage Weight Loss of Dika Nut

The effect of *Citrus* spp. on the percentage weight loss of Dika nut was presented in Table 5. The effectiveness of *Citrus* spp. on the percentage weight loss of dika nut was as relevance with respect to the inclusion rate. It was observed that the percentage weight loss reduces with increasing inclusion rate for both *Citrus* spp. considered. The inclusion rate of 2.5g for both *Citrus* spp. showed a greater percentage loss which might be attributed to the minimal bioactive in *Citrus* to repel the insect pest considered while the higher the rate the lower the insect pest feed on the nut which implies that both *Citrus* spp. contain a repellant and antifeedant characteristics but effective at higher dosage. Although at the highest dosage considered, the percentage weight loss is still significantly different to the synthetic insecticide used. Aluminum phosphide reduced the percentage weight to negligible percentage but its residual effect might be questioned which is unsafe for human consumption.

Table 5: Effect of *Citrus spp.* on the Percentage Weight Loss of Dika Nut

Treatment	**Conc. (g)**	**Percentage weight Loss (%)**
Aluminum phosphide		0.94
Lime peel powder	2.5	13.49
Lime peel powder	5.0	9.19
Lime peel powder	7.5	4.61
Orange peel powder	2.5	14.33
Orange peel powder	5.0	10.45
Orange peel powder	7.5	6.05
Control		40.93

CONCLUSION

With the increasing awareness of consumers for ecofriendly products and at the same time increasing resistance of insect pests against insecticides, the demand for novel, safe and effective products is increasing. As discussed above, the existing literature revealed presence of a good number of terpene compounds in different *Citrus* species which are present in different ratios although in most cases limonene is the predominant constituent. Both the crude oil as well as individual compounds possess good insecticidal and repellent properties against diverse insect pests, both indoor and outdoor. The present study also showed promising potential against *Oryzaephius meccator* while using two *Citrus* peel powder with higher efficacy of *Citrus aurantifolia* and *Citrus* sinesis peel powders. The use of *Citrus* can be considered as an ecofriendly means of controlling O. *meccator* as against the aluminum phosphide

RECOMMENDATION

It is recommended that the further trials on citrus parts should be used in the management of insect pest of stored dika nut, for a more healthy, friendly environment and enhance food security.

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EFFECT OF VARYING COLOUR SHADES ON SEEDLING EMERGENCE, GROWTH MORPHOLOGY AND FRUIT YIELD ATTRIBUTES OF TOMATO (*Solanum lycopersicum* L. var. Cobra) IN NSUKKA, SOUTHEAST NIGERIA

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ABSTRACT

This experiment was conducted at the Department of Crop Science Teaching and Research Farm, University of Nigeria, Nsukka (Nigeria) to evaluated the seedling emergence, growth performance, and fruit yield of a tomato variety (Cobra F1) grown under six (6) environments comprising varying polyethylene colour shades (including red, yellow, transparent, blue, and green) and the control treatment (where the tomato seedlings were grown in the open). Each of the growth environments was lined with four (4) plastic baskets where twenty (20) tomato seeds were planted out. The four baskets represented the treatment replications in completely randomized design (CRD) format. The growth medium was a mixture of topsoil, poultry manure and sawdust formulated in volume ratios of 3:2:1, respectively. Data were recorded on seedling emergence parameters (days to 1st, 50% and 100% emergence, total emerged seedlings), seedling height, number of leaves, stem girth, number of fruits per plant, days to 1st, 50% and 100% flowering/fruiting during the growth stages. The fresh fruit weight and fruit circumference were also studied. The early growth records showed that plants grown under polyethylene shades were significantly ($p < 0.05$) taller and produced higher number of leaves than the control plants grown in the open. Plants under the red shade showed superior performance (in terms of emergence records, seedling height and number of leaves per seedling) compared to other environments. Growth parameters studied at 10 weeks after planting (WAP) were significantly ($p \leq 0.05$) influenced by growth environment. Green and the yellow shade had the tallest plants (127.8 cm and 126.2 cm, respectively), whereas the non-shaded control plants were the shortest (76.0 cm). Plants under the transparent shade had the greatest number (22) of leaves, while the control plants had the least (9 leaves). Base and stem girth were thinnest under the red and yellow shades, while plants under the transparent shade had the largest girth size. Flowering and fruiting were earliest in the transparent and green shades, but were delayed under the red and control treatments. The transparent, followed by the green shade, recorded the highest number of fruits and total fruit yield per plant. The control (non-shaded) plants and those grown under the blue shade were the poorest in most of the fruit yield parameters. The use of transparent shade is therefore recommended for tomato production under Nsukka condition as it supported superior seedling growth and the highest fruit yield.

Keywords: *Tomato, polyethylene colour shade, fruit yield, Nsukka – Nigeria.*

INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is an annual herbaceous crop that belongs to the Solanaceae family. It is one of the most widely cultivated vegetables in the world (Opena and Kyomo, 1990; Pierce 1987). Because tomato is a relatively short-duration crop and gives a high yield, it is economically attractive with widespread cultivation, and the area under cultivation is increasing (Naika *et al*., 2005). Tomato plays a vital role in human nutrition, serving as a rich source of vitamins and minerals, including vitamin C, potassium, and folate (Bjarnadottir, 2015). Among foods typically consumed by humans, tomatoes are particularly rich source of carotenoids. The visible red colour of the fruits is due to the quantities of carotenoids, such as lycopene and β-carotene, and chlorophylls inherent in them (Shi and Le Maguer, 2000). Red and orange colours result from the accumulation of lycopene and β-carotene, respectively. Green fruits contain chlorophylls, which usually degrade with ripening.

Tomato plants typically grow to a height of about 1 to 3 meters (Balajet *et al.*, 2017). They produce sprawling, fragile vines that usually require support. Tomatoes are cultivated across northern and southern parts of Nigeria, but the production concentrates more in the northern states like Sokoto, Kebbi, Plateau, Kano, Bauchi, Jigawa, Zamfara, etc., with longer durations of sunlight, lower humidity and clearer atmosphere. The most important constraint to tomato production in southern Nigeria is high air humidity and cloud cover, which characterize the climate of southern Nigeria.

There is an increasing interest in the use of controlled environment for growing horticultural crops. Some large commercial greenhouse farmers produce tomatoes, which give consumers access to the fruits at lean periods of the year when field-grown tomatoes are limited. Growing tomatoes in greenhouses or other controlled environments modifies the growth environment, and has great potential to influence the partitioning of crop growth resources, and sustainably enhancing yield. According to Read (2007), coloured films or plastics, also termed ‘high tunnel’ or ‘hoop house’, can have positive effects on the colour, size, and yield of tomato fruits. There have been several studies aimed at increasing tomato productivity in Nigeria both for small scale and commercial purposes. However, not much has been researched on the use of coloured shades to enhance tomato productivity in the southeastern Nigeria. Coloured polyethylene shades affect the spectrum of light that reaches the plants grown under the shades. Baiyeri (2006) reported that plants’ response to light would vary depending on the intensity and quality of the light they receive. Hence, the objectives of this study were to evaluate the seedling emergence, growth performance, growth phenology and fruit yield of tomato (*Solanum lycopersicum L.*) fruits grown under varying polyethylene colour shades in southeastern Nigeria.

MATERIALS AND METHODS

Study location

The experiment was conducted at the Department of Crop Science, University of Nigeria, Nsukka Research Farm, from February to October 2022. The climate of Nsukka (latitude 06°51'E, longitude 07°29'N, 475m a.s.l.) is characterized by lowland humid condition with bimodal annual rainfall of 1155mm to 1955m (with peaks in July and September, and a short break in mid-August), mean annual temperatures of 29°C to 31°C and a relative humidity ranging from 50 to 90% (Uguru *et al*., 2011) in a derived savannah ecology. The soil of the experimental site is ultisol (Asiegbu, 1989).

Experimental Design

The experiment evaluated the seedling emergence, growth performance, fruit yield and fruit nutritional quality of a determinate tomato variety (Cobra F1) grown under six (6) environments. The growth environments consisted of varying polyethylene colour shades (including red, yellow, transparent, blue, and green) and the control treatment (where the tomato seedlings were grown in the open). Each of the growth environments was lined with four (4) plastic baskets where twenty (20) tomato seeds were planted out. The four baskets represented the treatment replications in completely randomized design (CRD).

Treatment application

Topsoil, poultry manure and sawdust mixed in volume ratios of 3:2:1 (v/v/v, respectively) was used as the growth medium. The substrates were thoroughly mixed, moistened and covered for composting. The growth medium was turned and moistened fortnightly (to maintain the moisture level) until the composting was completed after four months. Four litre plastic baskets were filled with the formulated growth medium and laid, four each, inside the shades and planted with twenty (20) tomato seeds each.

Data Collection

Nursery Stage: Data were collected on days to 1st seedling emergence, days to 50% seedling emergence, days to 100% seedling emergence, and total emerged seedlings per basket. At 2 to 4 weeks after planting (WAP), data were collected from four sample plants per basket on plant height (cm) and number of leaves per seedling.

Seedling growth stage: At the completion of seedling emergence at 4 WAP, the seedlings were thinned down to one per basket and growth data were collected on plant height (cm), number of leaves per seedling, stem girth (cm) at the mid-stem height, and seedling base girth (cm) which was measured at the soil level.

At 8 to 10 WAP, data were collected on plant base girth (cm), plant height (cm), number of leaves per plant, stem girth (cm) at the mid-stem height, number of flower trusses per plant, number of branches per seedling, and total number of leaflets per seedling. At flowering, data were collected on days to first flowering, days to 50% flowering, days to 100% flowering, days to 1^{st} fruiting, days to 50% fruiting, and days to 100% fruiting.

At harvest, data were recorded on days to 1^{st} harvest, number of harvested fruits per plant, total fruit weight (kg) per plant, days to last harvest. Fruit circumference (cm) was measured from 15 composite fruits per treatment.

Statistical Analysis

All the data obtained were subjected to analysis of variance (ANOVA) according to the procedures outlined for completely randomized design (CRD) experiments using GenStat 10.4 analytical software. Detection of differences between treatment means was done using Fisher's least significant difference (F-LSD) at 5% probability level.

RESULTS

Table 1 shows the seedling emergence parameters of tomato (*Solanum lycopersicum*) as influenced by nursery colour shades. The colour shades did not have a significant impact on most of the emergence parameters studied. However, the red shade had the shortest days to 1st and 50% seedling emergence (7.0 and 10.8 days, respectively) and recorded the highest emergence percentage (88.8%) compared to the rest of the growth environments. The control (non-shaded) environment had the longest days to 1st and 50% seedling emergence (9.5 and 13.5 days, respectively). Percentage seedling emergence was the poorest (70.0%) under the blue shade, followed closely by the control environment (75.0%).

At 2 and 4 weeks after planting (Table 2), all the plants grown under polyethylene shades (irrespective of the colour) were significantly ($p < 0.05$) taller than the control plants grown in the open. The plants under the colour shades also produced significantly ($p < 0.05$) higher number of leaves than the control plants grown in the open. At 2 weeks after planting (WAP), the blue shade had the tallest plant height (39.0 cm), and with the red shade produced seedlings with the greatest number of leaves (16), compared to the control plants with 7 leaves and height of 12.0 cm. At 4 WAP, the seedling heights across the colour shades were statistically similar, but the red and the transparent shades had seedlings with the greatest number of leaves (27 and 26, respectively), compared to the control plants which had 14 leaves per seedling.

At 8 WAP (Data not shown), most of the seedling growth parameters were significantly ($p \leq 0.05$) influenced by the varying colour shades. Seedling heights were similar across the colour shades, but plants under the polyethylene colour shades were statistically ($p < 0.05$) taller than the non-shaded control seedlings. The yellow and green shades had the tallest seedling height (99.8 cm and 95.2 cm, respectively), while the control treatment had the shortest (51.2 cm) seedlings. Number of leaves and leaflets per seedling were statistically ($p > 0.05$) similar across the treatments, but the control and the red shade had the least values across the treatments.

Seedling base girth, stem girth and number of flower trusses per plant were significantly influenced by the varying colour shades. Base girth and stem girth were the poorest under the red shade, but similar across the other treatments. Seedlings under the transparent polyethylene shade produced the highest number (5.0) of flower trusses, followed by the green (3.5) and blue shade (3.0), respectively. Plants under the red shade had no (zero) flower at 8 WAP, while the control plants and those under the yellow shade had 1.8 and 2.5 trusses, respectively. It is worthy to note that the red shade had already faded its colour at 8 WAP, necessitating a colour spray which produced an opaque effect restricting some light transmission within the chamber, thereby affecting the overall seeding performance.

All the growth parameters studied at 10 WAP were significantly ($p \leq 0.05$) influenced by the colour shade treatment (Table 3). Green and the yellow shade had the tallest plants (127.8 cm and 126.2 cm, respectively), followed by the blue shade (116.5 cm), whereas the non-shaded control plants were the shortest (76.0 cm).

Plants under the transparent shade had the greatest number (22) of leaves, although not significantly different from the 19, 17 and 16 leaves recorded under the yellow, green, and blue shades, respectively. The control plants had the least number (9) of leaves. The number of leaflets was highest (127) under the yellow shade, followed by the green (102) and the blue shade (92), and least with the red (57) and the control plants (66 leaflets). Plant base girth and stem girth were poorest under the red and yellow shades, while plants under the transparent shade had the largest girth size. Number of flower trusses at 10 WAP (Table 3) was highest (10 trusses each) under the transparent and green shades, followed closely by the yellow (with 8 flower trusses), while plants under the red shade had only one (1) flower truss at 10 WAP.

Delayed flowering was observed in plants grown under the red shade as evident in the number of days to 1st and 50% flowering (Figure 1). Plants grown under the red and yellow shades had the longest days to 100% flowering, followed closely by the unshaded control plants. Plants grown under the transparent (colourless) shade had the earliest flowering. Variability in days to 1st and 50% fruiting across the colour shades was not glaring; however plants under the red shade did not eventually fruit owing to the poor light transmission within the shade after a clour spray was applied to restore the faded polyethylene colour.

The varying colour shades had no significant influence on days to 1st fruit harvest, days to last harvest, and the mean fruit circumference per plant (Table 4). However, number of fruits harvested per plant, total fruit yield per plant and the mean fruit weight were significantly ($p < 0.05$) influenced by the varying polyethylene colour shades. The transparent shade, followed by the green shade, recorded the highest number of fruits and total fruit yield per plant, although the green shade had the least mean fruit weight. The control (non-shaded) plants and plants grown under the blue shade were the poorest in most of the fruit yield parameters.

DISCUSSION

Plants are highly adaptable organisms, but their growth and productivity are greatly influenced by the environment in which they are situated (Mendes *et al.*, 2013). According to Khandaker (2010), polyethylene colours used as shades have distinct optical characteristics and thus reflect different radiation patterns into the canopy of crops, thereby affecting plant growth and development. The discernible differences in the seedling emergence, growth performance, and fruit yield observed in this study are attributable to the variations in light penetration allowed into the growth environment. In the overall, the tomato plants grown under the polyethylene colour shades outperformed the control plants grown in the open.

Seedling emergence and growth performance of tomatoes

It was observed that polyethylene colour shades did not have significant influence on the seedling emergence, however, red coloured shade caused early emergence and vigorous seedling growth when compared to other colours. Although the control and transparent shade did not support rapid height increments in the tomato plants, other colour shades (probably due to their reduced light penetration) caused an increase in height of the tomato plants grown under them, particularly at the early juvenile stages. This is in consonance with the work of Stamps (2009) on shade netting, where darker shades reduced photosynthetically active radiation (PAR) the most, which caused elongated internode, increased number of leaves, shoot length, and leaf width compared to the no-net control. Blue light can stimulate stem elongation by promoting cell elongation in the stem's internodes (Briggs, 2002), which results in increased plant height. However, this increase in height did not translate to enhanced productivity of the plants. The blue shades caused an increase in the number of leaves per seedling in the first few weeks of the plants growth. This agrees with the work of Ito *et al*. (2006) on Phalaenopsis cultivars and hybrids, where blue netting showed a fairly consistent pattern of enhanced foliage biomass production despite reduced transmission of PAR compared with black and red nets.

The positive influence of the transparent shade was not very glaring during the early growth of the tomato plants, however the transparent shade had a great influence on the number of leaves per plant during the productive stage of the plants. The distinctive characteristics of transparent polythene and its impact on light transmission and plant growth may be responsible for the significant differences in stem girth, base girth, and the number of flower trusses observed under transparent shades. Transparent polyethylene allows a wide spectrum of light, including all visible wavelengths, to pass through. This provides the tomato plants with the full spectrum of light needed for photosynthesis and growth (Smith, 1995). This result agrees with the work of Shahak *et al.* (2004) where red/white shade net treatment that reduced PAR by 18% increased fruit set of apple compared with the no-net control. Transparent polyethylene ensures that the plants receive optimal light for photosynthesis (Hogewoning et al., 2010), and adequate photosynthesis supports greater carbohydrate production, which could lead to increased leaf production and expansion. Another important point to note is the influence of the transparent shade on the stem girth. Tomato is very susceptible to lodging due to its weak fragile stem, so the transparent shade helped to increase the stem girth and reduce lodging effect.

Influence of polyethylene colour shades on the tomato yield

Adequate light is crucial for the initiation and development of flower trusses in tomato plants. According to Hogewoning *et al.* (2010), consistent light exposure throughout the growth period supports continuous photosynthesis and carbohydrate production. This condition allows for optimal light penetration into the plant canopy, leading to larger fruit size. Transparent polyethylene shade provides optimal light conditions for photosynthesis and plant growth, leading to increased leaf production, thicker stems and bases, and more flower trusses and fruiting in tomato plants compared to other coloured shades.

CONCLUSION

(1) In the overall, it was found that polyethylene shades provided the tomato plants with optimal growth conditions than the non-shaded control treatment.
(2) Among the studied polyethylene colour shades, the transparent shade had much positive effect on the tomato productivity than other shade colours.
(3) It is evident from the study that shaded tomato plants outperformed the non-shaded control plants in terms of seedling growth, fruit yield and overall fruit quality.
(4) Tomato production under controlled environment, particularly with transparent polyethylene cover is recommended for the emerging tomato industry in Nsukka southeastern Nigeria.

Table 1: Effect of coloured shades on emergence parameters of tomato (*Solanum lycopersicum*) seedlings.

Shade Colour	Days to 1st Seedling emergence	Days to 50% Seedling emergence	Total percentage seedling emergence
Blue	9.3	12.7	70.0
Trnsparent	7.5	11.0	80.0
Green	9.0	13.0	81.2
Red	7.0	10.8	88.8
Yellow	9.3	13.0	78.8
Control	9.5	13.5	75.0
F-LSD $_{(0.05)}$	n.s.	n.s.	n.s.
C.V. (%)	17.3	16.5	22.7

F-LSD $_{(0.05)}$ = Fishers least significant difference at 5% probability level, C.V. = Coefficient of variation, n.s. = non-significant treatment effect.

Table 2: Effect of colour shades on growth morphology of tomato (*Solanum lycopersicum*) seedlings recorded at 2 and 4 weeks after planting.

Shade Color	2 Weeks after planting Seedling height (cm)	2 Weeks after planting No of leaves per seedling	4 Weeks after planting Seedling height (cm)	4 Weeks after planting No of leaves per seedling
Blue	39.0	16.1	32.6	23.0
Transparent	25.5	15.0	29.6	25.5
Green	27.1	14.9	31.8	20.2
Red	25.6	15.8	31.8	26.5
Yellow	27.8	12.3	33.9	22.3
Control	12.0	6.6	13.2	14.3
F-LSD$_{(0.05)}$	15.8	1.9	3.9	4.9
C.V. (%)	40.6	9.3	9.1	15.1

F-LSD$_{(0.05)}$ = Fishers least significant difference at 5% probability level, C.V. = Coefficient of variation, n.s. = non-significant treatment effect.

Table 3: Effect of coloured shades on growth morphology of tomato (*Solanum lycopersicum*) recorded at 10 weeks after planting (WAP).

Colour shade	Plant height (cm)	No of leaves per plant	No of leaflets per plant	Plant base girth (cm)	Stem girth (cm) at 5cm height	No of flower trusses per plant
Blue	116.5	16.3	92.2	3.8	4.2	6.0
Transparent	106.0	22.0	78.0	4.1	4.8	10.3
Green	127.8	17.3	102.2	4.0	4.0	9.5
Red	102.2	12.8	57.0	3.0	3.4	0.8
Yellow	126.2	19.3	127.0	3.1	3.7	7.8
Control	76.0	9.0	65.5	4.0	3.8	4.5
F-LSD$_{(0.05)}$	20.7	5.6	16.1	0.4	0.5	3.9
C.V. (%)	12.8	23.4	12.5	7.6	8.8	40.7

F-LSD$_{(0.05)}$ = Fishers least significant difference at 5% probability level, C.V. = Coefficient of variation.

Table 4: Effect of varying colour shades on days to harvest and fruit yield parameters of tomato (*Solanum lycopersicum*).

Colour shade	Days to 1st harvest	Days to last harvest	No. of fruits per plant	Total fruit yield per plant (g)	Mean fruit weight (g)	Mean fruit circumference (cm)
Blue	130.5	111.0	4.2	224.0	52.7	15.7
Transparent	128.0	113.5	19.0	913.8	48.2	15.8
Green	135.2	111.0	15.0	717.3	40.8	15.4
Yellow	136.5	113.5	12.8	554.8	47.6	15.7
Control	134.5	114.8	4.0	179.5	45.1	15.2
Red	-	-	-	-	-	-
F-LSD$_{(0.05)}$	n.s.	n.s.	8.4	423.4	6.9	n.s.
C.V. (%)	4.5	1.9	50.4	48.2	8.8	5.4

F-LSD$_{(0.05)}$ = Fishers least significant difference at 5% probability level, C.V. = Coefficient of variation, n.s. = non-significant treatment effect. **-** = not determined.

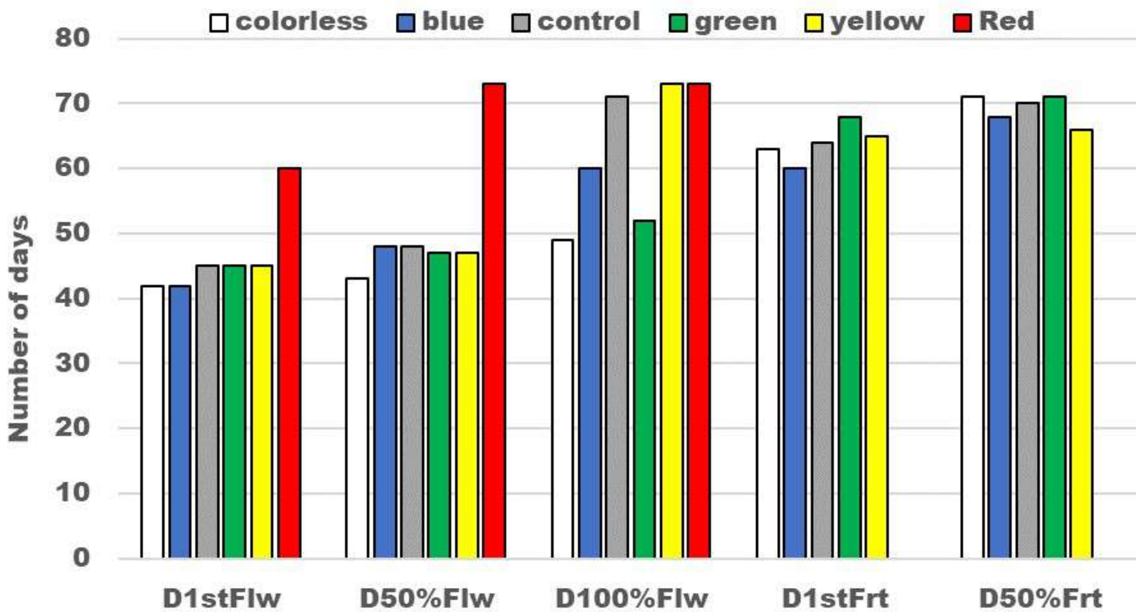

Figure 1: Flowering and fruiting phenology of tomato (*Solanum lycopersicum*) grown under varying colour shades.

D1stFlw = Number of days to first flowering; D50%Flw = Number of days to 50% flowering; D100%Flw = Number of days to 100% flowering; D1stFrt = Number of days to first fruiting; D50%frt = Number of days to 50% fruiting.

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EFFECT OF DIFFERENT RATES OF LIME (CALCIUM CARBONATE) ON THE GROWTH AND YIELD OF SOYBEAN (*Glycine max*) ON ACIDIC SOIL IN ZARIA

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ABSTRACT

Soybean is reputed to be better at fixing atmospheric nitrogen than cowpea and therefore has a higher potential to improve soil fertility. However, soil acidity which is characteristic of intensely farmed soil is a constraint to soybean production in Nigeria. on average yield of 0.93 t ha^{-1} are reported from farmers' fields as against a potential of more than 3.5 t ha-1 for improved varieties under optimal growth conditions. This study evaluated the effect of four rates of lime on growth and yield of soybean on acidic soil. Field experiments were carried out at Value Seed Production fields situated in Northern Guinea savanna agro-ecological zone in Nigeria between July and November, 2022 to assess the effect of four rate of liming on growth and yield of soybean in acidic soil. The experimental designs was 4 x 2 factorial experiments comprising of four rates (L0 =no application, L1=400 kg/ha, L2 = 800kg/ha, L3 = 1200 kg/ha) and two soybean varieties (V1 = TGx 1951-3F and V2 = TGx 1904-6F). The trials were arranged in a Randomized Completely Block Design, replicated thrice. Data were collected on growth and yield parameters, and were subjected to analysis of variance. Means were separated using Duncan's Multiple Range Test and significance level was tested at 5% level of probability ($p \leq 0.05$). Pre cropping soil analysis indicated the soil was strongly acidic (4.89) and the post cropping soil analysis shows that the liming rate of 800kg/ha and 1200kg/ha had a significant effect on the acidity level of the soil to moderately acidic (6.33 and 6.74) The liming rate of 800kg/ha significantly improved the growth and yield parameters of both varieties compared to the no application of lime. Higher seed weight per plant was observed with the application of 800kg/ha (TGx 1904-6F = 32g and V1= TGx 1951-3F = 29.30g). In conclusion, appropriate rate liming rate was the most important factor for changes in pH, therefore ameliorating the soil to improve the growth and yield of the crop for subsequent cropping.

INTRODUCTION

Soil acidification which is decrease in soil pH limit crop yields and can diminish farmers' incomes. Soil pH can easily be increased by application of lime, in practice application must be economically viable with yield benefits offering an acceptable return on investment. Liming is a long-term investment with carry-over benefits. Adopting long-term economic strategies in crop production can be challenging for farmers who lack investment capital and who may have short-term decision time frames, which is peculiar with most smallholder farmers in sub-Saharan Africa (Mahamood *et al*., 2009). In addition, application of lime causes substantial greenhouse gas (GHG) emissions (especially CO2). It is currently unclear how liming affects on a per hectare basis affect GHG emissions per tonne of crop produced.

Soybean (*Glycine max* (L.) Merill) is a legume plant that belongs to the botanical family *Leguminosae*. It is an economically significant leguminous crop globally and it is among the main crops that are grown in Nigeria. According to Dugje *et al*. (2009), soybean has higher protein content than any of the common vegetable or legume food crops in Africa. It contains 20-25% edible oil and 42-45% protein contents (Alam *et al*., 2009). Soybean has potential to address protein and oil deficiencies (Mahamood *et al*., 2009). It produces significantly more protein per hectare than any other leguminous crop and is good source of unsaturated fatty acids, minerals (Ca and P) and vitamins A, B, C and D (Alam *et al*., 2009).

Nigeria is the largest producer and consumer of soybean in Sub-Saharan Africa (Dugje *et al*., 2009). Soybean cultivation in Nigeria has expanded as a result of its economic and nutritive uses. Soybean meal and full fat soya are a major source of protein and calories in the livestock industry. The rapid growth in the poultry sector between 2004 and 2009 has also increased demand for soybean meal in Nigeria (Dugje *et al*., 2009). It is expected that soybean production will increase as more farmers become aware of the potential of the crop, not only for cash/food but also for soil fertility improvement and *Striga* control (Dugje *et al*., 2009). The crop can be successfully grown in many states in Nigeria with little investment in agricultural inputs. Production is mainly done by small farm holders on farms of less than five hectares (ACET, 2013). Average soybean yield of 1t/ha have been reported in farmers field (FAO, 2014)), which is much lower than 3t/ha achieved on research stations in Nigeria (Tefera, 2011).
Soybean production is mainly constrained by diseases such as soybean rust (Twizeyimana *et al*., 2008) and moisture stress (Tefera, 2011) and soil nutrient deficiency (Kamara *et al.,* 2007; Kolawole, 2012). Other constraints are limited access to good input such as fertilizer, inoculants, herbicides and insecticides (ACET,2013).
According to von Uexkull and Mutert (1995), acid soils occupy about 30% of the world's ice-free land area. Plant growth-limiting factors in acid soils include N, P, Ca, Mg, Mo, and Zn deficiencies and/or Al, Mn, Fe, and H toxicities. Mengel and Kirkby (2001) reported that the efficiency of added N, P, and K fertilizers was very low in acid soils. Moniz *et al*. (1997) recommend a combination of soil management practices as way to improve crop production in acid soils: liming in combination with corrective levels of P and the use of crop cultivars developed for low pH conditions. Naturally occurring minerals that are commonly used to raise soil pH are limestone (CaCO3) and dolomite ($CaMg(CO_3)$). In addition, waste products from manufacturing processes using limestone or similar raw materials can be used for neutralizing soil acidity. Liming and increased P fertilization are common recommendations for improvement of pseudogley soils in Croatia (Kisic *et al*. 2002; Petosic *et al*. 2003; Komljenovic *et al*. 2006). To successfully grow field crops on acid soils, liming, alone or in combination with mineral and organic fertilization, is recommended worldwide (Komljenovic *et al*. 2006).
The aim of this research is to know the effect of different rate of calcium carbonate on growth and yield of soybean cultivated on acidic soil

MATERIALS AND METHODS

Experimental Site

Field experiments were carried out at Value Seed Production field in the Northern Guinea Savanna agro-ecological zone of Nigeria (N11^0 14.559" E007^0 45.659") between July and November, 2022.

Pre and post-cropping soil sampling and analysis

The field was laid out in blocks of different areas and sampling was done per block. A minimum of 10 spots were sampled per composite/bulk sample which was mixed together and quartered accordingly. A minimum of one sample were taken per block depending on the variation of the field. Sampling was done with a soil auger at 0-15cm soil depth and the samples were bulked into a composite sample. The samples were air dried, crushed and sieved through 2 mm and 0.5 mm meshes for the determination of particle size, soil pH, electrical conductivity, organic Carbon, total Nitrogen, Phosphorus, Potassium, magnesium, iron, copper, zinc, manganese and boron. This were determined using harvesto digital soil testing machine (model WST – 314P). A post-harvest composite soil sampling was obtained at a depth 0 – 15cm on each representative plot six weeks after planting.

Treatments and experimental design

The Experimental site was cleared and prepared manually using simple farm tools. The experimental fields was divided into four blocks which comprised four levels of liming material (calcium carbonate). These were L0 (no application), L1 (400 kg/ha) L2 (800kg/ha) and L3 (1200 kg/ha). Two medium - maturing varieties of soybean were planted which are V1 (**TGx1951-3F**) and V2 (**TGx 1904-6F**) were the test genotypes. The experimental layout was a factorial experiment (4 x 2) laid out in a randomized complete block design (RCBD), replicated three times. Application of calcium carbonate was done on each plot base on the concentration allocated to each plot and the second harrowing was done for the lime to be thoroughly-worked into the soil. Broadcasting of diammonium phosphate (DAP) fertilizer was done at the rate of 120kg /ha. A bed size of 4 m x 2 m was made and the crop spacing was 50 cm x 50cm and seeds were sown at two stand per hole. Weeding was done at six weeks after planting (6WAP). Four plants from each subplot were randomly selected for the determination of the number of root nodules/plant, plant height and number of leaves /plant. Pod harvesting was done when the leaves had senesced and the pod turned brown and data were recorded on the number of pods per plants, number of seeds /plant and seed weight /plant. All data collected were subjected to analysis of variance (ANOVA) and means were separated using Duncan Multiple Range Test at 5% probability level.

RESULTS AND DISCUSSION

As indicated on Table 1 and 2, the pre-cropping and post-cropping soil samples were texturally sandy-loam. These results agree with Odunze (2003) who opined that the soils in the Northern Guinea Savannah are sandy to sandy-loam in texture. They have low available soil moisture retention capacity and encourage leaching of nutrients away from the rooting depth of most crops. The soils therefore become degraded due to effects of soil erosion, deforestation, overgrazing, nutrient mining and poor soil management strategies applied by farmers.

As observed in Table 3 application of Calcium carbonate at the rate of 800kg/ha significantly increased the growth parameters with crop height (101.3cm) and number of leaves (108), this was observed from the variety TGx 1951-3F. From Table 4 the application of 800kg/ha of calcium carbonate also increased the numbers of seeds per plant (367and 316) and this was observed on the two varieties cultivated. It also increases the seed weight per plant (32g and 39g). With all the aforementioned observation the application of calcium carbonate enhances the growth and yield of soybean. This was in line with (Chan and Heenan 1998; Bolan *et al*. 2003; Jaskulska *et al*. 2014), Which state that liming increases crop production primarily through direct effects on improving soil physical, chemical, and biological characteristics, which lead to increased availability and mobility of many plants' essential nutrients.

The increased nodulation observed in this study may be attributed to effect of lime application which lead to favorable condition for microbial activity by regulating the pH values. This was observed with crop with the application rate of 800kg/ha. France and Day (1980) had reported that liming of acidic soil increase nodulation and nitrogen fixation of *Phaseous vulgaris* (L) in acid which are in agreement with the results obtained in the study. Generally, the application of 400kg/ha of Calcium carbonate suggest that the soil was poorly buffered at the rate of 400kg/ha. Plant height, number of leaves and stem girth was affected significantly by 800kg/ha of lime application, while the other lime rates and its interaction did not significantly affect plant height. Liming at the rate of 800kg/ha and 1200kg/ha also increased number of pods irrespective of the varieties when compared to other rate of application. This is in line with Taufiq *et al.* (2011) who reported that application of appropriate liming material can increase plant height, number of pods per plant, and yield.

CONCLUSION

As indicated in this study, liming can lead to ample changes in soil pH, which in turn improve the soil productivity. This can lead to significant improvement of soybean yields in the Northern Guinea Savanna agro-ecology.

Table 1: Pre-cropping soil physical and chemical properties

Soil Characteristics	Values
pH (H_2O)	4.89
Organic Carbon (%)	0.24
Total N (kg ha^{-1})	87.2
Available P (kg ha^{-1})	5.18
Available K (kg ha^{-1})	197.2
Sulphur (mg/kg)	-0.01
Zinc (mg/kg)	15.4
Manganese (mg/kg)	10.76
Iron (mg/kg)	27.6
Copper (mg/kg)	15.36
Sand (%)	80.12
Silt (%)	09.48
Clay (%)	10.39
Textural class	Sandy loamy

Table 2: Impact of different rates of lime (calcium carbonate) on soil properties

Treatment	pH	Soil salinity (ms/cm)	Nitrogen (kg/ha)	Phosphorus (kg/ha)	Potassium (kg/ha)	Sand (%)	Clay (%)	Silt (%)	Textural class
V_1T_0	4.50d	0.19b	120.67a	803.67ab	443.63ab	84.30a	06.90a	08.80a	Sandy loam
V_2T_0	4.83d	0.17b	114.67a	1048.00a	1219.67a	84.60a	07.74a	07.66a	Sandy loam
V_IT_I	5.53c	0.14b	105.00a	579.00b	344.33b	82.70a	07.62a	09.68a	Sandy loam
V_2T_1	5.63c	0.16b	99.67a	541.00b	359.17b	82.40a	08.48a	09.12a	Sandy loam
V_IT_2	6.33b	0.38a	115.33a	683.33b	290.00b	79.28a	09.90a	10.82a	Sandy loam
V_2T_2	6.40b	0.13b	137.33a	640.33b	547.77ab	79.30a	09.94a	10.76a	Sandy loam
V_1T_3	6.97a	0.12b	117.33a	573.00b	230.40b	81.70a	08.62a	09.68a	Sandy loam
V_2T_3	7.10a	0.13b	139.00a	662.00b	496.33ab	84.40a	08.48a	07.12a	Sandy loam

Mean followed by same letters are not significantly different at 5% probability level, using Duncan's Multiple Range Test (DMRT). V1= TGX 1951-3F, V2= TGX 1904-6F, T_0= no application of calcium carbonate, T_1= application of 400kg/ha calcium carbonate, T_2= application of 800kg/ha calcium carbonate, T_3=9 application of 1200kg/ha calcium carbonate

Table 3: Impact of different rates of lime (calcium carbonate) on growth parameters

Treatments	Plant height (cm)	Stem girth (cm)	Number of leaves
V_1T_0	57.00d	2.10a	84.67abc
V_2T_0	52.33d	1.87a	76.67c
V_IT_I	65.00cd	2.70a	81.33bc
V_2T_1	61.33cd	2.83a	91.00abc
V_IT_2	101.33a	3.50a	108.67a
V_2T_2	89.33ab	2.70a	100.00abc
V_1T_3	68.00cd	2.23a	103.00ab
V_2T_3	75.00bc	8.80a	98.00abc

Mean followed by same letters are not significantly different at 5% probability level, using Duncan's Multiple Range Test (DMRT). V1= TGX 1951-3F, V2= TGX 1904-6F, T_0= no application of calcium carbonate, T_1= application of 400kg/ha calcium carbonate, T_2= application of 800kg/ha calcium carbonate, T_3= application of 1200kg/ha calcium carbonate

Table 4: Impact of different rates of lime (calcium carbonate) on yield parameters

Treatment	Numbers of pods	Number of seed	Seed weight (g)	Shoot weight (g)	Number of nodules
V_1T_0	76.67d	169.33d	15.73d	56.33cd	3.67e
V_2T_0	78.33cd	149.33d	18.73cd	49.00d	5.33de
V_1T_1	93.33cd	246.67c	25.73abc	60.33bcd	7.33cd
V_2T_1	98.33bc	296.00bc	24.40abc	58.33cd	10.33ab
V_1T_2	123.67a	316.67ab	32.70a	79.33a	10.00bc
V_2T_2	129.67a	367.33a	29.30a	73.67ab	12.67a
V_1T_3	117.00ab	283.67bc	28.03ab	64.00bc	8.00bcd
V_2T_3	118.00ab	262.33bc	20.48bcd	65.00bc	8.00bcd

Mean followed by same letters are not significantly different at 5% probability level, using Duncan's Multiple Range Test (DMRT). V1= TGX 1951-3F, V2= TGX 1904-6F, T_0= no application of calcium carbonate, T_1= application of 400kg/ha calcium carbonate, T_2= application of 800kg/ha calcium carbonate, T_3=application of 1200kg/ha calcium carbonate

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EFFECTS OF NITROGEN AND POTASSIUM FERTILIZERS RATES ON GROWTH, YIELD AND NUTRITIONAL QUALITY OF FLUTED PUMPKIN (*Telfairia occidentalis*) IN OGBOMOSO

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ABSTRACT
The effects of N and K fertilizers rates on the growth, yield and nutritional qualities of fluted pumkin was investigated during the 2022 cropping season at the Teaching and Research farm, Ladoke Akintola university of Technology Ogbomoso. The 3x5 factorial experiments were laid out in Randomized Complete Block Design with three replications. Result shows that applied N and K fertilizer rates significantly increase the number of leaves, vine length, fresh shoot and nutritional quality of Telfairia with the optimum values obtained from the sole application of 60Kg N and 60Kg K_2O/ha. Although, the combined application of 60KgN/ha +15Kg K_2O/ha gave highest fresh shoot yield, but there were no significant difference between this values and that at 30KgN +15KgK_2O/ha. In conclusion, application of 60KgN/ha and 15KgK_2O/ha gave the highest marketable yield of Telfairia in Ogbomoso.

INTRODUCTION

Telfairia occidentalis (Hook.F.) known as fluted pumpkin or *Telfairia* is a member of the family cucurbitaceae (Schippers, 2002). The crop is commonly called Ugu by the Ibos of South Eastern Nigeria. It is often planted solely from seeds often close to fences and walls to provide support for the shoots (Lathan, 2002). *Telfairia* occidentalis leaves are palatable and nutritious (Olomola *et. al*., 2006). The leaves of fluted pumpkin are used in soups and porridges as the vegetative parts of the crop make an excellent vegetable rich in vitamins and has 37.3% protein content on a dry weight basis (Schippers, 2002). The leaves are medicinal and used for the treatment of anemia and diabetes (Akanbi *et. al*., 2007). The tender vine and foliage are eaten as a pot herb, while the seed is consumed as a nut (Akoroda, 1990). The seed contains 20% protein, 45% fat, 23% carbohydrate, 2.2% fibres, and 1.8% total ash. The oil in the seeds is non-drying and contains lactating properties which are in high demand by nursing mothers (Akanbi *et al.,* 2007). The oleic and linoleic acids constitute over 63% of the fatty acids and that makes the oil useful in soup making and cooking, suitable for use in the manufacturing of pomade, margarine and as well as a carrier for certain drugs (Akanbi *et al.,* 2007).

The leaf has high nutritional, medicinal, and industrial values being rich in protein (29%), fat (18%), and minerals and vitamins (20%) (Tindall 1986). The oil in the seeds is non-drying and is useful in soap making and cooking (Fashina *et. al*., 2002). Also, Asiegbu (1987) reported that the protein and oil content of the seed is 30.1% and 47% respectively. The composition of the seed per 100g edible portion is water 6.0g; energy 2280kj (543k cal); protein 20.5g; fat 45.0g; carbohydrate 23.5g; fiber 2.2g; calcium (Ca) 84mg and Phosphorus (P) 572mg; (Leung *et. al*., 1968). The seeds are high in essential amino acids (except lysine) and can be compared to soya bean meal with 95% biological value. The fruit pulp has a protein content of about 1.0%. The main constituents of the seed oil are oleic acid (37%), steric and palmitic acid (both 21%); and linoleic acid (15%) (FAO,1988). In Nigeria, there is a widespread problem of soil degradation due to continuous cultivation of the soil (Schippers, 2002).

One of the problems of crop production in the tropics is that tropical soils have low fertility status (Agbede 2010). The soils are highly weathered and leached, low in organic matter and available nutrients, thus leading to low productivity within few years of cultivation (Soremi *et. al*., 2017). Applying inorganic fertilizer is one of the widely accepted ways of increasing soil nutrients both in the temperate and tropical

zones of the world. It has been reported that Nitrogen (N), Phosphorus (P), and Potassium (K) are the major essential elements required for physiological mechanisms for plant growth, with increasing pressure on soils of southwestern Nigeria, shifting cultivation is no longer sustainable and traditional bush fallow period for maintaining the productivity of the soil has become shorter and soils are no longer able to supply the number of nutrients required with the result, that yield level declines rapidly once cropping commences (Amhakhian *et. al*., 2010). Therefore, there is a need to augment soil fertility with external sources of nutrients. However, organic inputs alone will not meet the nutritional requirements of crops because they contain comparatively lower quantities of nutrients compared to inorganic fertilizers. Hence, the need to integrate the two forms to achieve better crop yields (Khan *et. al.,* 2008; Suge *et. al.,* 2011).
Although, many research activities have reported better performance of crops with fertilizer application; one of the methods through which plants would display their potential genetic capability is by supplying the plants with adequate amount and types of fertilizer at the right time (Aliyu, 2003; Olaniyi *et al*., 2010). Research efforts are therefore required to recommend combination of N and K fertilizer for sustainable production of *Telfairia* occidentalis in Ogbomosho

MATERIALS AND METHOD

The experiment was conducted at Teaching and Research Farm Ladoke Akintola University of Technology, Ogbomoso (8^0 10'N and 4^0 10'E), a location in the Guunea Savannah zone of South-western Nigeria. The treatment was laid out in a factorial experiment and fitted in a Randomized Complete Block Design (RBCD) with 3 replications. The experimental plot was divided into three blocks each containing 15 beds to give a total of 45 beds. The treatments involved three Nitrogen fertilizer rates (0, 30, 60kgN/ha) applied in form of Urea and Five Potassium fertilizer rate (0, 15, 30, 45, 60kgK/ha) applied in form of Muriate of Potash and their various combinations. Each bed size was 1.2m x 1.2m and 0.5m spacing within and 1m between beds to ease movement during cultural operations.
Planting was done in early April, with fluted pumpkin seeds procured from the Department of Crop Production and Soil Science, LAUTECH, Ogbomoso. Four seeds were sown at a spacing of 1m x 1m and later thinned down to two seedlings per stand at four weeks after sowing (WAS). The different fertilizer rates were applied to their respective plots according to the treatment combinations at 6 weeks. The fertilizer application was by band placement, watering was done every morning at 2 days interval during the drought periods to avoid wilting of the plant, staking, weeding and other crop management took place as at when due. Data were collected four weeks after planting and repeated at two weeks interval. Variable assessed include vine length, number of vines, number of leaves, height of the plant per plot and dry matter yield. Data collected were analyzed using Analysis of Variance (ANOVA) by the SASGLM procedure. The differences between treatment means were separated using the least significant difference at 5% level of probability.

RESULTS AND DISCUSSION

There were no significant differences ($p> 0.05$) among the number of leaves of fluted pumpkin with the fertilizer rates at 4, 6 and 10 WAS. At 4 WAS, the combined application rate 30 kg N/ha+60 kg N/ha produced the highest number of leaves (13.22) while 30 kg N/ha +30 kg N/ha recorded the least value of 8.44. At 12 WAS however, the highest number of leaves (79.33) was produced by combined rate 30 kg N/ha+ 60 kg N/ha while control recorded the least value of 44.89. The vine length increases as the plant aged (Table 2). Rate of applied fertilizer did not significantly ($p>0.05$) influenced the vine length throughout the experimental period. There were no significant differences ($p>0.05$) among the vine length throughout the period of the study. The combined application rate of 30 kg N/ha+45 kg K/ha produced the highest vine length while the lowest vine length was produced at 30kgN/ha fertilizer application. The fresh shoot yield as influenced by fertilizer rate and types are presented in Fig1. These were no significant difference ($p>0.05$) among the fresh shoot yield across the period of study. The combination of 60 kg N/ha+15 kg/ha produced the highest fresh shoot yield, closely followed by combined application of 60 kg N/ha+30 kg N/ha and the lowest fresh shoot yield was recorded from 30 kg N/ha fertilizer application.

The nutritional qualities of fluted pumkin are presented in table 3. The nutritional qualities of Fluted pumkin were significantly influenced by the fertilizers applied for the entire nutrient tested. The highest value was obtained from the combined application of 60 Kg Nha^{-1} + 60 Kg K_20 ha^{-1} except for Phosphorus that recorded highest value at 30kg K_20 while control recorded the least value for all the nutrients tested.

Table 1: Effects of nitrogen and potassium fertilizer rates on numbers of leaves of *Telfairia*

	Numbers of leaves				
	Week after sowing				
Treatments (kg/ha)	4	6	8	10	12
0N	11.10 a	16.45 a	27.22 bc	37.22 a	44.89 e
30N	10.00 a	14.56 a	26.11 c	35.67 a	53.11 cde
60N	11.56 a	19.00 a	28.00 abc	35.78 a	55.78 bcde
$15K_2O$	9.44 a	19.89 a	29.44 abc	38.78 a	49.45de
$30K_2O$	13.22 a	21.00 a	35.11 abc	36.78 a	61.22 bcd
$45K_2O$	11.11 a	14.98 a	30.89 abc	38.78 a	57.45 bcde
$60K_2O$	11.44 a	17.33 a	32.78 abc	44.56 a	66.00 abc
$30N+15K_2O$	9.67 a	16.44 a	37.45 ab	42.33 a	64.78 abcd
$30N+30K_2O$	8.44 a	17.55 a	32.78 abc	36.33 a	67.22 abc
$30N+45K_2O$	11.78 a	18.89 a	30.22 abc	37.24a	63.00 bcd
$30N+60K_2O$	13.22 a	19.78 a	34.55 abc	45.00 a	79.33 a
$60N+15K_2O$	9.56 a	18.78 a	34.11 abc	47.89 a	70.11 ab
$60N+30K_2O$	10.00 a	16.67 a	35.00 abc	38.11a	62.67 bcd
$60N+45K_2O$	9.11 a	17.00 a	33.11 abc	39.44 a	68.22 abc
$60N+60K_2O$	11.11 a	20.33 a	39.22 a	40.67 a	67.89 abc
LSD	5.7	9.43	9.55	10.76	13.59

Table 2: Effects of nitrogen and potassium fertilizer rates on vine length of *Telfairia*

	Vine length (cm)				
	Week After sowing				
Treatments (kg/ha)	4	6	8	10	12
0N	8.50 a	24.98 b	37.39 c	47.78 d	52.33 b
30N	6.61 a	32.22 ab	37.44 c	50.44 cd	61.78 ab
60N	13.50 a	32.45 ab	47.78 bc	49.00 d	69.11 ab
$15K_2O$	10.11 a	34.61 ab	48.44 bc	59.89 bcd	70.67 ab
$30K_2O$	11.00 a	32.00 ab	50.89 bc	57.78 bcd	82.11 ab
$45K_2O$	11.39 a	30.55 ab	44.60 bc	50.89 cd	69.89 ab
$60K_2O$	11.11 a	31.89 ab	44.72 bc	62.33 abc	71.00 ab
$30N+15K_2O$	9.55 a	35.06 ab	48.78 bc	60 bcd	82.67 ab
$30N+30K_2O$	13.04 a	31.78 ab	50.89 bc	63.11 abc	78.45 ab
$30N+45K_2O$	15.34 a	35.22 ab	57.61 ab	66.22 ab	73.33 ab
$30N+60K_2O$	14.00 a	41.06 a	69.00 a	75.44 a	93.00 a
$60N+15K_2O$	12.56 a	35.11 ab	50.00 bc	65.11 ab	86.55 a
$60N+30K_2O$	14.00 a	36.61 ab	55.33 ab	69.56 ab	89.67 a
$60N+45K_2O$	15.28 a	38.22 ab	60.11 ab	68.67 ab	80.33 ab
$60N+60K_2O$	15.05 a	37.78 ab	58.44 ab	74.11 a	91.22 a
LSD	9.45	12.49	13.98	11.63	26.61

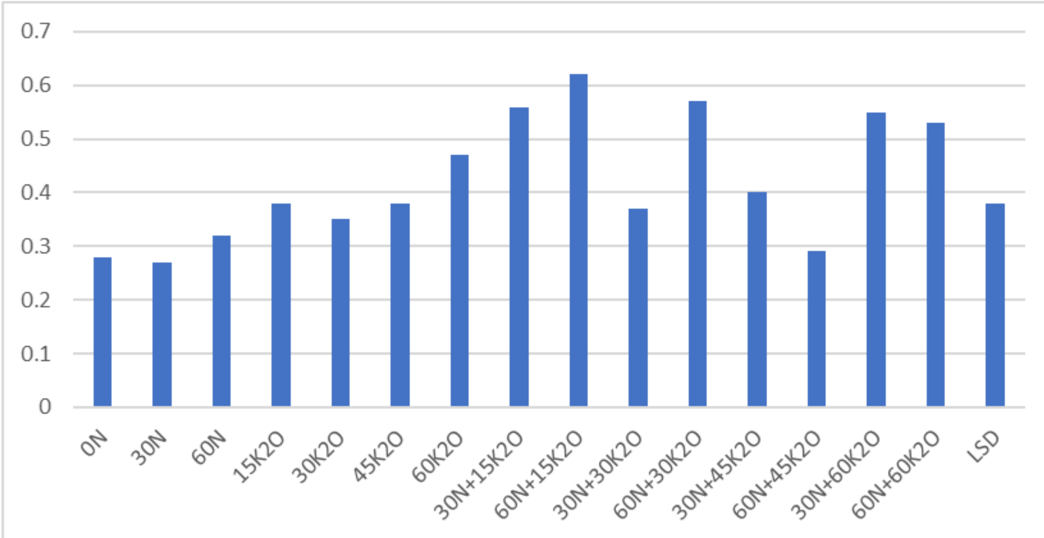

Figure 1: Fresh Shoot Yield of *Telfairia* as affected by organic fertilizer types 12 weeks after sowing

Table 3: Effects of nitrogen and potassium fertilizer rates on nutritional quality of *Telfairia*

	Nutritional quality (%)					
Treatments (kg/ha)	**ASH**	**CF**	**CP**	**K**	**N**	**P**
0N	1.04 m	1.22 n	2.25 n	0.48 n	0.36 m	4.5 f
30N	1.11 i	1.30 m	2.5 m	0.50 m	0.40 l	4.86 e
60N	1.20 k	1.37 i	2.88 k	0.57 i	0.46 k	5.42 d
15K$_2$O	1.23 j	1.40 k	2.94 j	0.64 k	0.47 k	5.44 c
30K$_2$O	1.25 i	1.45 j	3.25 i	0.72 j	0.52 j	5.74 a
45K$_2$O	1.27 m	1.22 n	2.25 n	0.48 n	0.36 m	4.50 f
60K$_2$O	1.30 h	1.54 i	3.56 i	0.76 i	0.57 i	5.70 b
30N+15K$_2$O	1.31 h	1.58 h	3.94 h	0.80 h	0.63 h	0.80 m
60N+15K$_2$O	1.35 g	1.62 g	4.19 g	0.84 g	0.67 g	0.84 i
30N+30K$_2$O	1.41 f	1.68 f	4.44 f	0.87 f	0.71 f	0.85 i
60N+30K$_2$O	1.43 e	1.71 e	4.63 e	0.91 e	0.75 e	0.88 k
30N+45K$_2$O	1.50 d	1.75 d	4.81 d	0.95 d	0.77 d	0.93 j
60N+45K$_2$O	1.54 c	1.81 c	5.06 c	0.97 c	0.81 c	0.95 i
30N+60K$_2$O	1.60 b	1.86 b	5.25 b	1.08 b	0.84 b	1.10 h
60N+60K$_2$O	1.63 a	1.91 a	5.44 a	1.12 a	0.87 a	1.17 g
LSD	0.01	0.01	0.02	0.01	0.02	0.01

DISCUSSION

The increased in the vine length, number of leaves and shoot yield confirms the earlier reports of other researchers (Akanbi *et al.,* 2008; Shiyan and Binang, 2014; Usman, 2015), that nutrient availability is a major determinant of the crop photosynthesis capacity. The higher leaf area development indices and vine growth parameters observed with increased fertilizer application suggests that these crop parameters can produce their potential capacity when soil nutrients are made available. Cechin and Fumis (2004) also observed high leaf development and shoot dry matter production in sunflower with increased nutrient supply. The enhanced growth of pumpkin in this study is due to rich nutrient content of applied fertilizer. The availability of nitrogen, phosphorus and potassium is essential for photosynthesis activities and enhance dry matter accumulation (Zhang *et al.,* 2006; Matsi, 2012). The improved performance with nitrogen and potassium combination may also be attributed to increase in soil quality.

Olsen *et al.,* (1993) and Olaniyi (2006) observed similar effects for pepper and melon respectively. The distribution of protein, fat and fiber and other minerals in the plant part of the fluted pumpkin was highly influenced by the applied amendment. This showed direct relationships between soil nutrients content and plant uptake of the nutrient. The 1.9 to 2.3% protein content obtained in the study is closer to 2.9% protein recorded for pumpkin leaves per 100g edible portion by FAO (1998) and the observed difference may be attributed to the variations in the experimental environment. However, the application of combined nitrogen and potassium produced the maximum quantity of the nutritional components signifying that the two elements are essential; nitrogen is an important component of all organic compounds while potassium is important for cell activities. Hence the observed result from their combination in fertilizer mixes.

CONCLUSION AND RECOMMENDATION

The application of inorganic fertilizer in this study influenced the numbers of leaves, vine length and fresh shoot yield of *Telfairia* occidentalis. From the result, the application of 60kgN/ha+15kgKha gave higher fresh yield however, since there were no observed significant differences between 60kgN/ha+15kgK/ha and 30kgN/ha+15kgK/ha in fresh marketable yield, it would be more economical to cultivate the pumpkin plants using rate 30kgN/ha+15kgK/ha. This will allow for proper development of plant growth parameters for maximum fresh marketable yield at a reduced cost.

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EVALUATION OF BIO-CONTROL PROPERTY OF *TRICHODERMA HARZIANUM* AND *TRICHODERMA VIRIDAE* AGAINST SOUTHERN BLIGHT DISEASE FUNGUS (*SCLEROTIUM ROLFSII*) OF OKRA

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ABSTRACT
Okra (Abelmoschus esculentus) is grown in the tropics and sub-tropics. Infection by Sclerotium rolfsii can result to serious economic losses to farmers. The use of synthetic fungicides to control diseases in crops are inimical to our environment and human health. This study evaluate the bio-control potential of two Trichoderma isolates against Sclerotium rolfsii causing southern blight disease of okra using pot culture experiment in the screen house. The treatments considered in a completely randomized experimental design (CRD) were: i) T. harzianum; ii) T. viridae; iii) T. harzianum + T. viridae; iv) mancozeb; and v) pathogen inoculated only (control). Data was collected on growth parameters of okra and on the incidence and severity of the disease. Analysis of variance was conducted on the data using R software version 4.1.2 and means were separated using Tukey test at 5% level of significance. The results showed significant difference (p<0.05) in the growth parameters and disease incidence in which all the Trichoderma treatments performed better than the control. It could be concluded that the Trichoderma isolates have the ability to suppress the incidence of southern blight disease of okra.
Keywords: *Okra, Bio-control, Trichoderma spp., Sclerotium rolfsii, Collar rot disease*

INTRODUCTION

The production of vegetables has become very popular in many countries of the world due to its importance in the diet of the people. Their production has been recognized as the most affordable and accessible sources of micronutrient and a means of generating and increasing foreign exchange in Africa (AVRDC, 2004). Okra is the most important fruit vegetable crop and a source of carbohydrate, proteins and vitamin C in large quantities (Adeboye and Oputa, 1996). It ranks first before other vegetable crops in Nigeria (Babatunde *et al.,* 2007). It is also one of the most commonly grown vegetable crops in the tropics. Okra cultivation and production has been widely practiced because of its importance to the economy and can be found in almost every market in Africa. Christo and Onuh (2005) documented that okra is consumed throughout Nigeria. The leaves, buds and flowers are also edible. Okra seed could be dried. The dried seed is a nutritious material that can be used to prepare vegetable curds, or roasted and ground to be used as coffee additive or substitute (Farinde *et al.*, 2001).

India is the world's leading producer of okra, producing 3.5 million tonnes (70% of total global production) on approximately 0.35 million hectares of land while Nigeria ranked first in Africa with 1.53 million tonnes (80% of global production) of total generated from 0.15 million hectares of land (FAOSTAT, 2008). Productivity of the crop is low in West and Central Africa with average productivity of (2.5 t/ha) compared to East Africa (6.2 t/ha) and North Africa (8.8 t/ha). Worldwide, India is the largest producer followed by Nigeria and Sudan (Varmudy, 2011).

Okra crop suffers from a number of biotic and abiotic factors, including insect pests and diseases. Southern blight disease caused by *Sclerotium rolfsii* is a devastating soil-borne fungal disease that is reported to infect a wide range of crops in different parts of the world including Africa (Liamngee Katoor et al, 2015). The disease has been reported on common bean (*Phaseolus vulgaris*) in Uganda (Paparu et al. 2018), India (Mahadevakumar et al. 2015), and Italy (Garibaldi et al. 2013); maize (*Zea mays*) in Pakistan (Yasmin et al. 1984); soy bean (*Glycine max*) in Nigeria (Akem and Dashiell 1991); potato (*S. tuberosum*) in Italy (Garibaldi et al. 2006); okra (*Abelmoschus esculentus*) in Cote d ˆ 'Ivoire (Kone et al. ´ 2010); and sesame (*Sesamum indicum* L.) in Mexico (Hernandez- ´ Morales et al. 2018). Studies have been carried out in Nigeria that shows susceptibility of okra to *Sclerotium rolfsii* and infestation can cause serious economic losses to farmers (Ekundayo et al, 2018).

Soil treatments with chemicals are often less sufficient and there is the need to reduce their usage because of adverse effects on the environment. Biological control through the use of antagonistic microorganisms has become very relevant in recent years. This alternative has the advantage of being specific and without risks to the environment. Fungal species of the genus *Trichoderma* have been investigated as biological control agents for more than 70 years. These species are free-living, ubiquitous fungi that interact in the roots, soil and leaf environment, which act as biological control agents and whose antagonistic properties are based on the activation of very diverse mechanisms. Not so much work has been done in this area of research particularly on such an important crop and pathogen that are already gaining attention in the study area.

MATERIALS AND METHODS

Isolation of the fungal pathogen and the biocontrol agents

The pathogen, *Sclerotium rolfsii* was isolated from infected Okra plant samples by tissue segment method on potato dextrose agar (PDA) medium amended with chloramphenicol (100 mg/L). The fungus was then purified by single hyphal tip method and maintained on potato dextrose agar (PDA) slants at room temperature (28 ± 2°C) until needed. The colony morphology, number of sclerotia, mycelial compatibility grouping and pathogenicity was performed. The isolate was consistently isolated from all the symptomatic plant samples. The fungal colony showed characteristic dense, aerial, fluffy, whitish, cottony mycelia with globoid sclerotia after 12–15 days of inoculation.

The biocontrol agent, ***Trichoderma viride*** and ***T. harzianu****m* cultures were obtained from the rhizosphere soil samples collected from the Teaching and Research Farm Field. Two *Trichoderma* species viz., *Trichoderma viride* and *Trichoderma harzianum* were isolated by soil dilution technique (Johnson and Curl, 1972) on *Trichoderma* specific medium. The colonies were identified by comparing with standard taxonomic key for *Trichoderma* identification (Rifai, 1969). The isolates were purified by single spore isolation method and maintained on potato dextrose agar (PDA) slants. The cultures were stored in the refrigerator at 4°C.

Preparation of inoculum

The pathogen was multiplied on sorghum grain for the pot culture experiment by filling 500ml capacity Erlenmeyer flask with 300 g of sorghum grain, moistened and plugged with aluminium foil wrapped cotton wool. The flask was sterilized in an autoclave at a pressure of 1.4 kg/cm^{-2} for 15 minutes. A 5mm-mycelia disc from the periphery of a 7-day-old culture of *S. rolfsii* was then inoculated onto the grains. The flask was then incubated at room temperature for 12-15 days before use.

Five millimeter mycelia disc from five-day-old pure culture of each *Trichoderma* isolates was transferred into 100 ml conical flask containing Potato Dextrose Broth (PDB) and incubated in the dark at 25 ± 2 0C until the entire liquid surface was covered with the hyphal mat. Fifty gram of the freshly harvested hyphal mat of each fungus was measured into 500 ml of sterile water and the mixture was blended with warring blender to produce the inoculum suspension.

Source of Okra seeds

The seeds of Okra variety NHAR 47-4 used for this study was obtained from Premier seed store by Ministry of Agriculture Ilorin Kwara State, Nigeria. The variety is one of the commonly grown in Ilorin and the neighborhood.

Collection and sterilization of soil

Sandy loam soil was collected from the teaching and research farm (TARF) and transported to the screen house the same day. Sterilization of the soil was done using steam heat method. Sterile soil was dispensed, after cooling, into 5 L plastic pots at the rate of 3 kg per pot. Each pot was punctured at the base to allow for easy drainage of excess water.

Setup of pot experiment to determine the effect of biocontrol agents on stem rot disease

Pot culture experiments were conducted in the screen house of the Department of Crop Protection Faculty of Agriculture University of Ilorin, Nigeria to study the influence of antagonists on stem rot disease incidence. Plastic pots of 5 litre capacity and 20 cm-diameter were filled with 3 kg of the prepared sterile soil. After two days, spore/mycelia suspension of the *Trichoderma* isolates was delivered at the rate of 5ml/kg of soil. The pathogen inoculum was applied one week later at the rate of 5g/kg of soil. Three seeds of the okra variety used were sown in each pot after one day of inoculation. Five pot replicates were maintained per treatment. The following treatments were included in the experiment. i) *T. harzianum*, ii) *T. viridae*, iii) *T. harzianum* + *T. viridae*, iv) Mancozeb; and v) pathogen inoculated only (control). The experiment was in form of a completely randomized design (CRD). Light watering was followed after planting which was done in the morning. An alternate day watering was done when there was enough moisture in the soil. Disease symptoms after inoculation were determined by visual observation. Per cent disease incidence was calculated using the formula: Disease incidence (%) = 100 X No. of infected plant /Total no. of observed plants. Disease severity was determined using the modified Shokes et al, (1996) rating scale of 1-5. Plant height, number of leaves, stem diameter were also recorded. Plant height was taken with thread and later measured using meter rule. Number of leaves was counted directly while stem diameter was measured using a venire caliper.

Table 1: Disease severity class and description

Disease Severity Index	Proportion of plant parts affected
1	Healthy (Plant not infected)
2	Lesion on stem only
3	Up to 25% of the plant symptomatic (wilt or dying)
4	26 – 50% of the plant symptomatic
5	>50% of the plant symptomatic

Data Analysis

The data generated was subjected to analysis of variance using R software version 4.12 and the treatment means were separated using the least significant difference (LSD) at 5% level of significance.

RESULTS

The results of the experiment on the response of inoculated and uninoculated potted okra plant to treatments with *T. harzianum* and *T. viridae* is presented in tables 2, 3 and 4. Generally, the treatments had significant effect ($p<0.05$) on the plant height throughout the duration of the experiment. There was significant difference ($p<0.05$) in the number of leaves only at 4WAP. Significant difference was also recorded for the stem diameter at 2, 5 & 6 WAP.

Table 2: Plant height

Treatments	2WAP	3WAP	4WAP	5WAP	6WAP
Trichoderma harzianum	3.267a±0.31	6.233b±0.25	10.200b±0.53	16.367bc±0.32	22.333ab±1.53
Trichoderma viridae	3.033ab±0.15	6.000b±0.20	9.700b±0.26	14.933c±0.90	20.167ab±0.76
T. harzianum + T. viridae	3.367a±0.31	6.467b±0.06	10.667b±0.50	17.333ab±0.58	23.400ab±1.04
Mancozeb	3.667a±0.31	7.233a±0.25	14.000a±1.00	19.067a±1.36	28.000a±2.00
Control	2.433a±0.25	4.433c±0.21	6.333c±0.42	11.667d±0.90	13.700b±7.88

Values are means of five replicates ± standard deviation
Mean values followed by the same letter(s) are not significantly different at 5% by LSD
WAP=Weeks after planting

Table 3: Number of leaves

Treatments	2WAP	3WAP	4WAP	5WAP	6WAP
Trichoderma harzianum	3.333a±0.58	4.667a±0.58	5.000a±0.00	5.667a±0.58	6.000a±1.00
Trichoderma viridae	3.000a±0.00	4.333a±0.58	4.667ab±0.58	5.000a±0.00	5.667a±0.58
T. harzianum + T. viridae	3.667a±0.58	4.333a±0.58	5.000a±0.00	5.333a±0.58	5.667a±0.58
Mancozeb	2.667a±0.58	4.333a±0.58	4.667ab±0.58	5.000a±0.00	5.333a±0.58
Control	2.667a±0.58	4.000a±0.00	4.000b±0.00	4.667a±0.58	5.333a±0.58

Values are means of five replicates ± standard deviation
Mean values followed by the same letter(s) are not significantly different at 5% by LSD
WAP=Weeks after planting

Table 4: Stem diameter

Treatments	2WAP	3WAP	4WAP	5WAP	6WAP
Trichoderma harzianum	1.467a±0.15	1.833a±0.15	2.367a±0.32	3.133ab±0.40	4.200ab±0.52
Trichoderma viridae	1.233ab±0.06	1.667a±0.15	2.233a±0.06	2.667b±0.15	3.100c±0.10
T. harzianum + T. viridae	1.467a±0.06	2.000a±0.20	2.733a±0.31	3.500a±0.30	4.700a±0.20
Mancozeb	1.367ab±0.12	1.800a±0.20	2.633a±0.06	3.200ab±0.20	3.733bc±0.12
Control	1.133b±0.12	1.633a±0.15	2.267a±0.12	2.733b±0.12	3.367c±0.15

Values are means of five replicates ± standard deviation
Mean values followed by the same letter(s) are not significantly different at 5% by LSD
WAP=Weeks after planting

Disease incidence and severity

Percentage disease incidence in treated samples differ significantly ($p<0.05$) from the control. Mean percentage disease incidence for *T. harzianum*, *T. viridae* and *T. harzianum + T. viridae* was 16.667, 33.333 and 16.667 respectively. Even though these mean values appear to be different in magnitude, they were statistically similar. Mancozeb treated samples were not affected by the pathogen (Table 5). There was no significant difference in the disease severity index values ($p>0.05$) in all the treatments compared to the control (Table 5).

Table 5: Disease incidence

Treatments	Disease incidence (%)	Disease severity index
Trichoderma harzianum	16.667ab±28.87	1.333a±0.58
Trichoderma viridae	33.333ab±28.87	1.667a±0.58
T. harzianum + T. viridae	16.667ab±28.87	1.333a±0.58
Mancozeb	0.000b±0.00	1.000a±0.00
Control	83.333a±28.87	4.333a±0.58

Values are means of five replicates ± standard deviation
Mean values followed by the same letter(s) are not significantly different at 5% by LSD

DISCUSSION

Sclerotium rolfsii (Sacc.) is a highly destructive soil-borne fungal pathogen of worldwide significance. It has a wide host range of more than 500 species of plants (Susleendra & Schlosser 1999). This has made its management through the use of fungicides a difficult task. The negative implications associated with the use of synthetic chemicals has made the search for alternative control measures a priority in the recent times. Biological control has been proved to be a promising disease management technology especially against soil-borne plant pathogens.

This study also demonstrate the bio-control property of *T. harzianum* and *T. viridae* against *Sclerotium rolfsii.* in line with the findings of many researchers (Yaqian Li et al; 2016; Chen J et al, 2021; Mohamed Taha Yassin et al, 2022) who reported antagonism of *Trichoderma* spp. against many plant pathogens. The finding of John et al, (2010), that reported T. *viride* as an efficient biocontrol agent for soybean root rot disease caused by fungal pathogens, *Fusarium oxysporum* f. sp. *adzuki* and *Pythium arrhenomanes* was attributed to the ability of *Trichoderma* sp. to parasitize these two pathogenic agents that were killed after 120 h of incubation on dual culture assay. The mechanism of action employed by *Trichoderma* spp. include antibiosis, mycoparasitism, competition for nutrients and space, promotion of plant growth, induced plant defense mechanism and modification of environmental conditions (Druzhinina et al, 2011). At first, they are able to detect plant pathogens through chemotropism and this is followed by complicated biochemical process leading to secretion of hydrolytic enzymes (chitinases and glucanases) which breaks down components that build up fungal cell walls (Qualhato et al, 2013). In his own study, Zhou et al, (2014) revealed that *Trichoderm*a spp. produce koninginins to inhibit the growth of pathogenic microorganisms. This report is supported by Hu et al. (2017) who found koninginins molecules produced by *Trichoderma* spp. which inhibit the growth of phytopathogens; *Fusarium flocciferum* and *Fusarium oxysporum*.

Findings have shown that the components that build up fungal cell walls were hydrolyzed by hydrolytic enzymes (chitinases and glucanases) secreted by *Trichoderma* spp. and this is immediately followed by lysis of the pathogen's cell wall (Lorito et al, 2010) through hyphal penetration by appresorial formation, production of cell wall-degrading enzymes and peptaibols mediated by heterotrimeric G-proteins and mitogen-activated protein kinases and parasitizing pathogen's cell wall content (Druzhinina et al, 2011; Mukherjee et al, 2012).

This study also showed that the *Trichoderma* spp. tested enhanced growth and development and improved tolerance of the treated okra plants to *Sclerotium rolfsii* inoculum. *Trichoderma* spp. have been described as plant symbiont opportunistic avirulent organisms that are able to colonize plant roots by mechanisms similar to those of mycorrhizal fungi and to produce compounds that stimulate growth and plant defense mechanisms (Harman et al. 2004). The root colonization allows the root to explore a bigger region of soil. This enables the plant to uptake more macronutrients and micronutrients in the soil that give advantages to the plant when encountered with other organisms to compete for the minerals or when minerals are depleted (Contreras-Cornejo et al. 2016). These mechanisms could actually have resulted to the improved growth observed in the okra plants and the tolerance shown against infection by *Sclerotium rolfsii*.

CONCLUSION

Farmers still depend on the use of chemical fungicides to control fungal plant diseases. These synthetic chemicals however, have hazardous effects on both the environment and human as well as animal health. The quest for alternative method of control has led to the studies on bio-control agents to replace the chemical fungicides. In this study, *Trichoderma harzianum* and *Trichoderma viridae* have been seen to promote the growth of okra and reduced the incidence of southern blight disease of okra. These findings can be useful to develop locally customized and innovative disease control approach to manage the disease in okra plant. The efficacy of these bio-control agents can be improved by the adoption of refined isolation techniques, use of adaptable formulation and application procedures for field crops in order to meet the growing demand for the food item.

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INFLUENCE OF ORGANIC FOLIAR SPRAY RATES ON THE GROWTH, FRUIT YIELD AND NUTRITIONAL QUALITY OF TOMATO *(Lycopersicom esculentum) VARIETIES*

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ABSTRACT
Foliar fertilizer is a chemical or natural substance applied directly onto a plant leaves to improve its health and increase fertility. Therefore, this research was carried out to determine the ***influence of foliar fertilizer rate on the growth, fruit yield and nutritional quality of tomato v****arieties. The experiment was conducted at the experimental site of the Department of Crop Production and Soil Science, Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria. The treatments consisted of Agrolyser Micronutrient Fertilizer (AMF) sprayed at 5 different rates (0, 25, 50, 75, and 100kg/ha) and three (3) varieties (Royal bold, Tina, and Larisa). The 3x5 factorial experiments were fitted into randomized complete block design (RCBD) with three replications. Data collected on growth parameters (number of leaves and plant height) fruit yield and nutrient content were subjected to analysis of variance and means separated using least significant difference at 5% probability level. The results showed that application of foliar fertilizers significantly ($p \leq 0.05$) influenced the growth and yield of tomato compared to control treatment. AMF at 75 kg/ha produced the highest number of leaves, plant height, number of fruits per plant, weight of fruits per plant and fruit yield (kg/ha). The varietal effect significantly influenced the growth, yield and nutritional quality attributes of Tomato. Tina variety gave the highest growth parameters and fruit yield with and without foliar fertilizer applied, although the values obtained was not significantly different from those recorded for Royal bold. Mineral nutrients content of tomato were significantly affected by application of AMF fertilizer rates. AMF at 75 kg/ha has been found as an alternative to recommended level of chemical fertilizer in ensuring optimum performance in terms of fruit yield and nutritional quality of tomato varieties in Ogbomoso. The mineral contenets and nutritional values significantly affected by the variety with Royal bold recording the highest values while Tina recorded the least value. It is therefore recommended that the farmers in Ogbomoso agro-ecological zone could make use of Royal Bold as the best performing variety at 75kg/ha foliar fertilizer application rate.*

INTRODUCTION

Tomato (*Lycopersicom esculentum* L) is a widely grown vegetable in the world because it is recognized as a rich source of vitamins and minerals. Consumption of tomato can prevent several diseases (Willcox *et al*., 2003) because it has anti-oxidants like carotene, phenolic compounds and ascorbic acid (Periago *et al*., 2009). Availability of tomato and other crops at all times cannot be attained without availability of essential plant nutrients (Chen, 2006; Ali *et al*., 2008). Therefore, plant nutrients become essential components of sustainable agriculture. In the same vein, the essential nutrients must be readily available in sufficient and balanced quantities for optimum plant growth and yield. Nevertheless, suitable and balanced combinations of macro and micro nutrients should be considered not only for essentiality of crop growth and yield but also for friendliness of our environment (Chen, 2006). Tomato can be grown in a variety of geographical zones in open fields or greenhouses, and the fruit can be harvested by manual or mechanical means. Under certain conditions (e.g. rejuvenation, pruning, weeding, irrigation, frost protection), this crop plant can be perennial or semi-perennial, but commercially it is considered an annual (Geisenberg and Stewart, 1986).The commercially important tomato fruit can vary in color, size and shape (Vaughan and Geissler, 1997). The fruit contains a large quantity of water, vitamins and minerals, low amounts of proteins and fats, and some carbohydrates. It also contains carotenes, such as lycopene (which gives the fruit its predominantly red color) and *beta*-Carotene(which gives the fruit its orange color). Modern tomato cultivars produce fruits that contain up to 3% sugar of fresh fruit weight. It also contains tomatine, alkaloid withfungicidal properties. The concentration of tomatine decreases as the fruit matures and tomatine concentration contributes to determining the taxonomy of the species.

Ahamad and Jabeen (2005) indicated that foliar nutrition generally increases the grain yield as well as decreases the amount of fertilizers which applied as soil application. Ali *et al.* (2005) reported that foliar spray increased the metabolic activity of plant. Girma *et al*. (2007) found that foliar application is a visible economic way to increase nutrients uptake. Fageria *et al.* (2009) also reported that crops respond to soil applied fertilizers in five to six days, while the response is faster (48 hours) in foliar application. Foliar application increase nutrients uptake at critical growth stages and resulted in enhanced physiological activity leading to increase yield (Kundu and Sarkar, 2009). Nutrient uptake via the foliage may be much faster as compared to soil nutrition (Lester *et al.,* 2006). Foliar nutrient applications can very quickly correct physiological disorders caused by nutrient deficiencies, as well as help to overcome various stress conditions (Franke , 1986). (Fernández and Eichert 2009) noted that one of the traditional applications of foliar application is to correct nutritional deficiencies in plants. The aims of this study are to determine the best tomato variety and appropriate organic foliar spray rate for the cultivation of tomato in the study area.

MATERIAL AND METHOD

The experiment was conducted at the experimental site of the Department of Crop Production and Soil Science, Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria. Ogbomoso lies on latitude 8^{0}10N, longitude 4^{0}10E and about 382 sea levels. It is located in the Guinea Savanna Zone of South west Nigeria. The temperature of the site ranged from 28^{0} - 32^{0}C with high humidity of about 74% all year round except in January when the dry wind blows from the north. Rainfall distribution is bio-modal and extends for eight to nine month of the year (Olaniyi, 2006).

The 3 varieties of tomato seeds used (Tina, Royal Bold and Larisa) were obtained from Irorun Agbe, Farmer’s center, Ogbomoso, Oyo state. These were planted on the nursery beds. Agrolyser Micronutrient Fertilizer (AMF) was used for higher yield and longer storability on all crops. The land was manually cleared, packing of debris, using of hoe to raise the bed for the sowing of the seeds. Palm frond was used as mulching materials in protecting the seed and seedlings from excess sunlight and predators. The seedlings were raised in the nursery, watered to avoid wilting and transplanted to the permanent site at 4 WAP at a spacing of 50cm y 50cm per bed.

Forty-five (45) beds were manually made. The experimental area was divided into three replicates, with each replicate having 15beds. These were arranged in a factorial experiment and fitted into Randomized Complete Block design with three replications. The bed size is of 1.2m by 1.2m each with the spacing of 50cm within and 100cm between the replicate. Agrolyser Micronutrient Fertilizer (AMF) was applied at different rate of 0, 25, 50, 75, and 100kg/ha on each block by spraying, at flower initiation.

All the plots of the experimental site were subjected to similar activities which includes weeding, staking and transplanting. Transplanting of three varieties of tomato seedlings were carried out onto the field at four weeks after sowing into the nursery. Weedings were done manually, two weeks interval to avoid retarded growth, competition of weeds and to prevent wide spread of diseases to the tomato plant. Staking was done at 6 WAT to help keep plant off the ground while assisting in their upward growth habit.

Data collection commences two weeks after transplanting (WAT) and repeated every two weeks till the tenth week. At each sampling time, data were collected on growth parameters (number of leaves and plant height) and the yield and yield components.

The Number of leaves was counted at each sampling period and recorded. The Plant height (cm) was determined as the distance between the soil surfaces to the tip of the plant while number of Tomatoes

fruits was collected on each plot per plant stand for the tagged plant. The Weight of fruit/plot (g/plot) was obtained by weighing the tomatoes with the sensitive weighing balance (g) per plot. The length and the diameter of the tomato at harvesting were obtained with the use of vernier caliper and recorded. Harvesting of tomato fruit began 8 weeks after transplanting at physiological maturity. The harvested fruits were taken to the laboratory for analysis for the determination of mineral nutrients and proximate contents of Tomato fruits.
Statistical analysis of data collected was carried out using analysis of variance (ANOVA) and mean separated using least significant difference at 5% probability level.

RESULTS

Number of leaves

The number of leaves of tomato increased as the sampling occasions increases with the highest values recorded at 8WAT (Table 1). The variety and application of foliar spray significantly influenced ($p \leq 0.05$) the number of leaves of tomato plants at all sampling occasions. The highest number of leaves (21.00) was recorded at 75Kg/ha of organic foliar spray while the least (17.83) value was obtained for control at 8WAT. Tina variety (21.80) closely followed by Royal bold (18.57) recorded the highest number of leaves while Larisa variety gave the least (16.88) value at 8WAT.
The organic spray rate and variety interaction effect also significantly ($p \leq 0.05$) affected the number of leaves of tomato plants at all sampling occasions. The highest number of leaves was obtained for all the varieties at 75Kg/ha of organic foliar spray with the highest values recorded for Tina and 75Kg/ha organic foliar spray treatment combinations but with no significant difference from that of Royal bold and 75Kg/ha combined treatment effects.

Table 1: Number of leaves of Tomato varieties as affected by fertilizer rate

		Number of leaves			
		Weeks After Transplanting			
	Treatments	2	4	6	8
	Fertilizer rate:				
	0	3.97	6.64	10.61	17.83
	25	4.19	6.81	11.81	18.86
	50	4.25	6.61	10.28	18.64
	75	4.58	7.39	12.61	21.00
	100	4.33	6.44	11.75	19.08
	LSD (0.05)	0.75	1.24	2.71	6.50
	Variety				
	Larisa	4.12	6.20	10.70	16.88
	Royal bold	4.40	7.03	11.83	18.57
	Tina	4.28	7.10	11.70	21.80
	LSD (0.05)	0.58	1.00	2.10	5.00
Fertilizer x Variety					
0	Larisa	3.83	6.25	10.08	13.50
25	Larisa	4.17	6.25	9.83	17.00
50	Larisa	4.08	6.08	9.00	16.58
75	Larisa	4.42	6.92	11.17	19.25
100	Larisa	4.08	5.50	13.42	18.08
0	Royal bold	4.17	7.08	11.17	17.75
25	Royal bold	4.33	7.50	12.75	18.33

50	Royal bold	4.33	7.00	10.75	18.17
75	Royal bold	4.58	7.58	13.50	19.50
100	Royal bold	4.58	6.00	11.00	19.08
0	Tina	3.92	6.58	10.58	21.17
25	Tina	4.08	6.67	12.83	21.25
50	Tina	4.33	6.75	11.08	22.25
75	Tina	4.75	7.67	13.17	24.25
100	Tina	4.33	7.83	10.83	20.08
LSD (0.05)		1.30	2.14	4.70	11.20

Table 2: Plant height of Tomato varieties as affected fertilizer rate

		Plant Height (cm)			
		Weeks after transplanting			
	Treatments	2	4	6	8
Fertilizer rate:					
0		3.53	5.41	9.87	16.95
	25	3.73	6.19	10.76	18.51
	50	3.95	5.89	11.45	17.71
	75	4.07	6.40	11.95	20.21
	100	3.95	5.57	11.70	20.49
	LSD (0.05)	0.97	1.60	2.77	3.50
	Variety:				
	Larisa	3.64	5.39	10.33	19.08
	Royal bold	4.23	5.89	11.19	16.39
	Tina	3.67	6.39	11.91	20.84
	LSD (0.05)	0.75	1.24	2.15	2.71
Fertilizer x Variety:					
0	Larisa	3.19	4.65	9.13	16.04
25	Larisa	3.41	5.36	8.98	18.86
50	Larisa	4.09	5.50	10.30	16.42
75	Larisa	3.67	5.79	12.31	20.58
100	Larisa	3.83	5.65	10.94	23.50
0	Royal bold	4.23	5.90	10.46	15.59
25	Royal bold	4.43	6.17	10.67	16.42
50	Royal bold	3.95	6.20	10.97	16.71
75	Royal bold	4.51	6.34	11.63	16.79
100	Royal bold	4.03	4.86	12.25	16.46
0	Tina	3.19	5.68	10.00	19.21
25	Tina	3.35	7.04	12.63	20.25
50	Tina	3.81	5.98	13.08	20.00
75	Tina	4.03	7.07	11.92	23.25
100	Tina	3.99	6.20	11.92	21.50
LSD (0.05)		1.68	2.77	4.80	6.07

Plant Height

The results of the plant height of tomato is presented in the (Table 2). 75kg/ha application rate recorded the highest plant height while control gave the lowest plant height across all the weeks. There were significant variations in plant height among the treatments. The plant height was at maximum in Royal bold and minimum in Larisa. The interaction of fertilizer rates and varieties significantly increased plant height compared to control, 100kg/ha with Larisa recorded the longest height while Royal Bold at control recorded the least for all the sampling periods.

Number of Flowers and Fruits

The results of Number of flowers and fruits in this study are presented in Table 3. The highest number of flower was found in 75kg/ha application rate, while control, 25Kgha and 50Kg/ha recorded the least value. Tina variety recorded the highest number of flower and fruit while Royal Bold gave the least value. 75kg/ha foliar application with Tina variety produced the highest number of flowers and fruits while Larisa with 25kg/ha recorded the least value.

Fruit Weight, Length and diameter

Weight of fruits, length and diameter is presented in Table 4. Tina gave the highest fruit weight and length while Royal Bold gave the highest fruit diameter. Larisa at 100kg/ha produced the highest number of fruit weight and 25kg/ha gave the least. For fruit length, 100kg/ha gave the highest while 0Kg/ha and 25kg/ha recorded the least value, for fruit diameter 75kg/ha gave the highest value and control the lowest. Royal Bold at 100kg/ha gave the highest fruit weight and control recorded the least value. For fruit length, 75kg/ha gave the highest value, for fruit diameter, 75kg/ha gave the highest and 100kg/ha the lowest. Interactive effect of foliar fertilizer significantly increased the number of fruits weight, length and diameter. At 75kg/ha, Tina recorded the highest value and the lowest 50kg/ha. For fruit weight, 75kg/ha recorded the highest number of fruit length and control gave the least. 75kg/ha recorded the highest value followed by 100kg/ha and the lowest 0kg/ha for fruit diameter.

Table 3: Numbers of flowers and fruits of Tomato varieties as affected fertilizer rate

Treatments		Number of flowers	Number of fruits
Fertilizer rate:			
0		11.22	8.70
25		11.22	10.30
50		11.22	12.10
75		16.39	16.70
100		15.81	14.60
LSD (0.05)		5.11	7.79
	Variety:		
	Larisa	12.30	11.70
	Royal bold	11.38	10.90
	Tina	15.83	14.90
	LSD (0.05)	4.00	6.03
Fertilizer x Variety:			
0	Larisa	9.33	5.70
25	Larisa	8.00	5.70
50	Larisa	10.25	10.30
75	Larisa	15.92	17.30
100	Larisa	18.00	19.30
0	Royal bold	8.58	9.00
25	Royal bold	11.17	11.30
50	Royal bold	11.33	11.30
75	Royal bold	11.67	13.00
100	Royal bold	14.17	9.70
0	Tina	15.75	11.30
25	Tina	14.50	14.00
50	Tina	12.08	14.70
75	Tina	21.58	19.70
100	Tina	15.25	14.70
LSD (0.05)		8.85	13.49

Table 4: Mineral content of Tomato varieties as affected fertilizer rate

Mineral Contents (%)

	Treatments	K	Mg	P	Na	Fe	Zn	Ca
	Fertilizer rate:							
0		232.53	0.58	4.91	0.33	0.45	0.44	5.87
	25	238.83	0.64	5.45	0.33	0.50	0.50	6.54
	50	242.27	0.66	6.25	0.37	0.54	0.54	6.70
	75	231.63	0.72	6.89	0.37	0.57	0.60	6.85
	100	238.89	0.79	7.02	0.38	0.58	0.63	6.92
	LSD (0.05)	0.03	0.02	0.13	0.026	0.02	0.02	0.02
	Variety:							
	Larisa	245.56	0.61	6.42	0.36	0.55	0.55	6.66
	Royal bold	243.60	0.59	6.35	0.37	0.56	0.56	6.66
	Tina	221.34	0.83	5.54	0.34	0.48	0.52	6.40
	LSD (0.05)	0.02	0.02	0.10	0.02	0.02	0.02	0.02
Fertilizer x Variety:								
0	Larisa	243.40	0.50	4.96	0.34	0.48	0.45	5.98
25	Larisa	250.40	0.56	5.46	0.33	0.52	0.50	6.80
50	Larisa	252.60	0.61	6.60	0.40	0.56	0.54	6.70
75	Larisa	234.70	0.66	7.48	0.38	0.60	0.62	6.91
100	Larisa	246.68	0.74	7.61	0.37	0.60	0.64	6.90
0	Royal bold	241.60	0.51	4.98	0.34	0.48	0.46	5.90
25	Royal bold	248.70	0.54	5.40	0.37	0.54	0.50	6.88
50	Royal bold	251.80	0.50	6.40	0.38	0.57	0.56	6.80
75	Royal bold	232.40	0.66	7.40	0.36	0.58	0.62	6.80
100	Royal bold	243.50	0.74	7.56	0.38	0.61	0.64	6.94
0	Tina	212.60	0.74	4.80	0.30	0.40	0.40	5.72
25	Tina	217.40	0.81	5.48	0.30	0.44	0.50	5.94
50	Tina	222.40	0.86	5.74	0.34	0.50	0.52	6.60
75	Tina	227.80	0.84	5.80	0.38	0.54	0.57	6.84
100	Tina	226.50	0.88	5.90	0.40	0.54	0.60	6.91
LSD (0.05)		0.05	0.03	0.23	0.04	0.04	0.04	0.04

The mineral nutrient content of tomato is shown in Table 6. At 50kg/ha, K recorded the highest while Mg, P, Na, Fe, Zn, Ca does at 100kg/ha with the least value at control. Larisa gave the highest value for K and P while Tina gave the least. For Mg, Tina gave the highest while Royal Bold gave the lowest. For Na, Fe, Zn, Ca, Royal Bold gave the highest while Tina gave the lowest. Application of foliar fertilizer rates with varieties significantly influenced all the mineral tested except P. 50Kg/ha on Larisa and Royal Bold gave the highest value except for Tina which recorded highest K content at 75kg/ha while control gave the least. For Mg and P content, 100kg/ha on Larisa, Royal Bold and Tina produced the highest value. For Na on Larisa, 50kg/ha gave the highest, 100kg/ha for Fe, Zn, Ca and Fe. On Royal Bold, 50kg/ha gave the highest for Na, 100kg/ha for Fe, Zn, Ca. And lastly on Tina, 100kg/ha gave the highest value of Na, Fe, Zn, and Ca contents.

DISCUSSION

This experiment was set up in order to investigate the influence of foliar fertilizer application of AMF (Agrolyser Micronutrient Fertilizer) on varieties of tomato namely royal bold, Tina, Larisa. The product has a good effect on the plant height and increase in the fruit yield as they had been treated compared to the control level. However, as the experiment is ongoing, there is one known disadvantage about the foliar fertilizer applied to the plant, which is leaf burn. There are signs of visible burns on the leaves after spraying on the leaf area, but not too much as the plant is maturing, and there is no other effect noticed. The results of current experiment showed a significant initial increase in plant height, number of leaves and fruit yield, but at the later stages of the experiment plants were significantly taller, numerous leaves, and the fruit size was increased in (Table 1, 2, 3). Foliar fertilizer rate at 75kg/ha increased the values of the three varieties used in the study. This foliar fertilizer application used reduced protein contents, but increase the mineral and the photochemical contents which could be because of the level of treatments used. Foliar spraying on plant increases the plant growth, especially during fruit set and development, which appears to improve the fruit nutritional quality.

CONCLUSION AND RECOMMENDATION

The result of this studies showed that the treatment used were significantly different for growth parameters and nutritional components. The variety Tina followed by Royal Bold at 75kg/ha gave the highest values in terms of growth, fruit yield and nutritional attributes, while variety Larisa recorded the least values. It is therefore recommended that the farmers in Ogbomoso agro-ecological zone can make use of Royal Bold as the best varieties, with 75kg/ha foliar fertilizer rate, since they both gave the highest values at 75kg/ha rate in the parameters considered.

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GROWTH AND YIELD OF BALSAM (*Impatiens balsamina*) IN RESPONSE TO COMPOST APPLICATION RATES

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ABSTRACT
In a landscape, balsam is an ideal choice for beddings due to its beautiful and colourful petals. The experiment was conducted at the Student's Field School Project, Ladoke Akintola University of Technology, Ogbomoso (Latitude 8° 10′ N; Longitude 4° 16′ E; 321 m above sea level) between May and October, 2020, to determine the growth and flowering response of Impatiens balsamina (balsam) to compost rates (0, 5, and 10 t/ha). The experiment was laid out in a completely randomized design with six replicates. Data were collected on plant height, number of leaves, stem girth, number of flowers, flower yield, pod weight, seed weight and percentage seed to pod weight. Data collected were subjected to analysis of variance (ANOVA) using GENSTAT 12th edition, and significant mean separation was done using least significant difference (LSD) at 5% probability level (Wahua, 1999). The results of the experiment showed that application of 5 t/ha compost to hybrid balsam increased plant height and flower yield more than other treatments. Furthermore, balsam that received 5 and 10 t/ha produced higher number of leaves, wider stem, more pod and seed weight than 0 t/ha compost. In conclusion, application of compost significantly improved growth and flowering of Hybrid Balsam. 5 t/ha of compost is optimum for balsam production.
Keywords: *balsam, organic fertilizer, compost*

INTRODUCTION

Organic fertilizers are sustained sources of nutrients due to slow release during decomposition. They enhance the natural soil processes, which have a long-term effect on soil fertility (Rajeev, 2012). Organic fertilizers are rich in nutrients mainly derived from animal manure and crop straws, which are agricultural waste. Commonly used organic fertilizers include compost, composted animal manure and food processing wastes. (Ojo *et al*., 2021). It has been demonstrated that use of organic inputs such as compost, crop residues and manures have great potential for improving soil productivity and plant yield through improvement of the soil as well as nutrient supply (Dauda *et al*., 2008). Compost is useful as soil amendment that provide stable carbon as well as slow-release nutrients which in turn can lead to soil quality improvement, better crop performance, fewer undesirable environmental impacts (WSU, 2021).

Impatiens balsamina commonly called Balsam, belong to the family of Balsaminaceae (Ojo *et al*., 2021). It is an annual plant growing to 20 - 75 cm tall, with a thick, but soft stem. The leaves are spirally-arranged, 2.5-5 cm long and 1-2.5 cm broad, with a deeply toothed margin and 2.5 - 5 cm diameter. Balsam is pollinated by bees, other insects and by nectar-feeding birds. *Impatiens balsamina* is widely cultivated as an ornamental for it attractive flowers, the flowers are pink, red, mauve, lilac, or white. It is used for ornamental purposes such as bedding and pot plant. It has medicinal purposes e.g anti- cancer (Annabelle *et al*., 2013). It is an ornamental plant (Gardeners, 2017) which is ideal for containers, hanging baskets, and beds. Balsam has high nectar production which attracts most insect pollinators, especially bees (Greenwood *et al*., 2017). Its green seed pods, seeds, young leaves and shoot are edible (Balogh, 2008). The flowers can turn into a jam or a parfait. The oil from the seeds can be used as ailment and it is good for lamp oil. It is also used for nail and skin painting (Ojo *et al*. 2021)

Compost improves soil fertility, soil texture and provides nutrients to crop. However, the use of compost among flower growers is low compare to the use of synthetic fertilizer. Hence, the study of this experiment was to provide information that will support the production of Balsam with respect to compost. The objective of the study was to determine the growth and flowering response of *Impatiens balsamina* to different compost rates.

MATERIALS AND METHODS

Pot experiment was conducted between May and October, 2020 at Student Field School, Ladoke Akintola University of Technology, Ogbomoso, Oyo State (Latitude 8° 10´ N; Longitude 4° 16´ E; 321 m above sea level) and is located within Southern Guinea - Savannah agro-ecological zone of Nigeria with two distinct bimodal seasons. Soil samples were collected for physical and chemical analysis (Table 1). Compost was derived from poultry manure, wild sunflower (*Tithonia diversifolia*) and woodash mixed in the ratio 3:3:1 (v/v/v) respectively. The compost was turned and watered weekly for 6 months. Nutrient analysis of compost was also done (Table 1). Prior to the land preparation, soil samples were sifted by a 2-mm sieve. Seeds were sown in a seedling tray using drilling method at 2 mm depth, 2 cm spacing at inter-row and 1 cm intra-row were used. The trays were kept under a natural shade of *Psidium guajava* tree. Seedlings emerged 3 days after sowing. The seedling pots were draped over with net to avoid insect pest attack. Perforated 5 kg pots were filled with well mixed sifted soil sample and a well cured Tithonia based compost at the rate equivalent to 0 t/ha (no manure), 5 t/ha (11.16 g) and 10 t/ha (22.32 g). Transplanting was done three weeks after sowing at one seedling/pot. The pots were arranged in a completely randomized design with six replicates. Factor considered was compost at the rate of 0, 5 and 10 t/ha. Data collection began a week after transplanting (WAT) at a week interval for 8 weeks. Data were collected on plant height, number of leaves, stem girth, number of flowers, flower yield, pod weight, seed weight, percentage of seed to pod weight. Data collected were subjected to analysis of variance (ANOVA) and correlation using GENSTAT 12th edition (commercial version) while significant mean separation was done using Least significant difference (LSD) at 5% level of probability.

RESULTS

Growth parameter

The plant height of balsam was affected by the application of compost. At 5, 7 and 8 WAT, plant height of Balsam was highest with the application of 5 t/ha compost, followed by 10 t/ha and the shortest was recorded for balsam with no fertilizer (Figure 1). From 3 to 8 WAT, balsam treated with 5 and 10 t/ha compost produced highest number leaves than control. However, there was no significant difference in the production of leaves from balsam treated with 5 and 10 t/ha compost (Figure 2). In Table 2, stem girth of balsam was significantly affected by the application of compost. From 5 to 8 WAT, balsam applied with 5 and 10 t/ha had widest stem when compared with balsam with no compost.

Reproductive parameter

Number of flowers was higher in balsam that received 5 and 10 t/ha compost when compared with control (Figure 3). Flower yield and pod weight of balsam was highest with the application of 5 t/ha compost, followed by 10 t/ha and the least was recorded for balsam with no compost (Figures 4 and 5). Conversely, seed weight per plant was higher in balsam treated with 5 and 10 t/ha compost when compared with no compost (Figure 6). The percentage of seeds extracted from pods of balsam treated with 5 and 10 t/ha compost was higher (7.4 and 8.3 % respectively) than no compost (3.2%) - Figure 7. The growth parameter measured had positive and significant correlation with reproductive parameters (Table 3). Number of leaves had positive and significant correlation with total number of flowers, flower and seed weight. This shows that growth parameters had direct and significant relationship with reproductive parameters.

DISCUSSION

Plant response to compost treatment is highly dependent on the source, composition and the quantities of compost utilized (Grigatti *et al*., 2007). It was observed that plant height, number of leaves and stem girth were enhanced in balsam treated with compost. This is similar with the findings of Ojo *et al*. (2021) on marigold response to compost application. The plants growth showed better performance where compost quantity was maximum, which was in accordance with the studies of Babajide *et al*., (2008) and Akanbi *et al*., (2007) which stated that plant growth increased with increase in rate of compost.

Adequate nutrient availability ensures improved crop growth and yield performances. The relationship between growth parameters and yield was significant and positive showing that yield parameter is dependent on growth performances. (Ojo *et al*., 2023). This study indicated that compost improved the flowering, pods and seeds weight of balsam than untreated balsam due to decomposition of organic materials that would provide additional nutrients to the growing medium, which may lead to higher uptake of nutrients by the crop and subsequently high yield (Shaheen *et al*., 2007, Skokalu *et al*. 2017).

CONCLUSION AND RECOMMENDATION

The study concluded that compost application to Balsam is necessary. 5 t/ha compost application is optimal for balsam growth and flowering. Application of 5 t/ha compost is recommended for balsam production.

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Table 1: Composition of the soil and compost used in the experiments

Textural Class	Soil	Compost
Exchangeable bases (cmol/kg)		
Calcium	0.63	0.57
Magnesium	0.88	1.47
Potassium	0.65	3.52
Chemical properties		
pH	8.24	10.08
Avalaible Phosphorus (mg/kg)	0.99	1293.96
Organic C (%)	0.77	6.68
Total Nitrogen (%)	0.09	0.38
Particle size distribution		
Clay (%)	5.80	
Silt (%)	4.60	
Sand (%)	89.60	
Textural class	Sandy clay	

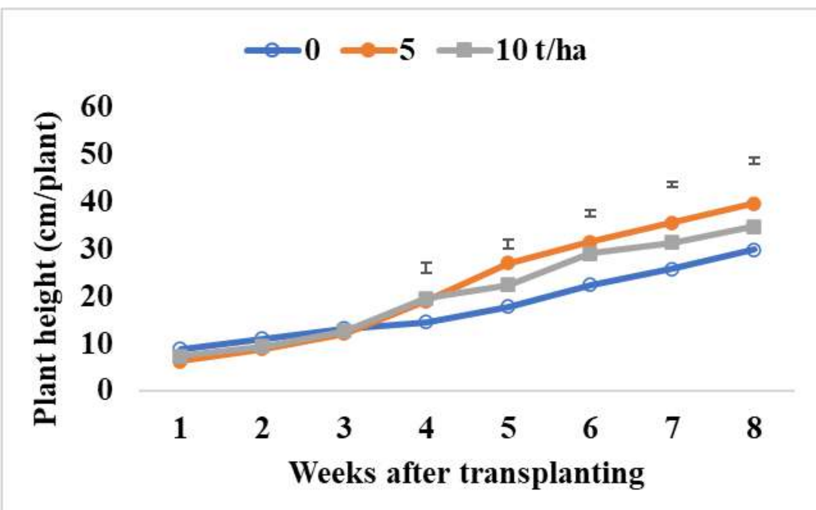

Figure 1: Plant height of hybrid balsam as affected by compost rate
Vertical bars are LSD at $p \leq 0.05$

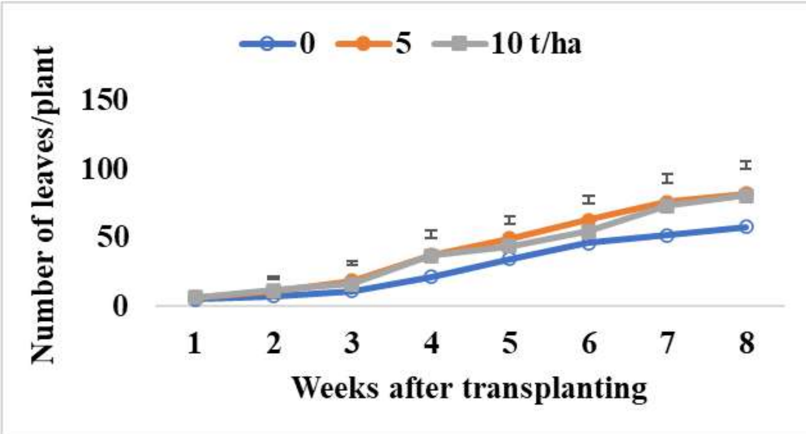

Figure 2: Number of leaves of hybrid balsam as affected by compost rate
Vertical bars are LSD at $p \leq 0.05$

Table 2: Stem girth of hybrid balsam as affected by compost rate

	Weeks after transplanting						
Compost rate (t/ha)	2	3	4	5	6	7	8
0	1.27	1.83	2.10	2.66	2.93	3.27	3.53
5	1.40	1.97	2.67	3.86	4.17	4.41	4.74
10	1.39	1.93	2.77	3.29	3.92	4.14	4.52
LSD ($p \leq 0.05$)	0.35	0.35	0.40	0.42	0.44	0.40	0.33

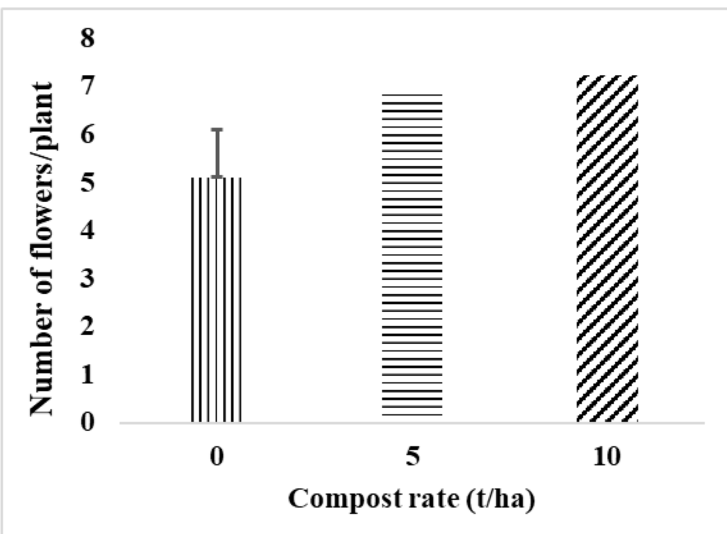

Figure 3: Number of flowers of hybrid balsam as affected by compost rate
Vertical bar is LSD at $p \leq 0.05$

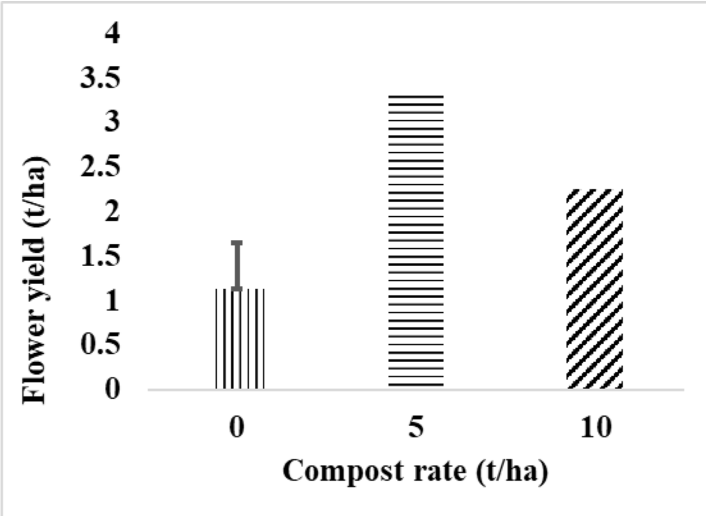

Figure 4: Flower yield of hybrid balsam as affected by compost rate
Vertical bar is LSD at $p \leq 0.05$

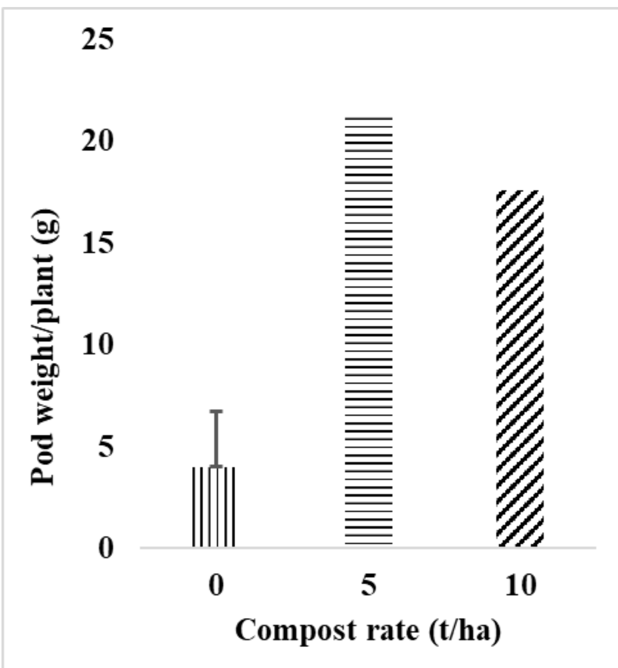

Figure 5: Pod weight of hybrid balsam as affected by compost rate
Vertical bar is LSD at $p \leq 0.05$

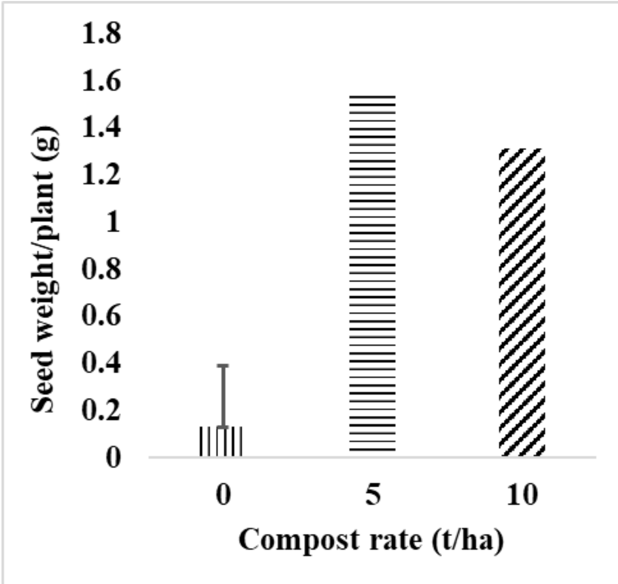

Figure 6: Seed weight of hybrid balsam as affected by compost rate
Vertical bar is LSD at $p \leq 0.05$

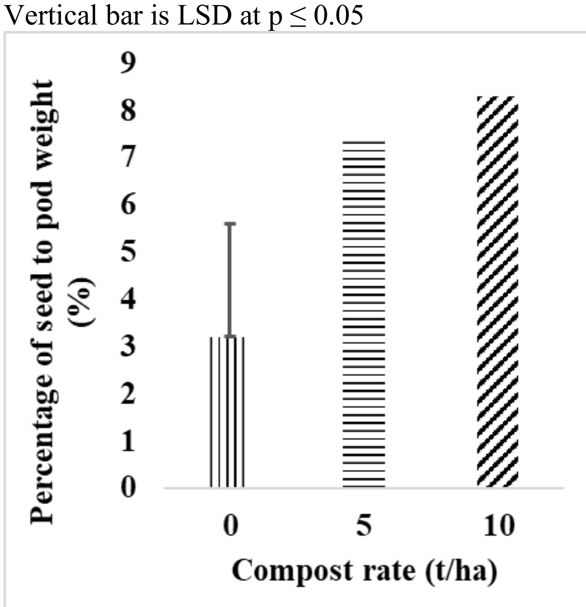

Figure 7: Percentage of seed to pod weight of hybrid balsam as affected by compost rate
Vertical bar is LSD at $p \leq 0.05$

Table 3: Correlation between growth and yield parameters of hybrid balsam (n = 48)

	Number of leaves	Total number of flowers	Seed weight
Total number of flowers	0.5474**	-	
Seed weight	0.5791**	0.7723**	-
Flower weight	0.5474**	1*	0.7723**

LEAF AREA INDEX AND DRY MATTER YIELD OF *Panicum maximum* AS AFFECTED BY RATES OF BIOCHAR/GOAT MANURE APPLICATION AND HARVEST STAGE IN THE SAHEL SAVANNAH ZONE OF NIGERIA.

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ABSTRACT
The study investigated the effect of varying rates of biochar and goat manure mixture and cutting stages on the leaf area index and dry matter yield of Panicum maximum in the Sahel Savannah region of Nigeria. The experiment was laid in RCBD with three main plots; 3t/ha (1.5 t/ha biochar + 1.5 t/ha goat manure), 6t/ha (3t/ha biochar + 3t/ha goat manure) and 9t/ha(4.5t/ha biochar + 4.5t/ha goat manure) and three subplots (6, 8, and 10 weeks after planting). The result showed that the varying rates of biochar/goat manure had a significant effect on the LAI but not on the DMY. The cutting stages had significant effect on the LAI and DMY. It was concluded that Panicum maximum cultivated with 9t/ha biochar/manure mixture and harvested at 10WAP produced the closest canopy and optimum dry matter yield. It was therefore recommended that farmers in this part of Nigeria should cultivate Paicum maximum using combination of biochar/goat manure at 9t/ha for higher LAI and DMY which is an indication of forage productivity.
Keywords: *biochar, goat manure, harvest stage, panicum, dry matter*

INTRODUCTION

Paucity of feed is a major challenge facing livestock productivity in Nigeria (Babayemi, 2006) as feed accounts for as feed accounts for 70-75% of the total cost of production. The Sahel Savannah region of Nigeria is known for high livestock population in Nigeria (FAO 2017). This higher livestock population is threatened by several factors such as low pasture productivity as a result aftermath effect of climate change, farmers/herders clash, armed banditry amongst other menace (Aruwayo *et al*., 2021). Tropical soils are characterized by low nutrient status which results in production of forage with poor nutrient value (Aregheore, 2002). Biochar and goat manure are organic soil amendments that have been shown to improve soil fertility and crop productivity (Andre et al., 2020). Though there is a paucity of information on the use of biochar and goat manure mixture on forage grass productivity, previous studies have shown that the combined application of biochar and inorganic fertilizer significantly affected phenological variables and agronomical parameters (Buli et al., 2022). Additionally, the effect of biochar on soil with varying doses of nitrogen fertilizer has been studied, and different nitrogen fertilizer application rates have been found to affect agro-physiological performance and productivity of maize (Gudade *et al*., 2022). A review on the effects of biochar on soil fertility and crop productivity suggests that biochar has the potential to improve the productivity of arid regions by increasing the water holding capacity and reducing infiltration rate (Andre *et al*., 2020). Furthermore, goat manure treatments have been shown to significantly increase the yield of grasses, the rate of application and type of manure have also been found to affect the forage dry matter yield of *Panicum maximum* (Dele *et al*., 2017). The results of this study will provide valuable information on the potential of biochar and goat manure mixture application and harvest stages on the LAI and DMY of *Panicum maximum* in the Sahel Savannah region of Nigeria.

MATERIALS AND METHODS

Experimental site

The experiment was conducted at the experimental field of the Prof Lawal Abdu Saulawa Livestock Teaching and Research Farm, Federal University Dutsin-Ma, Katsina State, Nigeria. Located on Latitude $11^0$9'45"N, and Longitude 07 ^{0} 38' E, at an Altitude of 610m above the sea level, along Kankara road is characterized by a defined wet and dry season. Wet season starts from early June to late September while the dry season is from September to June. The total annual rainfall ranges from 1110-1580mm with a long term average of 1058.60mm. Maximum air temperature of 28.25^0C were recorded in September and minimum air temperature of 23.35^0 C in September with relative humidity of approximately 68% during the rainy season (MSGRPF, 2023).

Soil Samples of Experimental Site

Soil samples was collected for nutrient analysis from the experimental site with the aid of Soil auger at four corners and center of the plots at 0-30cm depth to make a composite for soil analysis at the beginning of experiment so as to ascertain the level of nutrient in the soil as well as determining the nutrient requirement. The soil sample was analyzed for physical and chemical properties as described by A.E.S (1998). The analysis was carried out at the chemical laboratory of the Department of Soil Science, Faculty of Agriculture, Ahmadu Bello University, Zaria. The soil, at 0-15cm consist of 28% clay, 26% silt and 46% sand which is classified as being loamy soil. The soil is slightly acidic with pH (6.36) and of moderate Organic carbon (0.58%). The total nitrogen (0.18%) and available phosphorus (4.53ppm) were low. The exchangeable cations, Ca^{2+}, Mg^{2+}, K^+ were low to moderate in the soil while Na^+ was of moderate status.

Land Preparation and Experimental Design

A gross land area measuring 9m×9m was used for the trial. The land was cleared and seed beds were prepared to meet a better condition for early establishment of seedlings. The experiment was laid out in a randomized complete block design (RCBD) with 3x3 factorial arrangements, replicated three times. 3 levels of biochar/goat manure (3, 6 and 9 t/ha) were the main plot factors and 3 cutting stages (6, 8 and 10 WAP) were the sub-plot factors. Forage samples cut at each stage of harvest was bulked, and sub-samples analyzed for proximate composition. The analysis was carried out at the Chemical Laboratory, Department of Animal Science, Ahmadu Bello University Zaria.

Biochar/goat manure preparation and application.

Commercial biochar made from tree was purchased from the seller in Dutsin-Ma market. The biochar was made into powder form by pounding, using motar and pestle, Water was sprinkled to reduce dusting. Digital weighing scale was used to measure the biochar before application. Goat manure was sourced from the goat unit of the Professor Lawal Abdu Saulawa Livestock Teaching and Research Farm, Federal University Dutsin-Ma. The biochar and goat manure mixture were applied at the rate of 1:1 with Treatment 1 (3t/ha), Treatment 2 (6t/ha) and Treatment 3 (9t/ha). Each treatment was replicated three times making a total of nine (9) sub-plots. Biochar and goat manure mixture were applied to the experimental plots, incorporated into the soil using hoes three (3) weeks before transplanting, and allowed to rest for proper mineralization. Seed of *Panicum maximum* was sourced from the Seed Store of the National Animal Production Research Institute (NAPRI), Shika, Zaria. The seed was treated against insect attack using insecticide (Apron plus) at 5g/kg before planted in the nursery, where they were raised to seedling before being transplanted to the experimental field at three weeks after nursery establishment at a spacing of 50 x 20cm inter-row and intra- row space respectively, Weeds were kept under control throughout the experimental period.

Chemical Composition of goat manure

Goat manure was analyzed for its chemical composition in order to determine the nutrient content. The result showed that the manure contained 3.95% total nitrogen (N), 0.85% phosphorus (P). 24045.73mg/kg 4900.10mg/kg potassium (K) and micro minerals with 2892.5mg/kg iron (Fe), 217.5mg/kg manganese (Mn), 63.00% copper (Cu), and 350.00% zinc (Zn). This result indicates that goat manure is relatively nutrient loaded and is one of the organic manure of animal origin that can be used for soil amendment.

Sample Collection and Preparation

Samples of *Brachiaria ruziziensis* harvested at 6, 8 and 10WAP were oven dried, milled and subjected to laboratory proximate analysis according to the procedure of (AOAC 2006). The analysis was conducted at the biochemical laboratory, Department of Animal Science, Ahmadu Bello University Zaria.

Statistical analysis

All data collected were subjected to two-way analysis of variance (ANOVA) using general linear model (GLM) procedure of SAS (2005). Significant (P<0.05) different between treatment means were compared using Duncan Multiple Range Test, (Duncan 1995) of SAS package.

Table 1: Effect of biochar/goat manure mixture and stages of cutting on the Leaf Area Index and Dry Matter Yield of *Panicum maximum*

BC/GM	LAI	DMY
9	3.85[a]	8.78
6	2.84[b]	8.51
3	2.96[b]	7.61
SEM	0.46	1.62
Stages of cutting		
10	5.34[a]	16.27[a]
8	2.71[b]	6.40[b]
6	1.59[c]	2.23[c]
SEM	0.46	1.62

[abc]Means with different superscripts along the columns differ significantly (P<0.05). BC= Biochar, GM= Goat Manure, SEM= Standard Error of the Mean

Leaf Area Index (LAI) is an important factor in the dry matter accumulation and yield of *Panicum maximum*, it is the ratio of the total leaf area to the ground area covered (Jonathan et al 2017). In this study, the LAI was higher (P<0.05) in grass fertilized with 9t/ha biochar/goat manure and harvested at 10WAP this implies that the LAI increased as the rate of manure application increased and the harvest stage advanced. This could be as a result of essential nutrient present in the combination with adequate moisture, thereby increasing the root absorption, net assimilation rate (NAR), relative growth rate (RGR), maximum light interception increased LAI, high rate of photosynthesis and dry matter accumulation as the plant pass through the growth stages (Gomez, *et al*., 2012). The DMY observed in this study as affected by manure rate is lower than what was reported by (Dele, 2018). This variation could be as a result of different ecological zone or the inherent soil fertility of the experimental areas. The result of the DMY as affected by the rate of biochar/goat manure application was not (P>0.05) significant but the DMY at 9t/ha was 15% higher when compared with the 3t/ha application rate. However, the stage of harvest had a significant (P<0.05) effect on the DMY with the 10WAP producing the highest (16t/ha) DMY. This could be as a result of higher LAI index at this stage, as it has been established that the relationship between the LAI and DMY is directly proportional (Shuaibu *et al* 2018). This is within the range of DMY/ha reported by (Akinola, 2018, Jimoh, 2019, and Idowu, 2021) during separate studies on the DMY of *Panicum maximum.*

CONCLUSION

It was concluded that application of biochar/goat manure at 9t/ha and harvested at 10WAP produced forage with high productivity in terms of LAI and DMY. It was therefore recommended that livestock farmers in the Sahel Savannah region of Nigeria cultivate Panicum maximum using biochar/goat manure at the rate of 9t/ha and harvest at 10 WAP for a higher LAI and DMY for enhanced livestock productivity.

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IN VITRO EFFICACY OF FUNGI ISOLATED FROM BIO-ENRICHED COMPOSTED COW DUNG AGAINST *Fusarium oxysporum* f. sp. *lycopersici* (Sacc.) Snyder & Hansen

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ABSTRACT

In vitro experiments were conducted to evaluate the efficacy of three compost fungi (Trichoderma sp., Aspergillus niger and Aspergillus flavus) isolated from bio-enriched composted cow dung against Fusarium oxysporum f. sp. lycopersici. The experiment was laid out in a completely randomized design, consisting of five treatments, replicated five times. The treatments consisted of Fusarium oxysporum f. sp. lycopersici (Fol) + Trichoderma sp.), Fol + Aspergillus niger), Fol + Aspergillus flavus), Fol + fungicide (Contap Plus®) and Fol only (control). Data on radial growth (RG) and percent growth inhibition (GI) of the five treatments were measured at 3, 5 and 7 days after inoculation and subjected to analysis of variance, and treatment means were separated using LSD at P≤0.01. Trichoderma sp. significantly exhibited lower RG at 3 5and 7 DAI (1.22cm; 2.28cm; 2.32cm) than Aspergillus flavus and Aspergillus niger. Highest growth inhibition (GI) was recorded on Trichoderma-amended plates, where 31.1%, 32.3% and 39.4% were recorded at 3, 5 and 7 DAI, respectively. This was followed by Aspergillus flavus and Aspergillus niger, respectively. Least GI was found were Fusarium oxysporum f. sp. lycopersici was cultured alone as control treatment. Fusarium oxysporum f. sp. lycopersici is effectively suppressed by Trichoderma spp. isolated from bio-enriched composted cow dung and could be subjected to screenhouse and field studies to further ascertain its efficacy in managing tomato wilt caused by Fusarium oxysporum f. sp. lycopersici.

Keywords: *Aspergillus sp., Fusarium oxysporum f. sp. lycopersici, percent growth inhibition, radial growth, Trichoderma sp.*

INTRODUCTION

Tomato wilt caused by *Fusarium oxysporum* f. sp. *lycopersici* is a soil-inhabiting fungus. It is one of the most important diseases highly destructive both in greenhouse and field on tomato in many warm regions of the world (Thanh *et al*., 2009). It causes 10-50 % yield loss (Adebayo and Ekpo, 2004), and up to 80% loss in severe cases (Malhotra and Vashistha 1993). The occurrence of the disease on tomato in Nigeria was first reported in Kaduna (Adebayo and Ekpo, 2007). The disease is endemic in the savannah areas of Nigeria (Erinle, 1981). The pathogen can survive long periods in soil through the formation of certain resistant structures (Blum and Rodriquez-kabana, 2004), thus making management difficult.

Resistant cultivars had been the most effective and economical means of controlling Fusarium wilt of tomato (Adebayo and Ekpo, 2004). However, the occurrence and development of new pathogenic races often caused breakdown of resistance in the introduced resistant varieties within a few years of its commercialization. Several measures including the use of resistant varieties Attitalla *et al*., 2001), cultural practices pesticides (Song *et al*., 2004) had been attempted to control Fusarium, but losses are still substantial (Khaleed *et al*., 2007). There are no commercially acceptable cultivars with adequate resistance to all races of Fusarium wilt pathogen (Attitalla *et al*., 2001). The use of pesticides in the control of Fusarium wilt of tomato is not encouraged due to high cost of pesticides and environmental implications arising from its usage (Nwanguma *et al*., 1999). This necessitated the search for other eco-friendly options.

MATERIALS AND METHOD

The experiment was laid out in a complete randomize design (CRD) to determine the effect of fungi isolated from cow dung-based compost on radial growth and inhibition of *Fol* the incitant of Fusarium wilt of tomato. It consisted of five treatments: *Fusarium oxysporum* f sp. *lycopersici* (*Fol*) + *Trichoderma* sp. (T1), *Fol* + *Aspergillus flavus* (T2), *Fol* + *Aspergillus niger* (T3), *Fol* + CONTAP PLUS® (T4) and control (T5). All treatments were replicated five times. The experiment was conducted at Plant Pathology Laboratory of the Department of Crop Protection, Bayero University Kano. The bioassay started from June and lasted to August, 2018. The objective of the experiment was

Isolation and Purification of the test pathogen

Fusarium oxysporum f.sp. *lycopersici* was isolated from diseased tomato plant. Disease samples were rinsed in sterile distilled water three times and blot dried and plated on Petri dish containing potato dextrose agar (PDA) amended with Chloramphenicol and incubated at 25^0C for 7days. The fungus was sub cultured and was incubated at 38 ± 2°C for 10 days to ensure development of macro and micro conidia. The hyphal tip showing reddish purple colour and pinkish white mycelium was taken using sterilized needle. The colony was then sub-cultured to obtain pure cultures following the procedures of Booth (1977). The pure culture was then grown on PDA slants and preserved at room temperature (38 ± 2°C) as stock culture.

Isolation of Fungi from Bio-enriched Cow dung and Preparation of Bio-enriched Cow dung Extract

Three fungi (*Trichoderma, Aspergillus niger, A. flavus*) isolated from Composted cow dung were obtained from the Pathology Lab of the Department of Crop Protection, Bayero University Kano. Bio-enriched cow dung extract was prepared according to the procedures described by Weltzien (1991). One liter of water was added to 500g of the vermicompost and was kept in a 5L plastic bucket. The mixture was stirred for 5-10 minutes every day using stirring rod and allowed to ferment for seven days to enhance disease suppression as described by Hmouni *et al*. (2006). The compost extract was then filtered with two layers of Muslin cheese cloth to remove large particles and used as bio-enriched cow dung extract for the laboratory bioassay.

***In vitro* Bioassay of the Fungi isolated from Bio-enriched Compost**

Dual culture bioassay was used to determine the effects of the compost fungi on radial growth and percent inhibition of a fourteen day-old culture of *Fusarium oxysporum* f sp. *lycopersici*. A 6mm plug of the young culture of test pathogen and antagonistic fungi were placed 3 cm apart near the edge on the surface of PDA medium for each antagonist and test pathogen. The activities of the compost fungi against *Fol* were studied on the Petri dishes incubated at room temperature ±38°C under continuous light. Data on radial growth and growth inhibition were assessed on the 3, 5 and 7 days after inoculation. The measurement of the radial growth of the pathogen was done using a Vernier caliper in the morning at 9.00 O'clock. The average of the measurements was used to calculate the percent inhibition rate according to the formula used by Rini and Sulochana, (2007) as Follows: PGI = [(C- T) /C] X 100. Where PGI= Percent growth inhibition C= Radial growth of the pathogen in control plates (cm), T= Radial growth of the pathogen in treated plates (cm). Data collected were statistically analysed using GenStat Release 7.2 DE (PC/Windows XP) Copyright 2007, Lawes Agricultural Trust (Rothamsted Experimental Station) and treatment means were separated using LSD at 5% level of significance.

Efficacy of fungi isolated from bio-enriched cow dung on radial growth of *Fusarium oxysporum* f. sp *lycopersici*

Table 1 shows the effect of three fungi isolated from bio-enriched cow dung at 3, 5 and 7 days after inoculation. Least radial growth of the pathogen was recorded on plates containing *Fol* + CONTAP PLUS than the other treatments. The average radial growth (RG) of the pathogen at the three inoculation periods were 0.20, 0.40 and 0.56 cm at 3, 5 and 7 DAT, respectively. At 3 DAI *Fol* + *Trichoderma* sp. (1.22cm) significantly exhibited lower RG than *Fol* + *Aspergillus flavus* (1.46cm) and *Fol* + *Aspergillus* niger (1.50cm) which showed statistically similar radial growth. *Fusarium oxysporum* f. sp. *lycopersici* culture alone recorded longer RG (1.77 cm) compared to the other treatment. Similar observation was made at 5 and 7 DAI, where *Fol* + *Trichoderma* sp. had the least RG of 2.28 cm and 2.32 cm, respectively.

Efficacy of fungi isolated from bio-enriched cow dung on percent growth inhibition of *Fusarium oxysporum* f. sp. *lycopersici*

Effect of compost fungi on growth inhibition is presented in Table 2. There were significant differences between the treatments at 3, 5 and 7 DAI. Contap Plus (Fungicide) recorded highest percentage inhibition compared to the other treatments. Among the compost fungi, highest growth inhibition (GI) was recorded on *Trichorderma*-amended plates, where 31.1%, 32.3% and 39.4% were recorded at 3, 5 and 7 DAI, respectively. This was followed by *Aspergillus flavus* and *Aspergillus niger*, respectively. Least GI was found were Fusarium *oxysporum* f. sp. *lycopersici* was cultured alone as control treatment.

DISCUSSION

This experiment showed that *Trichoderma* spp has antagonistic effect against *Fol* and therefor inhibited the growth of the test pathogen. Several researchers have reported the ability of *Trichoderma* spp. to suppress the growth of soilborne phyto-pathogenic fungi, especially *Fol* (*Chen et al*., 2021; Debbi et *al*., 2018; Nashwa *et al*., 2019; Taghdi *et al*., 2015). Mycoparasites has been widely used as antagonistic fungal agents (Elad and Chet, 1983). Several *Trichoderma* species are considered to be stoutly antagonistic to other phytopathogenic fungi. Their different mechanism of parasitism to other phytopathogenic fungi occurs by various mechanisms such as competition, antibiosis, mycoparasitism, induced resistance and inactivation of pathogen's enzyme (Benitez *et al.,* 2004).

CONCLUSION AND RECOMMENDATION

Fusarum oxysporum f. sp. *lycopersici* is effectively suppressed by *Trichoderma* spp. isolated from bio-enriched composted cow dung and could be subjected to screenhouse and field studies to further ascertain its efficacy in managing tomato wilt caused by *Fusarium oxysporum* f. sp. *lycopersici*.

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Table 1: Effect of fungi isolated from bio-enriched cow dung on radial growth of *Fusarium oxysporum* f. sp. *lycopersici*

Treatment	Days after inoculation (DAI)		
	3	5	7
Fol + *Trichoderma sp*	1.22	2.28	2.32
Fol +*Aspergillus flavus*	1.50	2.56	2.83
Fol + *Aspergillus niger*	1.46	2.45	2.65
Fol + CONTAF PLUS	0.20	0.40	0.56
Fol	1.77	3.37	3.83
LSD (P<0.05)	0.212	0.334	0.336

Fusarium oxysporum f. sp. *lycopersici*, CONTAF PLUS = Hexaconazole 5%SC

Table 2: Effect of fungi isolated from bio-enriched cow dung on percent growth inhibition of *Fusarium oxysporum* f. sp. *lycopersici*

Treatment	Days after inoculation (DAI)		
	3	5	7
Fol + *Trichoderma sp*	31.1	32.3	39.4
Fol +*Aspergillus flavus*	15.8	24.2	26.1
Fol + *Aspergillus niger*	17.5	27.3	30.8
Fol + CONTAF PLUS	88.7	88.1	85.2
Fol	0	0	0
LSD (P<0.05)	1.82	1.39	1.28

Fusarium oxysporum f. sp. *lycopersici*, CONTAF PLUS = Hexaconazole 5%S

EVALUATION OF SAWDUST USED AS SOIL AMENDMENT ON THE PERFORMANCE OF GROUNDNUT (*Arachis hypogaea* L.)

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ABSTRACT

In this study, the effect of rates of sawdust (0g, 80g, 120g and 160g) on soil chemical properties and the performance of Groundnut (Arachis hypogaea L.) was investigated for a period of 15 weeks. The experiment was laid in a Randomized Complete Block Design (RCBD) and replicated 3 times. 48 polybags of sandy topsoil were prepared and 0g (control), 80g, 120g and 160g of sawdust were incorporated into the 10kg soil contained in each of the polythene bags. Then, 3 groundnut seeds were sown on the same day and the seedlings were thinned to one exactly 2 weeks after planting (2WAP), while data were collected weekly on parameters such as germination percentage, plant height, number of leaves, leaf area, number of pods, number of seeds, weight of pods and weight of seeds. Data collected were subjected to analysis of variance (ANOVA) using personal computer software packages SPSS version 20.1. Significant treatment means were compared using the Duncan multiple range test ((DMRT)) at $P \leq 0.05$. Results showed that increasing rates of sawdust increased the germination percentage and plant height of groundnut except at 6WAP. Leaf area increased from $8.918mm^2$ to $9.477mm^2$ at 120g, number of leaves was not significantly ($P \leq 0.05$) increased, number of seeds increased from 19 at 0g to 21 at 160g of sawdust application, seed weight increased from 20.0g at control to 22.3g at 160g but the number of pod and weight of pod was not significantly ($P \leq 0.05$) increased when compared to control. The sawdust rates (80g, 120g and 160g) incorporated in the soil significantly decreased the soil pH range but still within a pH range of 6 and 7, required for groundnut cultivation. It also decreased the available phosphorus and potassium content in the soil which resulted in the reduced number of pods and weight of pods of the groundnut plant. In conclusion, sawdust as a soil amendment significantly increased the number of seed and weight of the groundnut seed but did not significantly increase the number of pods and weight of pods of the groundnut plant.

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) or peanut as it is sometimes referred to is grown in a commercial scale in the Northern region of Nigeria. Nigeria is the 4th highest producer of groundnut in the world and groundnut is the 13th most important food crop and 4th source of edible oil and protein in the world according to Food and Agricultural Organization (FAO,1994). Groundnut is useful to humans and animals as food. A 100 grams of raw peanuts is estimated to contain: 567 Calories, 25.8g Protein, 49.2g Fat (Saturated - 6.28g, Monounsaturated - 24.43g, Polyunsaturated - 15.56g), 16.1g Carbohydrate, 4.7g Sugar, 8.5g Fiber and 7% Water (Toppo, 2021). It is useful in farm practices to help replenish nutrients in the soil due to its ability as a leguminous plant to fix atmospheric nitrogen in soil (Brady, 2017). Sawdust is a waste material generated from the timber industry and is composed of fine wood particles. It is a common and affordable organic material that lay waste in several sawmills, dumpsites, and parts of Nigeria (Owoyemi *et al.,*2016). Hence, the need for its usefulness and ability to influence plant growth should be investigated to determine to what extent it imparts the soil and improves the vegetative growth of crops and crop yield.

Sawdust contains 40% lignin and 60% cellulose with a little bit of waxes, resins and oils mixed in. It is low in nutrient density, only containing 0.048% nitrogen (N), 0.007 % phosphorus (P), 0.017% potassium (K) and 0.106% calcium (Ca) which varies depending on the wood the sawdust comes from. Also, the physical properties of sawdust such as water content (10.8%), apparent gravity (0.14%), porosity (84%), water retention capacity (50%), are favourable factors that improve soil properties for plant growth and development (Terazawa *et al*.,1999). Donald (1969) reported a decrease in nitrogen in soils mixed or mulched with sawdust.

Sawdust decomposition depends on the complete hydrolysis of lignin and cellulose by ligninase and cellulase, respectively (Ververis et al., 2007). Sawdust is converted to biofertilizers by composting, which ties up nitrogen for 180 days in soil (Olayinka & Adebayo, 1989). It is a non-degradable organic waste because of its low nitrogen content and high lignin and cellulose content. Studies have shown that sawdust does break down into humus, creates soil structure, increases aeration (porosity and permeability), increases a soil's water-holding capacity, and increases microbial activity after it has broken down. This depends on many factors and may take months to years. Some microorganisms, especially Actinobacteria, effectively decompose sawdust with nitrogen supplementation (Eriksson et al., 1990, Ting et al., 2014).

Soil microbial population was observed to have increased by incorporating sawdust with the soil (White et al., 1959). Researchers have reported the favourable effect that organic growing media (sawdust and Coir) have on plant growth (Maboko *et al;*2003, Tzortzakis and Economakis, 2008), as it increased the porosity and water retention of the growing medium (Hardgrave and Harrisman,1995; Marinou *et al;* 2013). Maboko *et al;*(2013) however reported that organic growing media (sawdust) did not have significant effect on tomato yield. Sawdust applied either as a mulch or mixed with the soil, decreased the nitrate content of the soil (White et al., 1959). The usage of sawdust as a plant growth medium in manufacturing industries is highly recommended due to the positive physical properties of the sawdust such as biodegradability at an acceptable rate, low superficial specific gravity, high porosity, high water retention, moderate drainage and high bacterial tolerance (Maharani *et al;*2010).

MATERIALS AND METHOD

Area of Study

The experiment was carried out in the Faculty of Agriculture, Teaching and Research Farm, Ignatius Ajuru University of Education (IAUE) Ndele campus, Rivers State, Nigeria (latitude 4^0 58' N and Longitude 6^0 48' E).

Sources of Samples and pot preparation.

The sawdust was collected from a Sawmill and a local variety of groundnut seeds was bought from a local market within the community. A digital weighing scale was used to measure the respective weight of the sawdust and applied to the soil in the polythene bag.

48 polybags of width 45cm and height of 27cm were perforated with 10 small holes each to allow easy drainage were made available for the pot. Sandy topsoil (0-15cm) was collected from the demonstration farm weighing 10kg and filled into the polybag up to the height of 25cm leaving a space from the top of about 2cm to allow for the application of water. This was replicated into three.

Experimental treatment design and field layout.

The experiment was laid in a Randomized Complete Block Design (RCBD) and replicated 3 times. The sawdust were measured into the polybag using a digital weighing machine at the rate of 0g, 80g, 120g and 160g. The 0g of sawdust polybag serves as control. On the same day, the polybags were prepared; sawdust treatment was applied and the groundnut seed was sown at 3 seeds per polybag in which the seedling was thinned to one after 14 days.

Collection and arrangement of Data

Data of the plant were collected from the field weekly from the date of planting. Data collected from the field include; Germination Percentage, Plant height, Number of leaves, Leaf area, Number of pod per plant, weight of pod per pot and weight of the groundnut per plant.

Soil samples were collected for laboratory analysis at planting (immediately after application of treatment) and at harvest (immediately after harvesting the plant).

Statistical analysis

The result was subjected to the analysis of variance (ANOVA) using a statistical software, SPSS 20.1 version. Significant treatment means was compared using Duncan multiple range test at P≤0.05.

RESULTS

Germination rate increased with increasing sawdust rate. Table 1 shows control at 87% while 80g, 120g and 160g sawdust rate resulted to 90%, 94% and 96% germination percentage respectively.

Table 1: Influence of sawdust rates on the germination of Groundnut.

Sawdust (g)	germination percentage
0	87%
80	90%
120	94%
160	96%

Increasing rate of Sawdust significantly at P≤0.05 increased the growth rate of the groundnut seedling when compared to the control as shown in table 2 except for week 6. At 3WAP growth increased from 15.21cm for control to 17.48cm for 120g sawdust rate. At 6WAP growth increased from 32.20cm for control to 30.28cm for 160g sawdust rate. At 9WAP growth rate increased from 41.53cm for control to 43.09cm for 10g sawdust rate. At 12WAP growth increased from 71.95cm at control to 77.13cm at 120g sawdust rate. At 15WAP growth increased from 83.28cm for control to 91.27cm for 160g sawdust rate.

Table2: Influence of sawdust rates on the Growth of Groundnut.

		Plant height week after planting			
Sawdust(g)	3WAP	6WAP	9WAP	12WAP	15WAP
0	15.21a	32.20d	41.53a	71.95a	83.28a
80	15.72b	31.72c	43.09d	68.84a	82.58a
120	17.48c	31.50b	42.98c	77.13b	89.88b
160	15.80b	30.28a	42.80b	76.03ab	91.27b
SE	0.047	0.020	0.037	1.505	0.710

Mean with different alphabets in same column are significantly different at P ≤ 0.05 using Duncan multiple range test. WAP=Weeks After Planting. SE=Standard Error.

Leaf area at 120g and 160g sawdust rate resulted to 9.477mm^2 and 9.200mm^2 respectively and exceeded leaf area of control of 8.918mm^2 significantly at P≤0.05 and 80g sawdust rate resulted to 8.558mm^2 leaf area which is below control.

The number of leaves was influenced by increasing sawdust rate which exceeded control;146.917 significantly (P≤0.05) at 120g;161.833 and non significantly at 160g; 147.333.

Table 3: Influence of sawdust rates on the number and area of leave of Groundnut at 8th weeks after planting respectively.

Sawdust(g)	Number of leaves	Leaf area(cm^2)
0	146.917b	8.918b
80	140.167a	8.558a
120	161.833c	9.477d
160	147.333b	9.200c
SE	0.875	0.012

Mean with different alphabets in same column are significantly different at P ≤ 0.05 using Duncan multiple range test, WAP=Weeks After Planting. SE=Standard Error.

Number of pod and pod weight were not significantly increased by sawdust as seen in table 4 while number of seed and seed weight were significantly (P≤0.05) increased by sawdust and exceeded control at 160g. Number of seed increased from 17.8 at 80g to 19.1 at 120g to 21.5 at 160g. Likewise Seed weight increased from 18.4g at 80g to 19.7g at 120g to 22.3g at 160g.

Table 4: Yield of groundnut response to sawdust rates.

	Groudnut Yield Parameters			
Sawdust(g)	Number of pod	Pod Weight	Number of seed	Seed weight
0	24.7c	51.3c	19.3b	20.0b
80	16.2a	43.5a	17.8a	18.4a
120	25.2c	44.7b	19.1b	19.7b
160	17.9b	50.6c	21.5c	22.3c
SE	0.320	0.276	0.331	0.336

Mean with different alphabets in same column are significantly different at P ≤ 0.05 using Duncan multiple range test. WAP=Weeks After Planting. SE=Standard Error.

Table 5: Influence of sawdust rates on the chemical property of the soil at Planting.

Sawdust	pH	%N	%O.M	Available P (Ppm)	K (Cmol/kg)	CEC (Cmol/kg)	EC (μ/cm)	%BS (g)
0	6.83b	0.184b	3.154b	15.386c	0.029b	7.380b	66.925c	97.180a
80	7.09c	0.215c	3.733c	13.055b	0.016a	7.891d	60.092b	97.643ab
120	6.64a	0.152a	2.267a	11.416a	0.030b	7.435c	58.692a	98.094b
160	6.84b	0.218c	3.742d	19.024d	0.028b	6.451a	88.758d	97.510ab
SE	0.007	0.005	0.001	0.375	0.001	0.002	0.058	0.270

Mean with different alphabets in same column are significantly different at P ≤ 0.05 using Duncan multiple range test. WAP=Weeks After Planting. SE=Standard Error. Available P= Available Phosphorus. CEC=Cation Exchange Capacity. EC=Bulk density. BS=Base saturation.

As observed in Table 5 at planting, pH was least at 120g; 6.64 but highest at 80g; 7.09 but at 160g; 6.84 it was not significantly different with Control 0g; 6.83. Total Nitrogen was least at 120g; 0.152%, but highest at 80g; 0.215% but not significantly different at 160g; 0.218% and that exceeded Control 0g; 0.184%. Organic matter was least at 120g; 2.267%, exceeded Control 0g; 3.154% at 80g; 3.733% and 160g; 3.742% . Available P was least at 120g; 11.416ppm, and exceeded Control 0g; 12.323ppm at 160g; 3.742ppm. Potassium was least at 80g; 0.008 Cmol/kg and exceeded Control 0g; 0.029 Cmol/kg at 120g; 0.030 Cmol/kg, and not significantly different at 160g; 0.028 Cmol/kg. Cation exchangecapacity (CEC) was least at 160g; 6.451Cmol/kg and highest at 80g; 7.891 Cmol/kg and still exceeded Control 0g; 7.380 Cmol/kg at 120g; 7.435 Cmol/kg. Bulk density (EC) was least at 120g; 58.692 μ/cm and exceeded Control 0g; 65.550 μ/cm at 160g; 58.575 μ/cm. Base saturation increased from 97.180% at control to 98.094% at 120g.

Table 6: Influence of sawdust rates on the chemical property of the soil at Harvest.

Sawdust	pH	%N	%O.M	Available P (Ppm)	K (Cmol/kg)	CEC (Cmol/kg)	EC(μ/cm)	%BS (g)
0	6.98c	0.202a	3.0199a	12.323b	0.023d	6.100b	65.550c	97.358b
80	7.11d	0.223a	3.990d	14.168d	0.008a	6.128b	51.128a	97.438b
120	6.18a	0.253a	3.521b	13.673c	0.012b	5.676a	67.675d	96.651a
160	6.96b	0.218a	3.663c	9.131a	0.014c	6.969c	58.575b	97.447b
SE	0.007	0.005	0.001	0.375	0.001	0.002	0.058	0.270

Mean with different alphabets in same column are significantly different at P ≤ 0.05 using Duncan multiple range test. WAP=Weeks After Planting. SE=Standard Error. Available P= Available Phosphorus. CEC=Cation Exchange Capacity. EC=Bulk density. BS=Base saturation.

At harvest as seen in Table 6, pH was least at 120g; 6.18 but exceeded Control 0g; 6.98 at 80g; 7.11. Application of sawdust did not significantly influence Total Nitrogen was least at 120g; 0.152%, but highest at 80g; 0.215% but at 160g; 0.218% and that exceeded Control 0g; 0.184%. Organic matter increased from 3.019% at Control to 3.990% at 80g, and still exceeded control at 120g; 3.521%, and 160g; 3.663% . Available P was least at 160g; 9.131ppm, highest at 80g; 14.168ppm, and still exceeded Control 0g; 15.386ppm at 120g; 13.673c ppm. Potassium increased with increasing rate of sawdust from 0.008Cmol/kg at 80g, (120g; 0.012Cmol/kg) to 0.014Cmol/kg at 160g but lower than Control 0g; 0.023 Cmol/kg. CEC was least at 120g; 5.676 Cmol/kg and exceeded Control 0g; 6.100Cmol/kg at 160g6.969 Cmol/kg which was not significantly different with 80g; 7.891 Cmol/kg. Bulk density exceeded Control 0g; 65.550μ/cm at 120g; 67.675 μ/cm but least at 80g; 51.128 μ/cm. Base saturation was least at 120g 80g; 96.651% but no significant difference at control 97.358% when compared to 80g; 97.438% and 160g; 97.447%.

DISCUSSION

From the results, the 80g sawdust incorporated in the soil increased pH significantly (P≤0.05) exceeding control but decreased pH at 120g and 160g. Agbim and Adeoye, 1994 have reported that organic wastes incorporated into the soils are capable of increasing the soil pH because they contain exchangeable cations. The Nitrogen was not significantly influenced by sawdust. Although, White et al., (1959) reported that sawdust applied either as a mulch or mixed with the soil decreased the nitrate content of the soil. Whereas Eneje and Ukwuoma, (2005) attributed this to nitrogen immobilization by the sawdust. The sawdust increased the organic matter content of the soil significantly (P≤0.05). Eneje and Ezeakolam, (2009) also reported soil organic matter significantly increased with the application of sawdust as a soil amendment. The Available phosphorus was decreased with increasing Sawdust at harvest but increased with increasing sawdust at planting. This can be attributed to the increased use of available P in soil by the groundnut plant for nodulation and root formation toward harvest. (Sulieman and Tran, (2015) Valentine *et al.,* (2017) already reported that Phosphorus is an essential nutrient used by groundnut plants, especially for nodulation and root development.

Sawdust had no significant difference in K at harvest but resulted in to decrease in K at harvest. However, as sawdust increased, K also increased significantly. This corresponds with Starbuck (1999) report of an increase in the K content of the soil with an increase in sawdust. Sawdust in this study increased the CEC of the soil. Moreover, sawdust as an organic matter will result in increased exchangeable cations. Ayuba et al., (2001) reported that organic matter contains high exchangeable cations. The bulk density of the soil decreased with increasing sawdust. Susan et al. (2020) also reported a decrease in bulk density with increased sawdust. The percentage Base Saturation was not influenced by the sawdust significantly (P≤0.05). However, Awodun (2006) reported an increase in the organic matter, pH, N, P, K, Ca and Mg contents of the soil with the incorporation of sawdust.

This study shows that increasing sawdust rate significantly (P≤0.05) resulted in increased germination percentage, vegetative growth (leaf area, number of leaves and plant height) and the number of seeds and weight of seeds of the groundnut plant. This increase can be attributed to favourable properties such as the bacteria nitrogen-fixing characteristic of the groundnut (leguminous) plant in the soil which supports vegetative growth of plant. Also, as seen in the Table 5 and 6, the sawdust maintained a pH range of between 6 and 7, which is suitable for groundnut cultivation (TIMEIS Project & TIMEIS Project, 2019). However, the Sawdust incorporated in the soil did not significantly increase the number of pods and pod weight. This can be attributed to decreased phosphorus and potassium which is highly required for pod production in groundnut. Baughman *et al,* (2015) reported that groundnut plant requires an adequate level of phosphorus, potassium and other micronutrients and a pH of less than 7.

CONCLUSION.

The sawdust rates (80g, 120g and 160g) incorporated in the soil significantly decreased the soil pH range but still within a pH range of 6 and 7, required for groundnut cultivation. However, it resulted in a reduced number of pods and weight of pods due to decreased soil potassium and phosphorus content required for pod growth and development. Increasing sawdust rates in the soil as a soil amendment did not significantly increase the number of pods and weight of pods of the groundnut plant but influenced the increase in the number of seeds and weight of seeds of the groundnut plant.

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GROWTH AND FLOWER YIELD RESPONSE OF AFRICAN MARIGOLD *(Tagestes erecta)* TO WILD SUNFLOWER *(Tithonia diversifolia)* BASED COMPOST

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ABSTRACT

Marigold (Tagestes erecta L) is a commercially valuable cut flower. The experiment was conducted at the Student's Field School Project, Ladoke Akintola University of Technology, Ogbomoso (Latitude 8° 10′ N; Longitude 4° 16′ E; 321 m above sea level) between March and August 2021 to determine the growth and flowering responses of African marigold to compost application rates (0, 5, 10 and 15 t/ha). The experiment was laid out in a completely randomized design with five replicates. Data were collected on plant height, number of leaves, stem girth, shoot weight and flower yield. Data collected were subjected to analysis of variance (ANOVA) using GENSTAT 12th edition, and significant mean separation was done using least significant difference (LSD) at 5% probability level (Wahua, 1999). The results of the experiment showed that application of compost to African marigold at rates of 5, 10, and 15 t/ha produced more leaves, taller plants and wider stems compared to African marigold treated with no compost. However, there was no significance difference in the shoot weight of marigold treated with 0, 5, 10 and 15 t/ha. The flower yield of plant applied with compost at the rate of 5, 10 and 15 t/ha were similar but greater than the control. In conclusion, application of compost significantly improved growth and flowering of African marigold. 5 t/ha of compost is optimum for marigold production.

INTORDUCTION

Compost as defined by (Paulin and Peter 2008), comprises organic materials that have undergone controlled aerobic decomposition, resulting in relatively stable, nutrient-rich matter. Compost, often referred to as "black gold" in gardening, have a transformative impact on both soil and plants. The diminished soil fertility not only leads to reduced crop yields but also renders crops more vulnerable to pest and disease infestations due to their weakened state (Madeleine et al., 2005). Compost empowers plants with enhanced nutrient access, improved resistance to pests and diseases, and efficient water utilization. It provides nutrients to the soil, improves its water holding capacity, and helps the soil to maintain good tilt and thereby better aeration for germinating seeds and plant root development (Edwards and Hailu, 2011). Therefore, it stands as a cornerstone of sustainable agriculture and a key ally in promoting healthier, more productive plant life. The utilization of compost stands as a pivotal factor in bolstering agricultural productivity and promoting sustainability. Furthermore, it offers a practical solution to the challenges confronting farmers dealing with soil fertility decline.

(Tagestes erecta) belong to the family of Asteraceae. is a genus of herbs, commonly known as marigold, native of Mexico and other warmer parts of America and naturalized elsewhere in the tropics and sub-tropics (Anonymous, 1976). The size of flower may vary from 4 to 6 cm (diameter) (Rajmani *et al*., 2020). The flowers of marigold are deep orange, light orange, golden yellow, bright yellow and lemon yellow in color. Several species are grow in gardens for ornamental purpose and its beauty. The plants are highly useful for suppressing the population of nematodes in the field also for the production of economical yield of better quality of marigold flowers, it is necessary to adopt a proper agro technique by applying important nutrients in mandatory quantity and special horticultural practices (Yadve LP and Bose TK 1993). Obvious varietal difference are found in marigold given that orange marigold has

emerged as rich source of carotenoid including xanthophyll, which is widely used as dietary supplement in the poultry industry to enhance chicken skin color and egg yolk pigmentation (Naik *et al.,* 2004).
Compost enhances soil fertility, improves soil texture, and supplies essential nutrients to crops, its adoption among flower growers remains relatively limited when compared to the widespread use of synthetic fertilizers. The study of this experiment was to provide information on compost rate that will support the production of marigold.

MATERIAL AND METHODS

Pot experiment was conducted between March and August, 2021 at Student Field School, Ladoke Akintola University of Technology, Ogbomoso, Oyo State (Latitude 8° 10´ N; Longitude 4° 16´ E; 321 m above sea level) and is located within Southern Guinea - Savannah agro-ecological zone of Nigeria with two distinct bimodal seasons (Babajide *et al*., 2012). Soil samples were collected for physical and chemical analysis. Compost was derived from poultry manure, wild sunflower (*Tithonia diversifolia*) and woodash mixed in the ratio 3:3:1 (v/v/v) respectively. The compost was turned and watered weekly for 6 months. Nutrient analysis of compost was also done (Table 1). Prior to the land preparation, soil samples were sifted by a 2-mm sieve. Seeds were sown in a seedling tray using drilling method at 2 mm depth, 2 cm spacing at inter-row and 1 cm intra-row were used. The trays were kept under a natural shade of *Psidium guajava* tree. Seedlings emerged 3 days after sowing. The seedling pots were draped over with net to avoid insect pest attack. Perforated 5 kg pots were filled with well mixed sifted soil sample and a well cured Tithonia based compost at the rate equivalent to 0 t/ha (no manure), 5 t/ha (11.16 g), 10 t/ha (22.32 g) and 15 t/ha (44.64g). The pots were organized in a completely randomized design with five replicates, Factor considered was compost at the rate of 0, 5, 10 and 15 t/ha. Data collection began a week after transplanting (WAT) and continued weekly for twelve weeks. Data were collected on plant height, number of leaves, stem girth, shoot weight and flower yield. Data collected were subjected to analysis of variance (ANOVA) using GENSTAT 12th edition (commercial version) while significant mean separation was done using Least significant difference (LSD) at 5% level of probability.

RESULTS

Compost application affects the height of Marigold. From 3 to 6 weeks after transplanting (WAT), Marigold applied with 10 t/ha produced taller plant when compared with 0, 5 and 15 t/ha compost. However, there was no significant difference between marigold that received compost at the rate of 5, 10 and 15 t/ha from 7 to 10 WAT with respect to plant height (Figure 1). From 3 to 8 WAT, marigold treated with no compost produced lowest number of leaves than 5, 10 and 15 t/ha except at 5 WAT where all the treatments had similar number of leaves (Figure 2). Stem girth of marigold was significantly affected by the application of compost. From 7 to 12 WAT, marigold that received 5 t/ha had widest stem, followed 10 and 15 t/ha and the thinnest stem was recorded for marigold with no compost except at 8 and 9 WAT (Figure 3). Shoot weight of marigold was similar in all the treatments applied (Figure 4). Marigold treated with 5, 10 and 15 t/ha compost had higher flower yield compared with no compost. However, there was no significance difference in the plant that received 5, 10 and 15 t/ha compost (Figure 5).

DISCUSSION

The soil used for this experiment was sandy clay and low in N, P, and K, along with compost low in nitrogen and potassium but high in phosphorus and calcium. Compost positively influenced African marigold's growth and flowering, in agreement with previous research by Yamato et al. (2006) and Ibrahim et al. (2004), who reported that compost application to soil is important to improve agricultural crops and amend soil deficiency. It was observed that plant height, number of leaves, and stem girth were enhanced in marigold treated with compost. This is similar with the findings of Ojo *et al.* (2021). Marigold applied with compost gave higher yield of flower than no compost. This observation was in accordance with the report of Ojo *et al*, (2021) who reported that higher application of compost to marigold was more effective for increasing number of flower yield and along with reducing the crop duration by early flowering. The result obtained could be attributed to compost application that help plant to produce more photosynthate that were used by the plant production of higher yield of flower. Marigold treated with compost had the highest shoot weight, possibly due to the calcium content in the compost, in line with Lucas da Silva *et al.* (2016), who reported that higher dry mass of shoot and root of common beans grown with high calcium concentration.

CONCLUSION

The result from the experiment showed that compost application supports growth and flower yield of African marigold. Compost application at the rate of 5 t/ha is optimum for the growth and flower yield of marigold. Application of 5 t/ha compost is recommended for African marigold production.

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Table 1: Composition of the soil and compost used in the experiment

Textural Class	Soil	Compost
Exchangeable bases (cmol/kg)		
Calcium	0.63	0.57
Magnesium	0.88	1.47
Potassium	0.65	3.52
Chemical properties		
pH	8.24	10.08
Avalaible Phosphorus (mg/kg)	0.99	1293.96
Organic C (%)	0.77	6.68
Total Nitrogen (%)	0.09	0.38
Particle size distribution		
Clay (%)	5.80	
Silt (%)	4.60	
Sand (%)	89.60	
Textural class	Sandy clay	

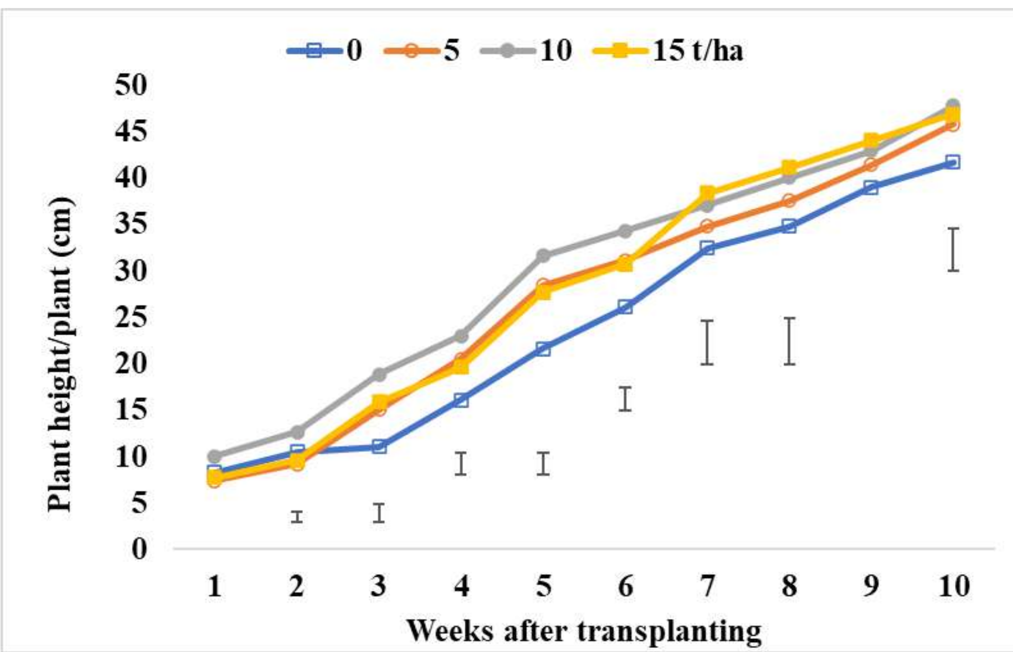

Figure 1: Plant height of African marigold as affected by compost rate
Vertical bars are LSD at p≤0.05

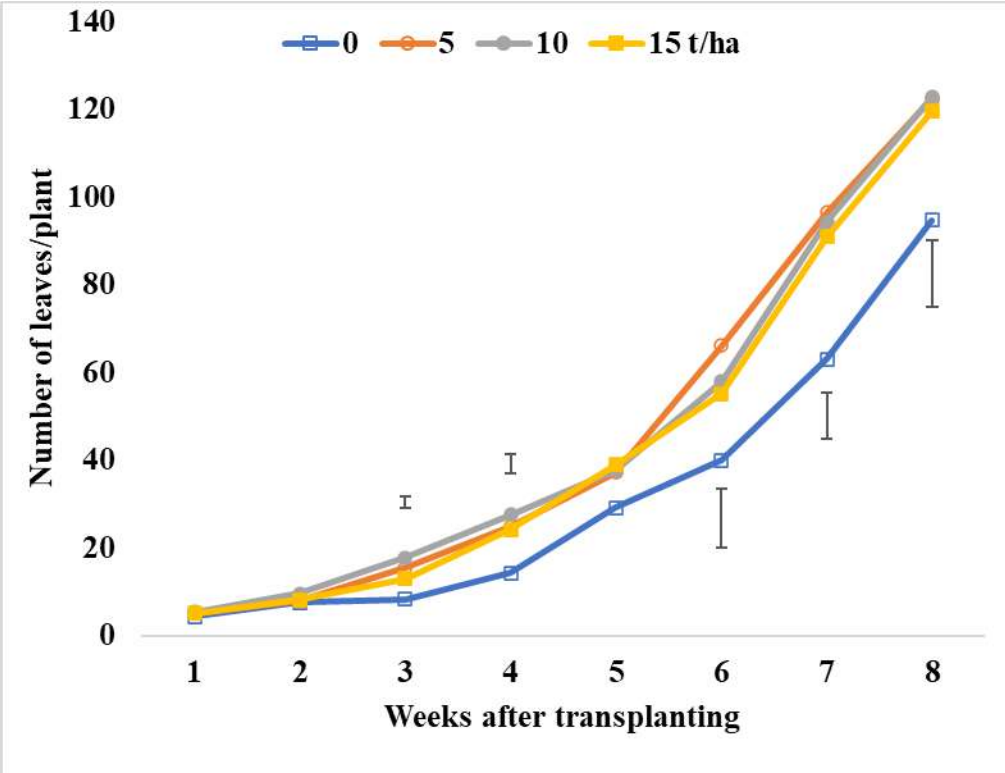

Figure 2: Number of leaves of African marigold as affected by compost rate
Vertical bars are LSD at p≤0.05

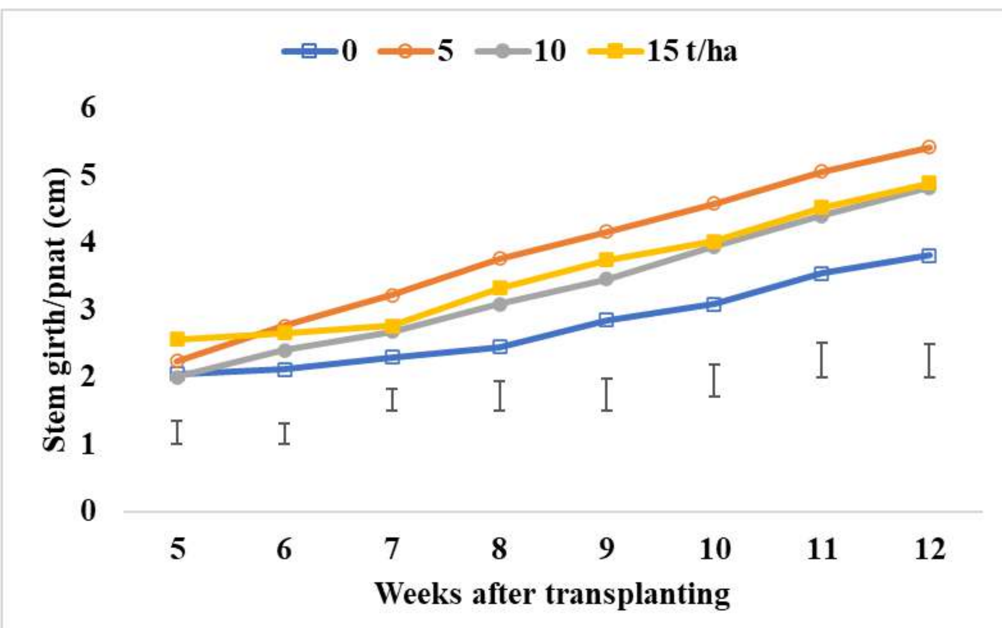

Figure 3: Stem girth of African marigold as affected by compost rate
Vertical bars are LSD at p≤0.05

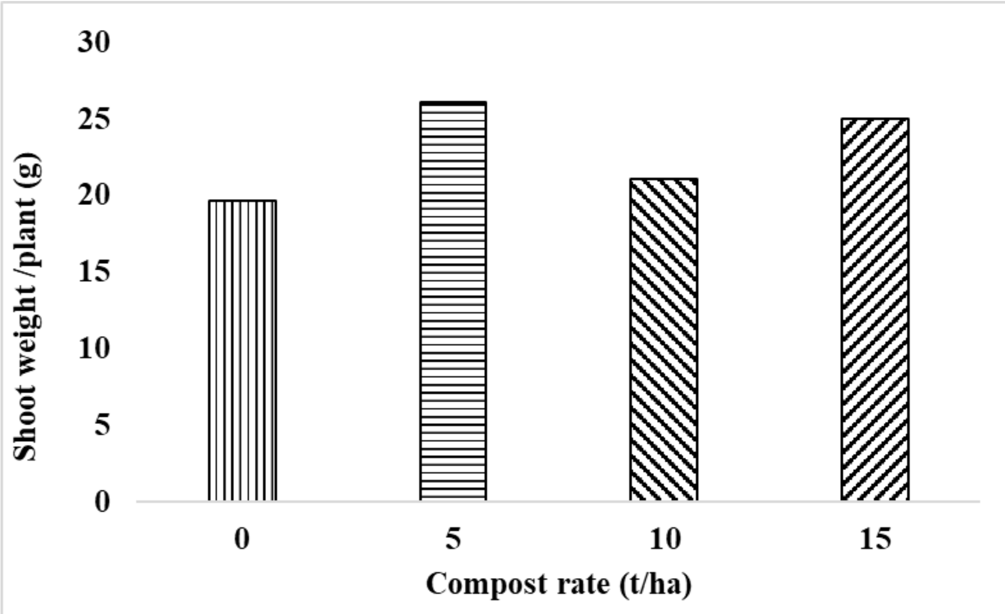

Figure 4: Shoot weight of African marigold as affected by compost rate
Vertical bar is LSD at $p \leq 0.05$

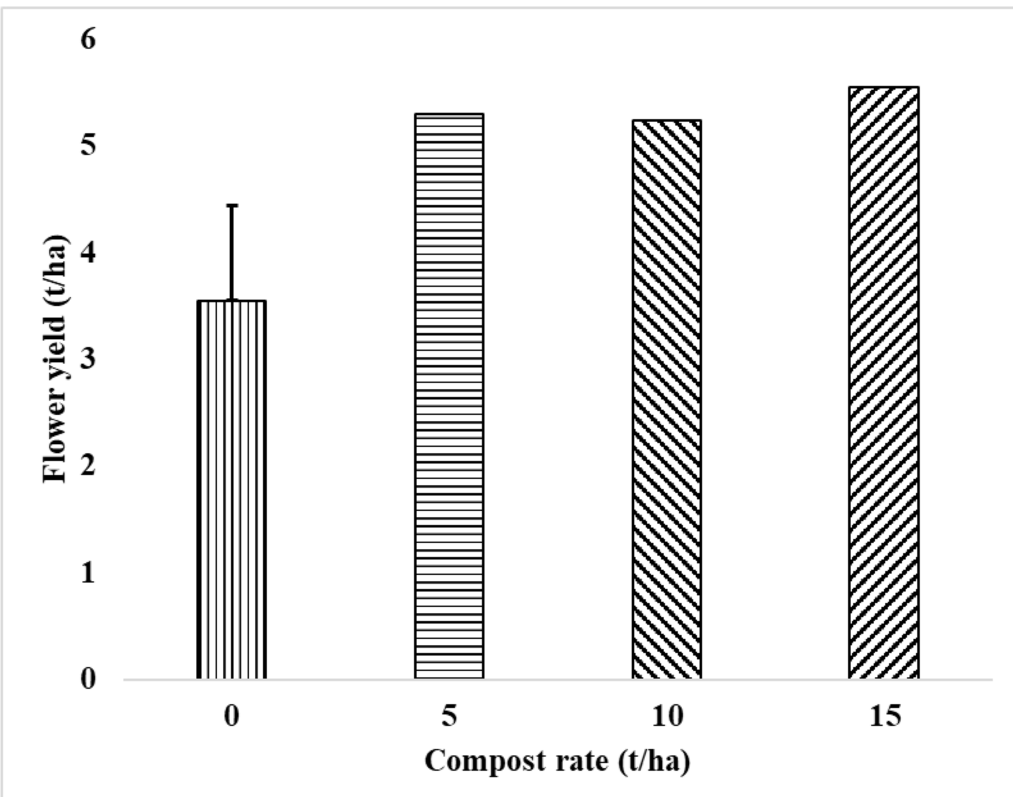

Figure 5: Flower yield of African marigold as affected by compost rate
Vertical bar is LSD at $p \leq 0.05$

EVALUATION OF CASHEW PLANTATION (*Anarcadium occidentale* L.) SOIL FOR PRODUCTIVITY AND CLIMATE CHANGE MITIGATION IN OGBOMOSO, SOUTH WEST NIGERIA

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ABSTRACT

Land use and soil management practices are the keys to improving the SOC of the soil and maintaining sustainable agricultural production. This research was conducted in Ogbomoso North, Orire and Surulere Local Government Areas of Oyo State to assess the soil organic carbon stock and other soil properties of Cashew (Anarcadium occidentale L.) under plantation crops. Three farms noted for cashew plantations were visited and in each village, three farms planted each with cashew (Anarcadium occidentale) were sampled at 0-20 cm depth for laboratory analysis of particle size, pH, C, N, P, EC and extractable micronutrients. The bulk densities at 0-5 cm, 5-10 cm and 10-15 cm depths were determined. Soil properties were analysed using descriptive statistics. The soil texture was sandy loam with soil pH ranging slightly acid to moderately acid (6.4 to 6.09). Irrespective of the local government areas, land use and OC (1.15 cmol kg^{-1}), N (0.08 g kg^{-1}), Na (0.74 cmol kg^{-1}) and P (4.91 mg kg^{-1}) were low. While Cu (7.68 mg kg^{-1}), Fe (112.00 mg kg^{-1}), Mn (154.5 mg kg^{-1}), Ca (4.09 cmol kg^{-1}) and K (0.233 cmol kg^{-1}) were medium and Mg (1.35 cmol kg^{-1}) were high. Total soil carbon (4011 kg C/ha) was very high. The bulk density ranged from 1.74 to 2.27 which were very high. In conclusion, most of the plantations were low in fertility, low carbon stocks which is assumed to be due to losses arising from continuous tillage practices and continuous cropping. The carbon storage status of land uses in the study area was low. Management practices like residue retention, use of organic fertilizer, green manuring, early harvesting and composting are recommended.

***Keywords**: Carbon storage, Organic carbon, Plantations, land use*

INTRODUCTION

Over the years, research efforts have indicated that crop production involves a complex interaction between the environment, soil parameters and nutrient dynamics (Ukpong and Moses, 2001). The failure to understand these complex interactions had resulted in lack of good quality and yield. The soil nutrient factor has therefore been found to be very important in the production of cashew in Nigeria (Ipinmoroti et al., 2011; Ipinmoroti and Akanbi, 2012). The evaluation of the soil physical suitability and constant monitoring of soil nutrient status have been advocated to ensure appropriate farm management for profitable arable and tree crop production in Nigeria (Ayoola and Agboola, 2002). In Nigeria and elsewhere in the tropics, extensive studies has been carried out on many tree crops including cocoa, coffee and cashew (Ipinmoroti and Ogeh, 2014), citrus (Pestana *et al.*, 2011), cocoa (Ololade *et al.*, 2010; Ibiremo *et al.*, 2010), cashew (Ramasamy *et al.*, 2013). Soil fertility levels vary, depending on the type and quality of minerals contained in their parent materials. The mineral nutrients in these parent materials are made available over decades, centuries, or longer through the process of weathering (Areola, 1982).

The soil nutrient factor has been found to be very important in the production of cashew in Nigeria (Ipinmoroti *et al*., 2011; Ipinmoroti and Akanbi, 2012).

For soil fertility to be sustained, extracted soil nutrients must equal replenished soil nutrients but in large areas of Africa, more soil nutrients are extracted than replenished (Ndala and Mabuza, 2006); thus, soil fertility and its management play an important role in farm productivity.

The need for improved crop productivity is more now than ever because of the increasing rate of population growth at about 3% in Nigeria (CIA, 2012) and the consequent pressures from competing demands for land over time have resulted in cultivable land being drawn from its traditional agricultural uses. Maintenance of soil fertility status is an important component of agricultural sustainability by most farmers, environmentalists and government policymakers (Sherwood and Uphoff 2000). Yakubu 2010, reported that soil fertility increases productivity, enables efficient use of nutrients, pesticides, water and lessening of greenhouse gas emissions. The characteristics of the soil affect many processes in the soil that qualify them for agricultural and other purposes. Therefore, assessing soil fertility involves measuring soil properties and using the measured values to detect changes in soil as a result of land use or management practices (Campos *et al*., 2007). Soil fertility is an important and essential components of a sustainable agricultural system in the tropical climates. The fertility status of a soil is a subject of soil characteristics especially physical and chemical property of the soil (Badalikova and Hruby, 2016).

The tropics are faced with the problem of declining per capital production, progressive deterioration of the environment and high spatial variability in the physical, chemical and morphological characteristics of soils which imply that different soils respond differently to land use types and management options. Also, continuous cultivation and indiscriminate deforestation through the use of fuel wood as source of alternative energy are attributed to the main source of declining per capital productivity of soils and fertility status especially in the rain forest zone (Chude *et al*., 2011, Osuji *et al*., 2011, Hassan *et al*., 2016). Land use affect soil fertility and productivity which manifest as change in soil properties such as nutrient content (N, P, K, Ca, Mg, S), pH, organic matter, CEC structure (Owoade *et al.,* 2020a, Owoade *et al*., 2020b). For instance Aluko and Fagbenro (2000) observed increase pH and organic matter for soil under teak (*Gmelina arborea*) than those under *Pins canaborea*, *Treculia Africana*, agroforestry and fallow land. He also observed increased phosphorus in fallow compared to other land uses. Successful agriculture requires the sustainable use of soil resource because soils can easily lose their quality and quantity within a short period of time for many reasons. Therefore, understanding of how soils respond to changes in management practice over time is essential in effective land management and hence ensuring soil quality. However, this can only be achieved when a good relationship has been established between soil fertility status and land use practices which may alter soil properties differently (Oyedele *et al.,* 2014).

Recent progressive increase in temperature results from global warming caused by rapid increase of the greenhouse gases concentration in the atmosphere since the industrial era (Daouda *et al*., 2017). In early May 2013, the atmospheric concentration of carbon dioxide (CO_2) reached 400ppm (Ralph, 2013). In terms of carbon emissions, the African continent accounts for 17% of global emissions from changes in land use patterns and management patterns (Bello *et al*, 2017). Changes in land use patterns contribute to 48% to Africa's total carbon emissions. This level has probably not been achieved in the last 20 million years and continues to increase at a rate of about 2 ppm per year. In general, tropical ecosystems are considered as sources rather than sinks of carbon dioxide since the savanna is grown and wood is harvested for energy and coal production (Tinlot, 2010). In the soil ecosystem, soil organic carbon influences soil physical and chemical processes, and serves as a source of plant nutrients. The balance between carbon gains and losses determines how much organic carbon can be stored in the soil. The balance between carbon gains and losses determines how much organic carbon can be stored in the soil. The processes of SOC storage or losses are influenced by biotic factors like biomass production and microbial abundance, mean annual precipitation and temperature, soil characteristics including texture and lithology and anthropogenic activities like land use and management (Olson, 2013). Predicting the effects of climate change will be made easier with a clear description of the distribution and changes of SOC as well as its controlling factors (Albaladejo *et al*., 2013).

MATERIALS AND METHODS

Description of Experimental Site

The study was carried out in three local government areas; Ogbomoso North Local Government Area, Orire Local Government Area and Surulere Local Government Area of Oyo State, Nigeria.

Field Study

Three different farms each in the three local government areas were studies, namely;

- Ogbomoso local government area: LAUTECH farm, katangua farm, Amamaa farm.
- Orire local government area: Olooru farm, Obamo farm, Fedegbo farm.
- Surulere local government area: Oloose farm, Iregba farm, Iresa adu farm.

Field study was carried out at the three different farms in each local government area, wherein three *Anacardium occidentale* trees were studied in each farm out of the three in each local government.

Soil Sampling and Laboratory Analysis

Soil samples were collected in triplicate with the aid of a soil auger. In each village, three farms planted each with *Anacardium occidentale* were sampled. Soils were collected from the farmland randomly at the depth of 0-20cm with the use of soil auger for physical and chemical analysis in the laboratory. The samples were bulked to form a composite and air dried, crushed and sieved through 2 and 0.5mm meshes for the determination of pH, particle size, C, N, P, cation exchange capacity (CEC), exchangeable cations (K, Mg, Ca, Na) and extractable micronutrients (Mn, Fe, Cu, Zn). The bulk density of each land use was taken 0-5cm and 10-15cm with core samplers. Laboratory analyses were carried out at the International Institute of Tropical Agriculture (IITA), Ibadan. Particle size analysis was carried out with the aid of hydrometer using sodium hexametaphophate as the dispersant (AOAC, 1990). Soil pH was determined in 1:1 soil water ratio (Black, 1965). Total nitrogen (N) was extracted by the macro-Kjeldahl digestion method (Bremner and Mulvaney, 1982) followed by colorimeter determination using Technicon Auto-analyser. Mehlich 3 (a multipurpose extractant) was used to extract available phosphorus, exchangeable cations (K, Mg, Ca and Na) and extractable micronutrients (Mn, Fe, Cu and Zn) (Mehlich, 1984). Phosphorus was determined colourimetrically using Technicon Auto- analyser, while the concentration of (calcium, magnesium, Copper, Zinc, Iron and Manganese) in the extract was determined by Atomic Absorption Spectrophometer. Sodium (Na) and Potassium (K) was determined using Flame emission photometer. Exchangeable acidity was determined by KCl extraction. CEC was determined by summation of Exchangeable bases (K, Mg, Ca and Na) and Exchangeable acidity. Organic carbon was determined by chronic acid digestion method (Heanes, 1984).

Determination of Bulk Density

The soil bulk density was evaluated using core method (Cresswell and Hamilton, 2002) as follows:

$$BD\ (g/cm^3) = \frac{\text{dry weight of oven soil (g)}}{\text{Volume of core } (cm^3)}$$

Where BD = bulk density (g/cm^3), volume of core = $\pi r^2 h$

Where π = 3.142, h = height of the cylinder, r = internal radius of the cylinder.

Determination of Carbon stock

Soil carbon stock (C-stock, kg/ha) at the 20cm depth was calculated from the total carbon content and bulk density (Ledo *et al.,* 2019) as follows:

C- Stock (kg/ha) = SOC x BD x A x D

Where SOC-soil organic carbon

BD-Bulk density (Mgm^{-3})

A-Area (1 ha = 10,000 m^2)

D-Soil depth (0.2 m)

Statistical Analysis: Data collected was analysed using analysis of variance (ANOVA) and significant means were compared using LSD at 5% probability level.

RESULT

The Mean Physiograpic Characteristics of *Cashew* in the Study Area.

The mean physiographic characteristics of cashew in the study area are presented in Table 1. The diameter breadth height (DBH) of the sampled trees ranged between 81.6 and 125cm. The height of most of the trees sampled ranged between 6 and 11.3m. The elevation of the area where data was collected ranged between 320 and 456.6m.

The Physical Properties of Soil under Locust Bean in Ogbomoso Agricultural Zone.

The physical properties of the soil under locust bean in the sampled area are presented in Table 2. Irrespective of local government, the soil under *cashew* trees was sandy loam. The bulk density was high for all the local government sampled. It ranges between 1.74 and 2.27g/cm^3.

The Chemical Properties of Soil Under cashew in Ogbomoso Agricultural Zone.

The chemical properties of soils in Ogbomoso agricultural zone (Table 3). The three local government area had significant effects on the soil pH while the villages did not significantly influence the pH content. The highest soil pH (6.44) which indicates a slightly acidic status was obtained from Oloose village in Surulere local government which was significantly higher than

Table 1: Physiographical characteristics of Cashew in the study area

LGA	Village	DBH (cm)	Height (m)	Distance (m)	Elevation (m)	Distance between	Distance within	GPS
Ogbomoso North	LAUTECH	125	11.3	10	326.6	7.6	9.3	8º10"12" 4º 16" 46: E
	KANTAGU	123.3	7.7	10	320	7	5.66	8º 8' 42"N 4º 16' 43" E
	AMAMA	114.6	8.3	10	350	7.23	5.43	8º 9' 55" N 4º 16' 12 " E
Orire	OBAMO	113.3	8.1	10	406.6	3.93	3.8	8º 20' 43" N 4º 10' 21" E
	FEDEGBO	103.6	7.6	10	456.6	3.96	3.56	8º 18' 54"N 4º 5' 58' E
	OLOORU	137	6	10	410	3.9	3.78	8º 20' 42" N 4º 10' 17" E
Surulere	OLOOSE	104	7.8	10	376.6	3.86	3.6	8º 6' 34" N 4º 22' 40" E
	IREGBA	81.6	8.5	10	363.3	4.83	4.2	8º 6' 35" N 4º 22' 42" E
	IRESA	93.6	7.3	10	383.3	4.3	3.73	8º6“34“N 4º 22" 39” E

N.B: DBH: Diameter Breadth Height, GPS: Global Positioning System, LGA: Local Government Area

Table 2: Physical properties of soil under Cashew (*Anacardium occidentale*) in the study area

LGA	VILLAGES	CLAY (%)	SAND (%)	SILT (%)	SOIL TEXTURE	BULK DENSITY (g/cm^3)
OGBO N	LAUTECH	12.37	79.41	8.00	SANDY LOAM	1.74
	KANTAGUA	12.04	80.57	7.00	SANDY LOAM	2.27
	AMAMA	11.37	82.74	5.33	SANDY LOAM	1.99
ORIRE	FEDEGBO	11.59	80.02	7.11	SANDY LOAM	1.91
	OBAMO	11.93	81.52	6.78	SANDY LOAM	2.09
	OLOORU	12.26	81.19	6.44	SANDY LOAM	2.14
SURULERE	IRESA	11.04	81.41	6.56	SANDY LOAM	2.07
	OLOOSE	11.70	80.74	6.89	SANDY LOAM	2.04
	IREGBA	13.04	80.57	6.89	SANDY LOAM	1.91
LSD LGA		1.183*	2.987*	2.161ns		0.163**
LSD VILLAGES		2.049ns	5.174ns	3.743ns		0.282*

N.B: LGA: Local Government Area

Table 3: Chemical properties of soil under Cashew (*Anacardium occidentale*) in study area

LGA	villages	pH	OC (g/kg)	N (%)	P (mg/kg-¹)	Ca (cmg/kg-¹)	Mg (cmol/kg-¹)	K (cmol/kg-¹)	Na(kg)	ECEC	TSC (kgC/ha)
OGBOMOSO	LAUTECH	6.33	1.15	0.08	4.91	4.09	1.35	0.21	0.11	5.75	38035
NORTH	KANTAGUA	6.09	0.87	0.05	2.71	2.46	0.56	0.21	0.74	3.28	39882
	AMAMA	6.34	0.78	0.05	-0.39	2.54	0.72	0.20	0.08	3.52	32542
ORIRE	FEDEGBO	6.25	0.95	0.07	2.46	2.99	0.84	0.21	0.09	4.23	33901
	OBAMO	6.15	0.91	0.06	2.39	2.86	0.83	0.19	0.10	4.00	36449
	OLOORU	6.37	0.94	0.06	2.38	3.23	0.96	0.22	0.07	4.31	40111
SURULERE	IRESA	6.11	0.94	0.06	1.25	2.50	0.77	0.17	0.09	3.52	38259
	OLOOSE	6.44	0.89	0.06	4.38	3.31	0.82	0.23	0.08	4.43	35737
	IREGBA	6.21	0.97	0.07	1.60	3.28	1.04	0.21	0.09	4.60	36464
LSD LGA		0.222**	0.204ns	0.02ns	2.84ns	0.89**	0.27ns	0.06**	0.02**	1.09**	7208.8ns
LSD VILLAGES		0.384ns	0.354ns	0.03ns	4.92ns	1.54ns	0.47ns	0.10ns	0.03ns	1.89ns	12485s

ECEC: Effective Cation Exchange Capacity, TSC: Total Soil Carbon, LGA: Local Government Area

the soil pH at Iregba, Iresa, Obaamo and Katangua which recorded the lowest soil pH (6.09).Nitrogen, Phosphorus, Sodium and organic carbon present in the soil are low in all the local government area. Calcium and Potassium in the soil are moderate in all the local government. Magnesium in the soil is high for all the local governments studied.

The Micronutrients Properties of Soils under Cashew

The micronutrients properties of soils of cashew in Ogbomoso Agricultural zone (Table 4). Irrespective of all the local government the micronutrients are very high (zinc, copper, iron and Manganese)

Table 4: Micronutrient properties of soil under Cashew (*Anacardium occidentale*) in the study area

LGA	VILLAGE	Cu(mg/kg-¹)	Fe(mg/kg-¹)	Mn(mg/kg-¹)	Zn(mg/kg-¹)
Ogbomoso NORTH	LAUTECH	6.60	112.00	89.2	54.7
	KANTAGUA	7.22	86.40	154.5	42.5
	AMAMA	6.65	73.60	101.5	50.9
ORIRE	FEDEGBO	7.11	90.50	105.4	37.1
	OBAMO	5..96	91.20	119.1	35.2
	OLOORU	7.40	90.20	120.8	35.8
SURULERE	IRESA	6.53	90.30	101.9	33.4
	OLOOSE	6.25	89.70	123.6	32.5
	IREGBA	7.68	91.90	119.8	42.2
LSD LGA		1.44**	11.67ns	17.38**	11.42**
LSD VILLAGES		2.49ns	20.21ns	30.10ns	40.05ns

LGA: Local government area.

DISCUSSION

In all the different land use types, sandy loam was the dominant textural type. The textural class was sandy loam in all the various land use types. The high percentage of sand could be attributed to the geology of the area. Soil texture is an important physical property of soils that is not easily changed by humans as a result of changes in land use (Brady & Weil 2017). High sand fractions could also be due to the parent material (coastal sand) considering the fact that the texture of a soil is highly influenced by the parent material and topography overtime (Oguike and Mbagwu, 2009). Similar report has been made by Udom and Ogunwole (2015) and Nwite and Alu (2017) that the dominance of sand fraction was recorded under different land uses in Nigeria.

The bulk density for lautech farm was high and it is very high in other farms in the study area and this due to the use of heavy farm equipments on the farm e.g. tractors, ploughs, and subsequent trips across the field by farm equipment, rainfall events, animals, and other disturbance activities will also compact soil. To prevent high bulk density in the soil some measures like minimizing soil disturbance and avoid operating equipment when soils are wet; using designated roads or rows for equipment; reducing the number of trips across a field; and practices that increase organic matter such as continuous no-till, cover crops, solid manure or compost application, diverse rotations with high residue crops and perennial legumes or grass used in rotation (USDA NRCS, 2019).

The levels of organic carbon in soils under cashew in the study area were low for some villages (Obamo, Iresa, Iregba, Oloose, Olooru, Fedegbo and Amama) and at medium level for lautech farm in the study area. Anderson-Teixeira *et al*. (2009) reported that conversion of uncultivated land for agricultural purpose results to significant soil organic carbon loss. This finding is supported by Anikwe (2015) who made similar observations and corroborated by Lal (2008) that trees trapped carbon dioxide from the atmosphere and sequestered it in plants' part and finally as soil carbon. According to Nair *et al*., 2010 and Nair, 2011 opined that factors that can influence the total amount of carbon sequestered include previous land use, tree species and density (broadleaves are higher sequesters compared to coniferous and deciduous trees), the type of agroforestry system (nature of components), age of perennials like trees (mature stands of trees have the capacity to storage more carbon compared to young stands), ecological region.

The villages have no significant on the phosphorus. In general, the soils were deficient in available phosphorus and phosphorus deficiency is likely to be an important factor limiting crop yield as the levels of the nutrient are well below 10mg/kg. The low phosphorous status of soils can be adduced to the practice of burning prior to cultivation, frequent cultivation and the slow rate of organic matter accretion in savannah fallow soil. Yang and Post (2011) reported that in tropical soils (e.g. oxisols) as the iron and aluminium content dominate soil mineralogy, leading to low phosphorus availability despite high total phosphorus content. According to Osman (2013) the cause for low available phosphorus might be resulted from high exchangeable acidity where phosphorus is combined with Al, Fe, and Mn (as their presence is predicted at the pH values of the soils of the study area) and becomes fixed.

In contrast to the level of phosphorus, the level of potassium in the soil under cashew was medium. The complete removal of crop residue, intensive cropping, extensive use of fertilizers (diammonium phosphate and urea) which include no potassium and non-use of mineral K fertilizer in soils of the study area might have led to the prevalence of K depletion (Hailu *et al*., 2015; Laekermariam *et al*., 2016; Wassie, 2019). The lower available K in the crop land could also be due to soil degradation and losses by leaching (Moges *et al*., 2013). There were however a significant build-up of exchangeable calcium and a decrease in the mean level of effective cation exchangeable capacity (ECEC) in the soil under cashew in the study area.

Phosphorous are low in all farms in the study area and the deficiency of this nutrients may affect the growth of plant and cause reduction in yield of crop. Low N content can occur because of leaching and volatilization owning to its mobile nature (Igwe and Akamigbo, 2001). The low nitrogen content recorded might also be as a result of absence of crop rotation with leguminous crops. According to Okpara and Igwe (2014) reported that legume-cereal rotations gave higher soil nitrogen than continuous maize whether there was addition of residues or not. Smil (2000) reported that when N and P are in excess in soils, they may be misplaced through leaching and erosion (for example, globally, an estimated 15 million tons of P are lost annually from crop fields due to erosion, and an estimated of 8 million tons of P are lost in runoff from arable land annually) (Cordell *et al*., 2009).

Magnesium was high in all the farms in the study area. Chlorophyll molecules in plant tissues have Mg as their main component. As a result, poor and stunted growth comes from a Mg deficiency due to a lack of chlorophyll. The enzymes systems are also helped by Mg. Mg also helps to activate specific enzyme systems. According to Grzebisz (2011), mobilization and leaching leads to lack of magnesium and calcium. Ayoubi *et al*. (2011) noted that several researchers have proven that deforestation and cultivation of virgin soils often leads to depletion of macronutrients and reducing soil quality. Banafshe *et al*. (2011) obtained lowest Mg in cultivated land which can be due to the high intensity of cultivation, abundant crop harvest with very little use of inputs and also leaching from forest or cultivated farm land.

CONCLUSIONS AND RECOMMENDATION

The pH of the soil is slightly acidic, which resulted in the low soil chemical properties N, P, OC and Na virtually in all the study area while all the micronutrients are higher for all the farms in all the local government area and very in other villages in the study area. The bulk density for the soil in LAUTECH cashew farm is high and this may be due to the use of heavy machines on the soil e.g. tractor, plough and continuous tillage practices which may expose the soil.

It is recommended in the study area that organic carbon or manure should be applied to the soil for improved crop yield and productivity and also practices that increase organic matter such as continuous row till, application of compost and solid manure to help reduce high bulk density in the soil and help increase the level of nutrient in the study area.

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ASSESSMENT OF THE EFFECTS OF EXTREME CLIMATIC VARIABILITY ON COCOA PRODUCTION IN IDANRE COMMUNITY, ONDO STATE, NIGERIA

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ABSTRACT

The variability of extreme climatic variables such as temperature, precipitation and soil texture has been significant in agricultural produce. These effects pose a major threat to agricultural development viz-a-viz cocoa production in the Idanre community. Cocoa production in the last decade has been marked by fluctuations and irregularities of these variables. This study's objective examine the variation in the trends of sunshine, temperature, rainfall and humidity on cocoa production in the community. Primary data were obtained from 10 selected wards from the 3 communities of Atosin, Alade and Odode that constitute the study area through a purposive sampling technique. In each of the selected streets and communities, the 2nd, middle and 2nd to last households were administered with questionnaires. A total of 90 copies of questionnaires were administered in 112 pollen unit stations and 82,449 numbers of registered voters were used for this study. The multiple regression analysis was applied. The results revealed that sunshine and temperature have only contributed significantly to cocoa production and that climate change has a huge and substantial effect on cocoa production in the Idanre community, Ondo State. The study recommends that more awareness of climate change should be created among cocoa farmers through public-private partnerships on the effects, coping and adaptation strategies of climate change.

***Keywords**: Extreme Climatic Variability, Irregularities, Cocoa Production, Idanre Community*

INTRODUCTION

The variables of climatic factors vary from one ecological zone to another. These variations could be attributed to frequency changes in weather and climatic conditions, environmental pollution and human interactions and intervention with the earth's resources. There is a connection between and among the indices of geography, climatic factors, environmental variability on crop production and food security (Agbebaku, 2021; Agbebaku and Agbebaku, 2023). Proceeds from agriculture activities especially cocoa production have been the second largest foreign exchange earner after crude oil in Nigeria. Given this importance, one would expect it to be produced on a large scale and its production should be on the increase to boost the nation's foreign exchange earnings. But despite the nation's commitment to increase cocoa production, it is still being faced with problems ranging from over-reliance on the oil sector, extreme climatic variability, neglect and inaccessibility of farm inputs for resuscitation of the product (NBS, 2012). Before the discovery of oil in Nigeria in the early 50s, the country's main domestic product was agriculture, the sector provided the country with employment and foreign exchange earnings but shortly after the oil boom in 1970, the contribution of Agriculture to GDP reduced to 22% in 2012 (NBS, 2012; Agbebaku and Agbebaku, 2023). Thus, the sector employs over 60% of the entire population in recent times where white-collar jobs are not forthcoming. Ethan (2015), opined that that in recent times, there has been a long-term temperature increase in most parts of Southern Nigeria on crop production.

These extreme climatic variabilities are plagued with diverse ecological problems in crop production in general and cocoa production in particular in the Idanre Community. Climate change is a threat to rural farmers especially those living in the tropics and subtropics. Among the most limiting factors to cocoa production is climate change. This is because every stage of cocoa production requires adequate weather conditions (Orimogunje, Ogundeji, Ademola, Balogun, Awodumila, Olorunmota & Oyeledun, 2020). Consequently, cocoa is highly susceptible to drought and pests' attacks but its cultivation is related to rainfall distribution (Koissy and N'Zué, 2020). Thus, several factors have interrelated impacts on the growth of cocoa plants. These factors range from the combination of the extreme conditions of; weather elements of rainfall, temperature, sunlight and humidity to others such as soil nutrient status, pests and diseases, and farmers' planting practices. The cocoa plant is known to produce well with minimal but sustained water availability throughout the year Furthermore, black pod diseases account for quite a lot of cocoa production losses by attacking the ripened or very young pods (Agbebaku, 2016; Orimogunje, et al., 2020; Okeniyi, Okeniyi & Mustopha, 2021).

The diseases are closely related to the pattern of rainfall distribution. It is more prevalent in damp situations with utmost pod infection in years when the short dry period from July to August is a very wet season. Nigeria Meteorological Agency (NIMET, 2011), states that some places in the South-West, Nigeria including Ondo state recorded rainfall values that were 200 -300 percent higher than normal. To this end, the researcher will employ variables of rainfall, temperature, humidity, and sunshine as proxies for climate change and cocoa production in the Ondo State context (Orimogunje, et al., 2020; Okeniyi, Okeniyi & Mustopha, 2021; Agbebaku and Agbebaku, 2023). The choice of the effects of extreme climatic variability on cocoa production in Ondo State, Nigeria, was predetermined by a combination of factors such as; Ondo State being rated as the largest cocoa-producing state in Nigeria, records of the fluctuations in some extreme variability of environmental and climatic factors especially rainfall, temperature and sunshine hours. The study aims to examine the variation in the trends of sunshine, temperature, rainfall, and humidity on cocoa production in Ondo state, Nigeria. The study objective is to examine the trends of sunshine, temperature, rainfall and humidity on cocoa production in the Idanre community of Ondo state.

Conceptual Clarifications

Cocoa Production

Cocoa was introduced into Nigeria in 1874 and the plant has since gained prominence rapidly in the country such that in the early seventies, cocoa production has spread to all the agroecological zones in Nigeria. Presently, 14 of the 36 states produce cocoa in the country; these states include, Ondo, Cross River, Osun, Ekiti, Ogun, Oyo, Edo, Delta, Kwara, Kogi, Abia, Taraba, Adamawa and Akwa Ibom (Oluyole & Sanusi, 2009; Adedokun, 2023). Cocoa has contributed to the economy of the country over the years and gained popularity because of the benefits from earnings and contribution to Gross Domestic Product (GDP) as the highest foreign exchange earner among all agricultural commodities (Oyekale, Bolaji & Olowa, 2009). However, the modest growth in the cocoa subsector has been traced among other things to include favorable weather conditions. Cocoa is highly sensitive to changes in climate, particularly to temperature due to its effects on evapotranspiration (Anim-Kwapong & Frimpong, 2005) and is known to thrive well with minimal but sustained water availability throughout the year (Obatolu, Fashina & Olaiya, 2003). Meanwhile, yearly variation in the yield of cocoa is affected more by rainfall than any other climatic factors. Cocoa prefers calm conditions and persistent moderate wind can cause severe damage to yield. Thus, being a selective plant, cocoa reacts badly to any incidence of extreme weather (Orimogunje, et al., 2020).

The International Cocoa Organization (2005), described extreme weather to include weather phenomena that are at the extreme of the historical distribution and observed that temperature and rainfall are important factors that impact optimum yield. This occurs when changes in weather elements alter the stages and rate of development of cocoa, cocoa pests, and pathogens, modify host resistance and result in changes in the physiology of host pathogens and pest interaction, causing a shift in the geographical distribution of host. This ultimately results in low cocoa yield and crop losses and a resultant effect on socio-economic variables such as farm income, livelihood and farm-level decision-making. However, basic skills in cocoa production, coupled with an optimum motivation, are sensitive requirements for best practices and consequently high-quality yield of cocoa (Ajewole & Iyanda, 2010). This is worrisome because agriculture (especially cocoa production) plays a significant role in supporting the livelihoods of individuals and the economic growth of many African countries (Okeniyi, Okeniyi & Mustopha, 2021; Agbebaku and Agbebaku, 2023). High dependence on agriculture and the predicted high negative impact of climate change on the productivity of agriculture draws a bleak picture of the rural and national economies of most West African states.

Climate Change on Environmental Variability

Climate change as a concept is used to explain changes in the earth's climatic system. It is concerned mainly with a change due to an increase in the average atmospheric temperature and ocean rise. The incessant features of desert encroachment, glacier melting, wind and wave patterns, floods, environmental imbalance and challenges, tsunamis, drought, epidermis-outbreak and ocean surges are clear indicators that the ecosystem is affected by climate changes (Agbebaku, 2021). Climate change is a function of environmental challenges and imbalance in the ecosystem, it is attributed to prolonged indices of environmental imbalance and environmental challenges. The variability of these indices results in climate change. The causes of climate change all over the globe are attributed to three main factors. The factors are (a)frequency changes in climatic variables, (b)environmental pollution, and (c)human interactions and relationships with the ecosystem. For instance, the frequency changes in climatic variables such as rainfall, temperature, wind and humidity) are major causes of climate change in regions of the world (IPCC, 2013; Afolayan, Agbebaku & Arhyel, 2022). Environmental pollution is a function of the amount of toxic waste and pollutants in the atmosphere. The amount and nature of greenhouse gases in space determine the environmental imbalance and climate change of a place. An increase or reduction of these gases in the atmosphere has adverse effects on the environmental challenges of a place. Greenhouse gases (GHGs), come from a variety of sources e.g. (machines, automobiles, bush burning, waste, fertilizer, insecticide, ashes, lava and stem). The manufacturing sectors and other related fields (fossil coal, industrial waste, oil and natural gas) also constitute mainly environmental pollution. Furthermore, the use of fossil fuels to meet the world's needs is another contributor to the increase in greenhouse gases e.g. (carbon dioxide (Co^2), chlorofluorocarbon and methane (Cunningham and Cunningham, 2015; Agbebaku, 2016 Agbebaku, 2021; Afolayan, Agbebaku & Arhyel, 2022).

MATERIALS AND METHODS

This paper is purely an experimental survey and a combination of content analysis of articles from journal publications, documentaries and field surveys. The study utilizes evidence mainly from primary and secondary sources from field surveys. Primary information was sourced from on-the-spot surveys of cocoa production farms. In essence, 10 selected wards from the 3 communities of Atosin, Alade and Odode were used for the study through the purposive sampling technique. In each of the selected streets and communities, the 2nd, middle and 2nd to last households were administered with questionnaires. A total of 90 copies of questionnaires were administered in 112 pollen unit stations and 82,449 numbers of registered voters were used for this study. The multiple regression and analysis of variance (ANOVA) were applied. Secondary data were sourced from documentary materials and established sources such as; existing literature, academic journals, conference papers, theses, internet materials and archival sources. Descriptive and purposive sampling techniques were used for this study.

RESULTS AND DISCUSSION

The results of the study were summarized and presented in Tables 1 to 4 showing the multiple regression of sunshine, temperature, rainfall, and humidity on cocoa production in the study area.

Table 1: Model Summary of Regression Analysis

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.716[a]	.647	.615	.373

a. Predictors: (Constant), Sunshine, Temperature, Rainfall, Humidity

Source: This Study, 2023

The result from Table 1 indicated that the model had a correlation value of 0.716, which manifests a good linear relationship between the dependent and independent variables. The Table further showed that the goodness of fit (R^2) is 0.647 which depicted that 64% of the changes in the dependent variable (cocoa production) are accounted for by the independent variables (Sunshine, Temperature, Rainfall, Humidity). More so, the adjusted R square of 61.5% specifically indicated that the explanatory variables of Sunshine, Temperature, Rainfall, and Humidity account an approximate of about 62% of changes in cocoa production while the remaining 38% accounted for scholastic error term, that is, variables outside the regression model which also influence cocoa production in Ondo State.

Table 2: Analysis of Variance (ANOVA)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	10.314	4	6.105	15.751	.003[b]
	Residual	16.406	45	.139		
	Total	26.720	49			

a. Dependent Variable: Cocoa production

b. Predictors: (Constant), Sunshine, Temperature, Rainfall, Humidity

Source: This Study, 2023.

The findings from the ANOVA analysis presented in Table 2 help in indicating the weakness or the strength of the model. According to Belle (2008), an insignificant F-test value indicates a weak regression model. From the findings obtained in Table 2, the F-test value is 26.720 which is greater than F- tabulated of 3.64 with a significance value of 0.000 at 0.05 level of significance. Since the F-test value of 26.720 is far greater than the 3.64 F-calculated value and the P-value obtained 0.000 was <0.05, it implies that the overall model is significant. The F-test is significant hence the conclusion that the regression model was good. This showed that the model does not suffer from specification bias.

Table 3: Regression Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.524	.320		4.766	.000
	Sunshine	.088	.110	.118	3.798	.009
	Temperature	.141	.142	.192	3.990	.004
	Rainfall	-.232	.161	-.278	-1.447	.155
	Humidity	-.060	.113	-.081	-.530	.599

a. Dependent Variable: Cocoa production

Source: Field Survey, 2023

From the Table above, the following regression equation was established

$COCO= 1.524 + 0.088_{SUN} + 0.141_{TEM} - 0.232_{RAIN} - 0.060_{HUM}$

The coefficient of sunshine is 0.088 which is significant and positively related to cocoa production in Ondo State. This implies that a 1% change in the sunshine will positively and significantly increase cocoa production in Ondo State Nigeria by 08.8%. Therefore, it can be concluded that sunshine positively and significantly influences cocoa production in Ondo State, Nigeria. Also, the coefficient of temperature plays an increasing role in the production of cocoa production in Ondo State to the tune of 0.141. By implication, this suggests that temperature has a positive and significant effect on cocoa production at a 5% level of significance. If the temperature continues to increase, it will increase photosynthesis, thereby increasing the output of cocoa production in the Ondo State. Furthermore, the coefficient of rainfall is estimated to be -0.232 which indicates a negative and insignificant effect on cocoa production. Therefore, a percentage increase in rainfall will produce about a 23% change decrease in cocoa production. The hypothesis that rainfall positively and significantly influences cocoa production is rejected. Lastly, the coefficient of humidity is 0.060 which showed a negative and insignificant effect on cocoa production in Ondo State Nigeria. The result therefore implies that a percentage change in humidity will bring about a decrease in cocoa production by 6%. Hence, humidity has a negative and insignificant effect on cocoa production in Ondo State, Nigeria.

Table 4: Summary of Test of Hypotheses

Hypothesis	Independent variable	Dependent variable	$p < 0.05$	Decision
H_{01}	Sunshine	Cocoa production	.009	Reject H_0
H_{02}	Temperature	Cocoa production	.004	Reject H_0
H_{03}	Rainfall	Cocoa production	.155	Accept H_0
H_{04}	Humidity	Cocoa production	.599	Accept H_0

Source*:* This Study, 2023.

DISCUSSION

The research hypotheses were tested through a t-test of regression analysis which found that sunshine and temperature are among the variables that significantly affect cocoa production in Ondo State Nigeria. Ideally, increasing temperatures reduces cocoa yield. Temperatures are expected to keep rising over the 21st century due to climate change, the number of heat spells will increase and cold spells will decrease (Change, Intergovernmental Panel on Climate, 2013). Sofoluwe, Tijani, and Baruwa, (2011), claim that even slight temperature changes are likely to greatly affect yields and some types of cocoa plants are already at their temperature limit, causing a reduction in yields and potentially shunting growth. Nonetheless, temperature increases cocoa production as found in the analysis, yet, when temperature increases, it decreases rainfall, and raises humidity which can both stand as factors that threaten the impact of cocoa crop (Sofoluwe, Tijani, & Baruwa, 2011). As a result of these factors, cocoa production will likely be affected as climate change progresses. The finding of this study corroborates the finding of Koissy and N'Zué (2020), that temperature and sunshine significantly impact crop production in Nigeria. Thus, the results revealed that sunshine and temperature have only contributed significantly to cocoa production and that climate change has a huge and substantial effect on cocoa production in the Idanre community, Ondo State.

CONCLUSION AND RECOMMENDATIONS

Cocoa cultivation as one of the major cash crops in Ondo state and also a major agricultural produce that contributes significantly to employment generation and foreign exchange in the country has been observed with marked fluctuations which could be attributed to the change in climatic variables over the years. Given the above, the study however, concluded that the climate of Ondo state is not stable and this amongst other factors has brought about fluctuations in cocoa production in the study area. Thus, the study recommends that more awareness of climate change should be created among cocoa farmers through public-private partnerships on the effects, coping and adaptation strategies of climate change

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RESPONSE OF SOYBEAN (*Glycine Max (L) Merr*) VARIETIES TO DIFFERENT INORGANIC FERTILIZERS IN OGBOMOSO, SOUTH WEST, NIGERIA

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ABSTRACT
Crops response to nutrients effect in terms of growth and yield; soybean is not an exception to the major nutrients. Hence, a pot experiment was conducted in Ogbomoso, Oyo State, Nigeria to determine the response of ten soybean varieties to NPK fertilizers. The treatments are: NPK application; (NAF-No fertilizer application), (P+K-Phosphorus and potassium), (P+N-Phosphorus and Nitrogen), (P; phosphorus alone) and (N+P+K application). It was a factorial experiment, laid in Completely Randomized Design with four replicates. Data collected are: plant height and number of leaves, flowers and pods, weights of; fresh and dry biomass, root and dry matter, and nutrient uptake. Data were subjected to Analysis of Variance and treatment means were separated using (DMRT $^{a}{}_{0.05}$). In conclusion, the interactions between the two factors were highly significant on the growth parameters and nutrient uptakes. The interactive effects on soybean variety TGm1057 under NFA produced the highest fresh shoot and root weights, while under (P+K) application, TGm1052 had the highest fresh root weight. Variety TGm1057 under NFA has the highest N uptake while variety TGm1052 under (P+K) application had the highest P uptake. But TGm1057 under (P+N) application had the highest N and K uptake. The highest soybean pod yield was obtained from variety TGm1052 under phosphorus and potassium (P+K) application while TGm1057 had the least yield under the same fertilizer application. In conclusion, it can be recommended that soybean variety TGm1057 be cultivated with little or no N fertilizer but with phosphorus and potassium fertilizer application for optimal pod yield.
Keywords: *Different, Fertilizers, Response, Soybean, Varieties*

INTRODUCTION

Soybean (*Glycine max* L. Merrill) is an important leguminous and oilseed crop that is widely grown because it is adaptable to different agro-ecological zones (Agarwal and Singh, 2015). Soybean is the world's leading source of protein and oil. It has the highest protein content of all food crops and is second only to groundnut in terms of oil content among grain leguminous crop (Ikeogu and Nwofia, 2013). Soybean is a plant that possesses the traits such as; high nutritional value, resistance to diseases and pests, and lower susceptibility to lodging compared to other legumes (Gawęda *et al*. 2016). It is one of the most important fodder plants which account for about 58% of total oilseed production worldwide and 69% of protein in the diet of livestock animals (Borawska *et al*. 2014). Soybean is high of polyunsaturated fatty acids, refers to as one of the most valuable oilseed plants (Agarwal, 2013; Medic *et al*. 2014). Due to its high nutritional value and beneficial effect on the soil, there is increasing interest in soybean cultivation (Jaskulska *et al*. 2017).

Soybean is among the major industrial and food crops grown almost in all agro-ecological zones in Nigeria. The crop is successfully grown in Nigeria with low agricultural input; this has made its cultivation to be expanded coupled with its nutritional and economic importance among other diverse local uses. The seeds contain about 20% oil on a dry matter basis and this is 85% unsaturated and cholesterol-free. The rapid growth of both the poultry and food processing industries in the past decade has also increased demand for soybean in Nigeria (Xiang, Yong, Yang, Wan, Gong, Cui & Lei , 2012).

However, its cultivation and production increased as farmers were aware of the potential of this crop for cash, food and for soil fertility improvement and Striga control (Omoigui *et al*., 2020). There are several soybean varieties; Notable promising soybean varieties for both southern and, northern guinea, savanna and sudan savanna zones are: TGX 1448-2E, TGX1951-3F, TGX 1904-6F, TGX 1987-62F and TGX 1987-10F. However, it is important to choose a variety suitable to particular agro ecological zone. Hence, variety selection should be done based on the time to maturity, yield potential, susceptibility to stem lodging, drought tolerance, and resistance to pests and diseases. The maturity period should be considered when choosing a variety, suited to your geographical zone. Although late maturing varieties have the potential to increase in yield, but the danger of late-season drought is eminent (Omoigui *et al*., 2020).

Despite the high yielding potentials of soybean across the production zones, there are number of reasons identified for declining productivity of the soybean viz., heavy or very low rainfall, pests and diseases attack, pests to diseases susceptibility, imbalanced use of fertilizers, soil fertility problems, low soil organic matter, water stress, poor management *(*Walikar *et al*., 2018*);* Lu and Tian, 2017). Moreover, the problem of soybean response to the major nutrients; nitrogen, phosphorus and potassium (NPK) is soil has received little or not much research focus in most soybean producing zones in Nigeria. According to Mourtzinis *et al*., (2018), soybean seed production requires larger amounts of N compared to cereal crops because of its chemical composition, however, soybean response to N fertilization has not always increased seed yield. Moreover, N fertilizer application reduces the biological N fixation (BNF) activity by inhibiting the process (Mourtzinis *et al*., (2018). Soybean plants assimilate a large amount of nitrogen (about 330 kg N ha^{-1} for a yield of 4 t ha-1) during vegetation period, and the amount of N adopted in a plant is highly correlated with the soybean seed yield (), as well as with the chemical composition of soybean grains (Gai *et al*., 2016; Popović *et al*., 2016).

On the other hand, Phosphorus is a vital element in crop production which performs important role for many characteristics of plant growth such as sugar and starch utilization, photosynthesis use, cell division and organization, nodule formation, root development, flower initiation and seed and fruit development (Gangasuresh *et al*., 2010; Sanginga *et al*., 2015). The role of Potassium (K) is essential as factor for optimal production of soybean crops (Redel, Escudey, Alvear & Borie, 2011). It is the most abundant cation in plants involved in many physiological processes which include activating over 80 enzymes, regulating cellular osmotic water potential, photosynthesis, protein metabolism, and helping plants adapt to environmental stresses (Walikar, Bhan, Giri, Dubey & Agrawal, 2018).

From the various established works about soybean response to NPK, there is need to be soybean varietal specific in their response in term of yields and other growth parameters. Hence, the aims of the work are: to assess the response of different soybean varieties to various inorganic fertilizers in Ogbomoso agro-ecology and to identify the soybean variety and the inorganic fertilizer that would have highest significant effect on soybean performance.

MATERIALS AND METHODS

Experimental site: A screen-house experiment was carried out at Faculty of Agriculture, Ladoke Akintola (LAUTECH) Teaching and Research Farm, Ogbomoso, Oyo State, located on longitude 4° 30'E and latitude 10° 5'N. The climate hot, humid, tropical, of southern guinea savannah of Nigeria with mean temperature of 27°C, annual rainfall of 1400mm and marked with wet and dry season.

Soil sampling and pre-planting soil analysis: Soil samples were collected at a depth 0 – 20 cm from the Teaching and Research Farm of University of Technology (LAUTECH). The soil collected was used to filled the pots (5 kg polythene bag size). Parts of the composite soil samples were air dried and processed for physical and chemical analyses.

Source of Soybean seeds and fertilizer: Ten varieties of soybean seeds were obtained from the genetic resources center, IITA, Ibadan. The varieties are; (TGm 1002 = V_1, TGm 1052 = V_2, TGm 1057 = V_3, TGm 1434 = V_4, TGm 1537 = V_5, TGm 1816 = V_6, TGm 1817 = V_7, TGm 264 = V8, TGm 4360 = V_9, TGm 623 = V_{10}).

The following were nutrients evaluated: Phosphorus (P), Nitrogen (N) and Potassium (K). Nitrogen was supplied using urea, while phosphorus and potassium were supplied using SSP and MOP respectively. Basal application of fertilizers were done at; 20kg nitrogen, 40kg P_2O_5 and 20kg K_2O, per hectare respectively, before planting.

Fertilizer application/treatments application: The fertilizers recommended rates for the experiment, are: Urea-0.11 g/ 5 kg pots, MOP-0.06 g/ 5kg pot and SSP-0.24 g/ 5 kg pots; the treatments are: NAF= No fertilizer application, P+K = Phosphorus and potassium application, P+N = Phosphorus and nitrogen application and P only = Phosphorus application alone and NPK application.

Experimental treatments, design and layout: The pots/ bags for the experiment were arranged in a Completely Randomized Design (CRD) with each treatment replicated four times, given a total number of two hundred (200) experimental units or pots.

Sowing and other agronomic practices: Four seeds were sown per pot at a depth of 2 cm and latter thinned to two per pot, manual irrigation were carried out except on raining days and weeding was regularly carried out. Cypermethrin was applied was applied to control pests.

Data Collection and analysis: The following data were collected biweekly after sowing: plant height (cm), numbers of leaf, number of pods, plant weight and root weight (g), Nutrient uptake (nitrogen, potassium and phosphorus (NPK) uptake.

All data collected were subjected to analysis of variance (ANOVA) and significant means were compared with Least Significance Difference at 5% probability level.

RESULTS AND DISCUSSION

Experimental soil used: The chemical and constituents and the particle sizes results of the experimental soil used reveal that the soil pH is slightly acidic (6.50) while the soil organic carbon and nitrogen are (0.55 and 0.05 g kg^{-1}) very low but the available phosphorus was (105.94 mg kg^{-1}) very high. The potassium and calcium of this soil are of low values; (0.17 and 3.39 cmol kg^{-1}) while Mg and Na are 0.40 and 0.08 cmol kg^{-1}, respectively. The micronutrients (iron, manganese, copper and zinc) values ranged from 6.79 – 273.87 cmol kg^{-1} of which Fe was very high. The exchangeable cations (K, Ca, Mg, Na) values ranged from 0.08 – 3.39 cmol kg^{-1} while the exchangeable acidity was infinitesimal. The values of sand, silt and clay particles showed that the soil textural class was loamy sand (Table 1).

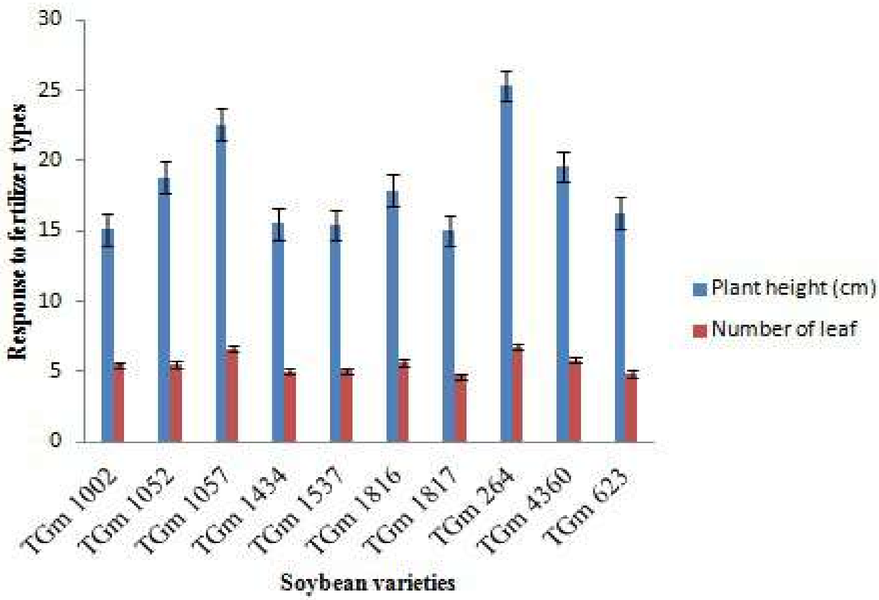
Table 1: The chemical composition and the particle sizes of the experimental soil used

Soil pH, Org. Carbon, TN and Available Phosphorus		**Exchangeable cations (cmol kg^{-1})**			**Micronutrients (mg kg^{-1})**	
pH (H_2O)	6.50	K	0.17		Fe	273.87
Organic carbon (g kg^{-1})	0.55	Ca	3.39		Mn	150.20
Total Nitrogen (g kg^{-1})	0.05	Mg	0.40		Cu	6.79
Av. Phosphorus (mg kg^{-1})	105.94	Na	0.08		Zn	198.80
		Exchangeable acidity		0.00 cmol kg^{-1}		
		Sand	**Silt**	**Clay**	**Textural class**	
Particle size distribution (g kg^{-1})		82	5.0	12.0	Loamy sand soil	

Soybean number of leaf: At 6 weeks after sowing (6WAS), there was varietal significant difference in the number of leaf per the fertilizers application, the mean numbers of leaf of the soybean plant ranged from 5 – 7 while under the various fertilizers application, the number of leaf ranged from 5 – 6. It was observed that soybean varieties under P application had 6 leaves (mean value of 5.93) the application of P and N had the lowest number of 5 leaves (mean value; 5.10), while variety 8 (V8 = TGm 264) had 7 leaves (mean value; 6.80) and the least number of leaf (4.70) was observed with variety 7 (V_7 = TGm

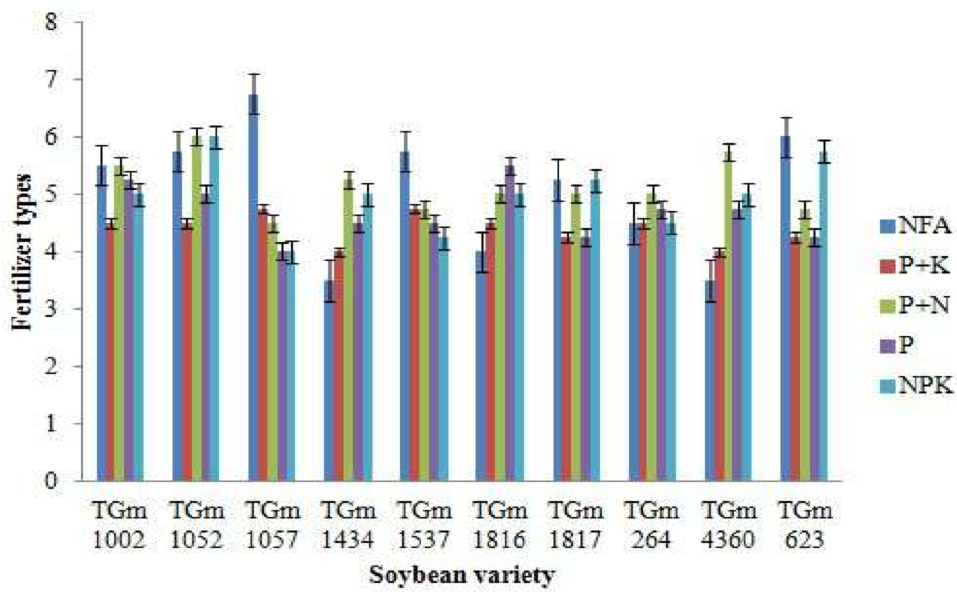
1817). However, there was no significant interaction effect between the fertilizer application and soybean variety on the number of leaves at 6 weeks after sowing (Figure 1).

Plant height: At 6 WAS, on average, all the soybean varieties the least (17.27 cm) and the highest (19.12 cm) plant heights under P+N and NFA fertilizer application, respectively, however, while on the variety basis of responding to fertilizer application the TGm 1817 had the least plant height (15.05cm) and the highest (25.35 cm) plant height was observed with variety TGm 264. There was significant varietal effect as well as significant interaction between the fertilizers and the variety (Figure 1).



Bars represent the $LSD_{0.005}$

Figure 1: Response of plant height and number of leaf different soybean variety to different fertilizer types at 6WAS



Bars represent the standard error (SE)

(NAF)= No fertilizer application, (P+K) = Phosphorus and potassium application, (P+N) = Phosphorus and nitrogen application and (P) = Phosphorus application alone (NPK) application

Figure 2: Number of pod of ten varieties of soybean as influenced by fertilizer types

Under the application of NFA soybean varieties TG_m1057 and 623 highest number of pods while TG_m1434 and 4360 has the least number of pods under the NFA application (Figure 2).

Yield parameters: Under the applications of all these fertilizer types, the fresh and dry root weights of the ten soybean varieties ranged from 0.73 – 1.76g (fresh) and 0.22 – 0.42g (dry), respectively. Similarly, variety TGm1002 had the lowest total fresh biomass (5.25g) while TGm264 had the highest total biomass. Meanwhile, this pattern was not followed other yield parameters that were observed under all the fertilizer types. However, the pod yield ranged from TGm 1002 (8.77g) - TGm264 (11.46g) as average pod yield under the different fertilizer application, Howbeit, there were significant effect of these fertilizers on the yield parameters both on each soybean variety so also the interaction of the fertilizer types on the variety (Table 2).

Table 2: The response of different varieties of soybean to different fertilizer types

Soybean variety	Soybean yield parameters weights (g/pot)					
	Fresh yield parameter weights		Dry yield parameter weights			
	Root	Total biomass	Root	Pod	Total biomass	Dry matter
TGm 1002	0.73	5.25	0.23	8.77	3.62	1.926
TGm 1052	1.76	6.99	0.28	10.13	4.68	2.528
TGm 1057	1.65	8.54	0.35	10.39	5.59	2.970
TGm 1434	1.02	6.007	0.22	7.81	3.36	1.792
TGm 1537	0.98	5.27	0.26	8.39	3.60	1.929
TGm 1816	1.48	7.31	0.36	9.39	4.59	2.475
TGm 1817	1.40	7.50	0.30	9.52	4.72	2.507
TGm 264	1.65	8.78	0.42	11.46	6.81	3.615
TGm 4360	1.57	7.60	0.32	8.90	4.30	2.309
TGm 623	1.47	6.83	0.21	8.68	3.68	1.948
Variety $LSD_{0.05}$	0.18**	0.77**	0.07**	0.44**	0.31**	0.50 **
Fertilizer*variety $LSD_{0.05}$	0.41**	1.72**	0.15**	0.98**	0.56	1.12 **

*, ** significant at 5%, 1% and 0.1% probability levels respectively, ns= not significant

(NAF)= No fertilizer application, (P+K) = Phosphorus and potassium application, (P+N) = Phosphorus and nitrogen application and (P) = Phosphorus application alone (NPK) application.

Interaction effects of variety and fertilizer:

The interaction effects of variety and fertilizer on mean performance of soybean; for root, pods and shoot of soybean (Table 3), showed that there were significant interactive effects between the variety and fertilizer application, and these effects are noticeable on the fresh shoot and root weights of variety 3 (TGm 1057) and under NAF (No fertilizer application) treatment, which makes it the best plant and treatment that aids root development. Also the interaction between the variety and treatment had significant effects on the dry shoot and dry root weights of variety 3 (TGm 1057) under P+N application (Table 3).

Table 3: Interaction effects of different variety and fertilizer types on growth and yield performance

Interaction Variety + fertilizer types	Number of flowers	Interaction	Fresh shoot weight (g)	Interaction	Fresh root weight (g)	Interaction	Root length (cm)	Interaction	Dry shoot weight (g)
V_2(NFA)	7.75[a]	V_3(NFA)	10.87[a]	V_2(P+K)	2.96[a]	V_2(P+K)	15.50[a]	V_8(P+N)	3.76[a]
V_2(NPK)	7.25[a]	V_9(P+K)	10.62[a]	V_{10}(NFA)	2.88[a]	V_2(NPK)	15.25[a]	V_8(NFA)	3.64[a]
V_1(P+K)	7.00[a]	V_7(NPK)	10.48[a]	V_3(NFA)	2.85[a]	V_4(NPK)	13.00[a]	V_3(P+N)	3.56[a]
V_{10}(P+N)	0.50[bc]	V_{10}(NFA)	3.49[bc]	V_5(NPK)	0.74[bc]	V_1(P)	3.75[bc]	V_4(P+K)	1.12[bc]
V_{10}(P)	0.50[bc]	V_2(P+N)	3.45[bc]	V_4(P+N)	0.69[bc]	V_4(P+N)	3.60[bc]	V_2(P+N)	1.11[bc]
V_{10}(NPK)	0.50[bc]	V_9(NFA)	3.00[bc]	V_1(P)	0.23[bc]	V_6(NPK)	3.00[bc]	V_{10}(P+K)	1.10[bc]
SE (Df =59)	±0.79		±0.63		±0.15		±1.08		±0.35

Means with the same letter are not significantly different. SE = Standard Error, Df = Degree of Freedom
(NAF)= No fertilizer application, (P+K) = Phosphorus and potassium application,
(P+N) = Phosphorus and nitrogen application and (P) = Phosphorus application alone (NPK) application, TGm 1002 = V_1, TGm 1052 = V_2, TGm 1057 = V_3, TGm 1434 = V_4, TGm 1537 = V_5, TGm 1816 = V_6, TGm 1817 = V_7, TGm 264 = V_8, TGm 4360 = V_9, TGm 623 = V_{10}

Table 4: Interaction effect of variety and fertilizer on the nutrient uptakes of soybean

Interaction Variety + fertilizer types	N uptake (%)	Interaction	P uptake (%)	Interaction	K uptake (%)	Interaction	NPK uptake (%)
V_3(P+N)	0.10[a]	V_2(NAF)	0.01[a]	V_3(P+N)	0.06[a]	V_3(P+N)	0.04[a]
V_3(NAF)	0.08[a]	V_2(P+K)	0.01[a]	V_6(P+K)	0.04[b]	V_3(NPK)	0.03[b]
V_6(NAF)	0.08[a]	V_6(P+K)	0.01[bc]	V_7(NPK)	0.04[b]	V_2(P+N)	0.03[b]
V_{10}(P)	0.03[bc]	V_6(NPK)	0.003[bc]	V_5(P+N)	0.01[bc]	V_4(P+N)	0.01[bc]
V_1(P+K)	0.03[bc]	V_4(P+N)	0.003[bc]	V_6(NPK)	0.01[bc]	V_6(NPK)	0.003[bc]
V_6(NPK)	0.02[bc]	V_1(NPK)	0.003[bc]	V_5(NAF)	0.003[bc]	V_5(NAF)	0.001[bc]
SE (Df= 59)	±0.01		±0.001		±0.004		±0.004

Means with the same letter are not significantly different, SE = Standard Error
(NAF)= No fertilizer application, (P+K) = Phosphorus and potassium application,
(P+N) = Phosphorus and nitrogen application and (P) = Phosphorus application alone (NPK) application, TGm 1002 = V_1, TGm 1052 = V_2, TGm 1057 = V_3, TGm 1434 = V_4, TGm 1537 = V_5, TGm 1816 = V_6, TGm 1817 = V_7, TGm 264 = V_8, TGm 4360 = V_9, TGm 623 = V_{10}

DISCUSSION

The availability of nitrogen (N), phosphorus (P) and potassium (K) among other nutrients in soil are essential for the growth and yield of crops generally (Broch & Ranno, 2012). However, deficiency of phosphorus has been identified as the most limiting nutrient in soybean production as proved in this trial which corroborated Karikari *et al.,* (2015) findings. This may be attributed to the immobility of P in soils (Table 2). Nitrogen is less needed nutrient for soybean due to its ability to fix nitrogen, but most soils in the tropics are low in nitrogen (Table 2). However, nitrogen and phosphorus fertilizer application among other nutrients will have a residual effect on the successive crops grown on such soils (Xiang,Yong, Yang, Wan, Go, Lei, 2012).
Plant height was significantly affected by phosphorus and potassium fertilizer as noticed in the interaction with the soybean variety. TGm264 produced the tallest plant while TGm1816 produced the shortest plant

under these two nutrients application. At the end of the experiment, maximum plant height of 25cm was recorded (Figure 1). The pot experiment thus confirmed the results of the field experiment where increase levels of potassium resulted in taller plants as reported by Snyder (2000). These findings are similar to those of Qureshi *et al (*2010) who found a significant increase in plant height due to phosphorus fertilizer application, as also reported by Qureshi, Beg and Siddiq, (2003).

The highest soybean seed yield was obtained from variety TGm 1052 under phosphorus and potassium (P+K) application while TGm1057 had the lowest yield under the same fertilizer application. The result is in agreement with that of Pauline *et al*. (2010), and Aise *et al*. (2011) who reported a similar finding on soybean seed yield application of P+K fertilizer. According to IITA (2000) report, and Popovic *et al.* (2016), other factors such as rainfall distribution, among other factors, substantially modify the quantity and quality of soybean seed yield. The soybean seed yield reduction at the lowest and highest P- fertilizer application was been recorded because, the growth and development of soybean was influenced by little or excess of phosphorus as reported by Xiang *et al.,* (2012). More conclusive results on yield responses of soybean were obtained in experiment conducted by Qureshi, Beg and Siddiq, (2003), where the yield was increased.

Nutrients uptake pattern by these varieties of soybean revealed that phosphorus uptake was significantly affected by the use of different fertilizers source and soybean cultivars. The uptake of nutrients was significantly related to the total biomass produced by a cultivar, the increase in P uptake with the application of phosphorus over control (NFA) was significant. This showed that the application of P to soybean improved the efficiency of cultivars in accumulating more P, N and K (Mustafa, Darwesh & Luay, 2013).

From this trial, it can be deduced and recommended that this finding provides evidence that the application of P fertilizer positively influenced soybean growth and yield. And that soybean cultivar TGm1052 with highest performance under (P+K) fertilizers application is recommended for cultivation especially in soil with low nitrogen.

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GROWTH AND YIELD OF CARROT (*Daucus carota*) AS INFLUENCED BY DIFFERENT FERTILIZER SOURCES IN KABBA, NIGERIA

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ABSTRACT
Carrot is gaining more popularity due to its nutritional, health and economic benefits. Recently, the production of carrot has been on the decrease as a result of low fertility status of the soil. Hence, pot experiment was conducted in 2022 cropping season at the College of Agriculture, Kabba to examine the impact of different fertilizer sources on growth and yield of carrot. The treatments included four fertilizer sources (0 t/ha (control), 10 t/ha of cow dung, 10 t/ha of poultry manure and 200 kg/ha of NPK (20:10:10)). The experiment was laid out in Completely Randomized Design (CRD) with five replicates. Analysis of variance result showed that fertilizer sources had positive impact on most of the traits assessed. Plants treated with poultry manure exhibited superior performance in terms of plant height, canopy diameter, root length and root diameter than others. It was evident that number of leaves was more in plants that received cow dung. Fresh shoot weight and total fresh weight were highest in plants fertilized with cow dung. Interestingly, plants grown with poultry manure produced the heaviest root weight. Heaviest dry shoot weight, total dry weight and highest shoot/root ratio was associated with plants grown with cow dung. Dry root weight and percent dry matter distribution to the root were obtained in plants treated with poultry manure. Percent dry matter distribution to the shoot was highest in the control. In conclusion, application of poultry manure that increased plant height, canopy diameter, root length, root diameter and root weight is recommended for carrot growers in the study area.
***Keywords**: Carrot, fertilizer sources, growth, yield*

INTRODUCTION

Carrot (*Daucus carota* L.), an herbaceous biennial plant belonging to the family Apiaceae (Kabir *et al.,* 2013). It is an important short duration root vegetable (Afrin *et al.,* 2019) and it is cultivated in many parts of the world (De Lannoy, 2001; Melese *et al.,* 2018). Carrot is becoming more popular especially among the urban people because of its high nutritive value and possible diversified use in making different palatable foods. Carrot is used as salad and as cooked vegetable in soups, stews, curries and also used for the preparation of pickles, jam and sweet dishes (Kabir *et al.,* 2000). Carrot contains appreciable amount of carotene, thiamin, riboflavin, iron, calcium, phosphorus and also serves as a source of carbohydrate, protein, fat, minerals, vitamin C and calories (Kabir *et al.,* 2000). Despite the enormous benefits of carrot, its yield per hectare had been greatly hampered by the low fertility status of the soil, faulty nutrient application and the type of fertilizer. The type and the way producers are applying fertilizer is one of the major problems in carrot production (Hailu *et al.,* 2008).

Soil nutrients could be supplied in organic or inorganic form (chemical fertilizers and lime) and in combinations (Aba *et al.,* 2020). In most cases, carrot growers use chemical fertilizers as the major supply of nutrients to attain higher growth and yield (Hochmuth *et al.,* 1999; Amjad *et al.,* 2005). Excessive amounts of inorganic fertilizers are being applied to vegetables in order to achieve a higher yield (Abou *et al.,* 2012). However, the use of inorganic fertilizers alone may cause problems for human health and the environment. Manure can serve as a substitute to synthetic fertilizers. Application of manure supplies the required nutrients; improves soil structure, water holding capacity, porosity, bulk density, moisture retention; increases microbial population; and maintains crop quality (Dauda *et al.,* 2008; Adekiya and Agbede, 2009; Adeleye *et al.,* 2010; Agbede *et al.,* 2013, 2014). Report by Abou *et al.* (2012) showed that vegetative growth and yield of different crops were increased with addition of organic manure. Khandaker *et al.* (2017) investigated six different fertilizers sources (no fertilizer, NPK fertilizer, poultry manure, rat manure, goat manure and rabbit manure) on the growth and yield of okra, according to the study, application of poultry manure significantly increased the growth and yield performances on okra compared to other types of organic fertilizers. There is limited information on the effect of different organic sources on growth and yield of carrot in the study area. Therefore, the study evaluated the influence of different organic sources on growth and yield of carrot.

MATERIALS AND METHODS

Experimental site: The experiment was conducted at the Horticulture section, College of Agriculture, Kabba (7.8231˚N, 6.0732˚E and 400 m above sea level). The area is located in the Southern Guinea Savanna Zone of Nigeria. The monoidal rainfall spans April to November with peak in June and dry season extends from December to March. The mean annual rainfall is 1570 mm per annum with an annual temperature range of 18-32˚C. The mean relative humidity is 60%.

Plant material: Carotte touchon variety was obtained from a seed company at Zaria and used for the experiment. A total of ten seeds were planted into polyethylene bags of size 48 x 38.5 cm filled with 8 kg soil in May 2022. The polyethylene bags were perforated to allow water to drain and to improve aeration. After emergence, the seedlings were thinned to three per pot. Watering was done as required. Weeding was done by hand-pulling the weeds from the pots as well as hoeing the weeds between the rows.

Treatments and Experimental Design: The treatments comprised of four fertilizer sources (0 t/ha (control), 10 t/ha of cow dung, 10 t/ha of poultry manure and 200 kg/ha of NPK (20:10:10)). The experiment was laid out in Completely Randomized Design (CRD) with five replicates.

Fertilizer application: The required quantity of cow dung, poultry manure and NPK fertilizer was applied in split doses.

Data Collection: Data were collected on plant height, number of leaves, canopy diameter, root length, root diameter, fresh shoot weight, fresh root length and total fresh weight. In addition, dry shoot weight, dry root length, total dry weight, shoot/root ratio, percent dry matter distribution to the shoot (%DMS) and percent dry matter distribution to the root (%DMR) were also taken. Oven dry weights of the shoot and root were taken from which dry matter content and distribution were estimated. The various plant parts were oven dried at a temperature of 80°C to a constant weight. All the data were taken at harvest. Harvesting was done in August, 2022.

Data Analysis: All the data collected were subjected to Analysis of Variance (ANOVA) following the procedure for experimental design in Completely Randomized Design (CRD) using GENSTAT (2013) statistical software package. Mean separation was done using Least Significant Difference (LSD) at 5% probability level.

RESULTS AND DISCUSSION

Physico-chemical properties of the potted soil, poultry manure and cow dung used in the study is shown in Table 1. The results indicated that the soil is characterized as sandy clay loam with low pH in water (5.10). The soil organic carbon, nitrogen and phosphorus were low at 1.33%, 0.09% and 7.11 ppm, respectively. The K^+, Ca^{2+} and Mg^{2+} were 0.10, 1.00 and 1.20 cmol kg^{-1}, respectively. The poultry manure and cow dung used shows high contents of nitrogen (1.35 and 1.21%), phosphorus (0.54 and 0.48%) and potassium (0.19 and 1.03%). The poultry manure and cow dung have the potential to enhance plant growth. Chukwuka and Omotayo (2009) reported that application of organic fertilizers significantly improves the soil chemical properties and nutrient uptake in plants which in turn enhanced plant growth.

Table 1: Soil properties of the potted soil before planting and the organic fertilizers utilized in the study

Mechanical properties	Soil Particle size	Poultry manure	Cow dung
Clay (%)	26.00	-	-
Silt (%)	9.00	-	-
Fine sand (%)	28.00	-	-
Coarse sand (%)	34 .00	-	-
Textural class	Sandy clay loam		
Chemical properties			
pH in water	6.20	8.4 (%)	7.10 (%)
pH in KCl	5.10	8.2 (%)	5.12 (%)
Organic carbon (%)	1.33	57.96 (%)	6.11 (%)
Total nitrogen (%)	0.09	1.35 (%)	1.21 (%)
Phosphorus (ppm)	7.11	0.54 (%)	0.48 (%)
Exchangeable base			
Sodium (Na^{+}) cmol/kg	0.07	0.01 (%)	0.30 (%)
Calcium (Ca^{2+}) cmol/kg	1.00	6.70 (%)	0.20 (%)
Potassium (K^{+}) cmol/kg	0.10	0.19 (%)	1.03 (%)
Magnesium (mg^{2+}) cmol/kg	1.20	5.24 (%)	2.3 (%)
CEC	15.34	-	-
Base saturation (%)	52.00	-	-
Exchangeable acidity in me/ 100 g soil			
Aluminium (Al^{3+})	0.40	-	-
Hydrogen (H^{+})	5.80	-	-

Source: Laboratory of the Department of Soil Science, Faculty of Agriculture, University of Nigeria, Nsukka.

Plant height, number of leaves, canopy diameter, root length and root diameter of Carrot were positively influenced by different fertilizer sources (Fig.1). It is pertinent to know that soil amendment using organic manures improved the growth and yield attributes of carrot than others. The maximum plant height, canopy diameter, root length and root diameter were attributed to plants treated with poultry manure. This was directly followed by cow dung. The least was obtained in plants that grew where no fertilizer was applied. The result obtained in this study was attributed to the sufficient amount of nutrients supplied by poultry manure which enhanced the growth and yield attributes of carrot. The superior performance of the poultry manure as reported herein is in agreement with the results obtained by Maxime Merlin *et al.* (2020) in carrot where chicken manure application enhanced root length and root diameter than other treatments. Ani and Baiyeri (2008) reported that poultry manure is the richest of the animal manures and is a valuable source of nutrients, organic matter, particularly nitrogen and potassium. Chukwuka and Omotayo (2009) reported that application of organic fertilizers significantly improves the soil chemical properties and nutrient uptake in plants which in turn enhanced plant growth. It was evident that number of leaves was highest in plants that received cow dung than others. The least was recorded in the control. The result obtained in this work contradicts the findings of Kiran *et al.* (2016) who reported increase in number of leaves of carrot in plants treated with NPK.

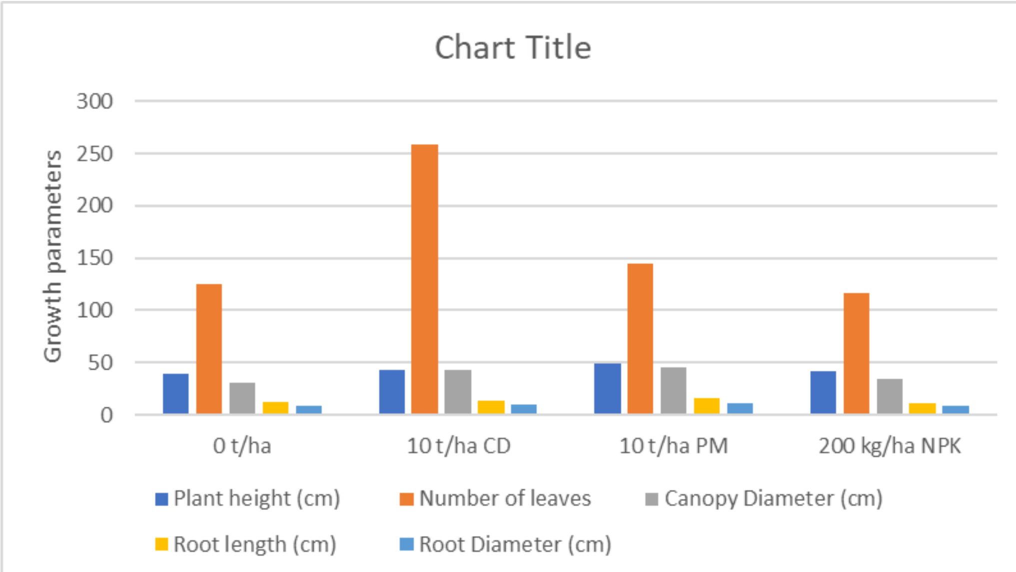

Figure 1: Plant height, number of leaves, canopy diameter, root length and root diameter of Carrot as influenced by different fertilizer sources. CD-Cow dung and PM-poultry manure.

Figure 2 presents the influence of fertilizer sources on fresh shoot weight, fresh root length and total fresh weight of carrot as affected by different fertilizer sources. Application of organic manures increased most of the traits assessed. Fresh shoot weight and total fresh weight were highest in plants fertilized with cow dung which was followed by plants treated with poultry manure. However, fresh shoot weight was lowest in plants that received NPK. The least total fresh weight was obtained in the control. It is interesting to note that application of poultry manure which increased plant height, canopy diameter, root length and root diameter also produced the heaviest root weight. The result obtained here could be linked to adequate nutrients supplied to the plants which increased yield attributes of carrot. The result is in accordance with the findings of Maxime Merlin *et al.* (2020) who reported that application of chicken manure significantly increased yield parameters of carrot than others. The inability of NPK to increase fresh shoot weight could be as a result of acidification. Qaswar *et al.* (2020) reported that NPK application decreased soil pH and increased soil acidification, whereas organic matter addition buffered acidification. For certain reasons, organic manure is preferred to inorganic fertilizers. Apart from adding nutrients to the soil (Ndukwe *et al.,* 2009), it also improves soil structural properties (Thompson and Troeh, 1978) and acts as a liming material by reducing soil acidity (Olatunji *et al.,* 2012).

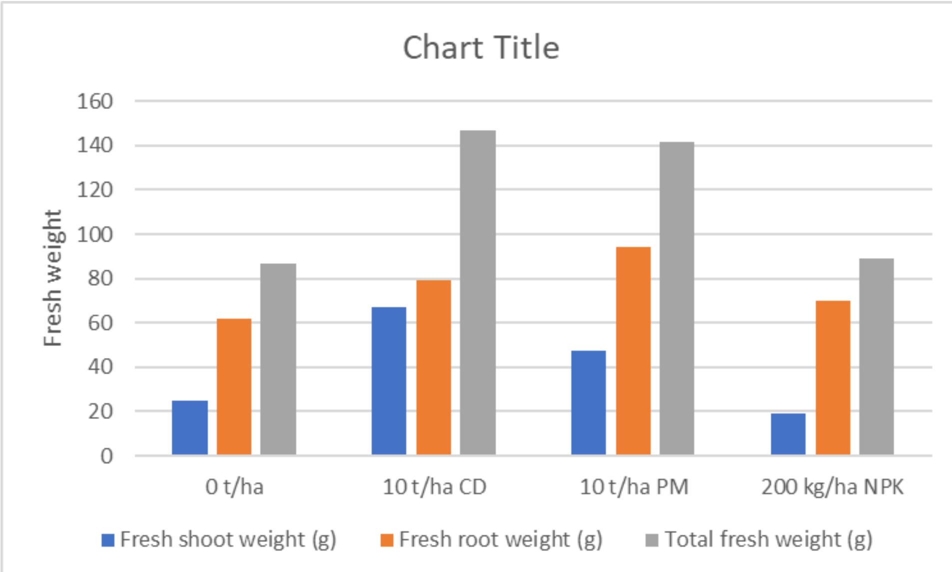

Figure 2: Fresh shoot weight, fresh root length and total fresh weight of carrot as influenced by different fertilizer sources. Cow dung and PM-poultry manure.

As shown in Fig. 3, different fertilizer sources positively impacted dry shoot weight, dry root length, total dry weight, s/r ratio, %DMS, %DMR of carrot. Heaviest dry shoot weight, total dry weight and highest shoot/root ratio was associated with plants grown with cow dung. The least was recorded in the control. Dry root weight and percent dry matter distribution to the root were obtained in plants treated with poultry manure. The lowest was obtained in the control where no fertilizer was applied. Dry matter allocation to the root which was associated with the application of poultry manure seem impressive. Root development as enhanced by poultry manure could be a strategy for survival in the harsh savanna environment. Percent dry matter distribution to the shoot was highest in the control but lowest in plants treated with poultry manure.

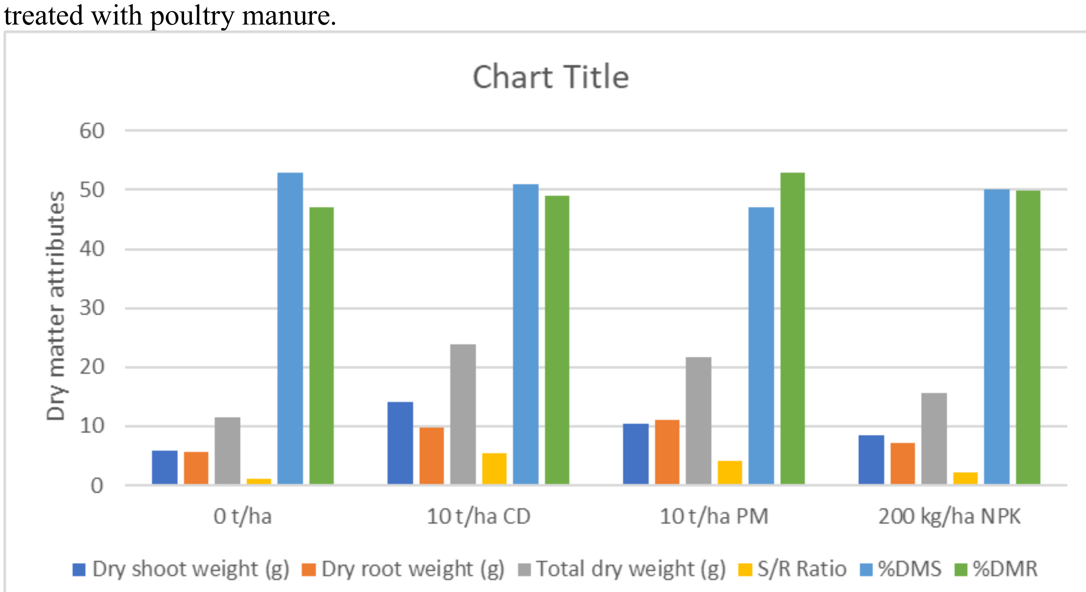

Figure 3: Dry shoot weight, dry root length, total dry weight, s/r ratio, %DMS, %DMS of carrot as influenced by different fertilizer sources. CD-Cow dung and PM-poultry manure, s/r ratio-shoot/root ratio, %DMS-percent dry matter distribution to the shoot and %DMR- percent dry matter distribution to the root.

CONCLUSION

It was evident that application of cow dung and poultry manure increased most of the traits evaluated in this study. Interestingly, application of poultry manure enhanced plant height, canopy diameter, root length, root diameter and root weight. Therefore, soil amendment using poultry manure is recommended for carrot growers in the study area.

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EFFECT OF CLIMATE CHANGE ON SUGARCANE PRODUCTIVITY IN ESWATINI

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ABSTRACT
This study provides an understanding to the relationship between climatic factors and sugarcane productivity in Eswatini. Two data sets were used for weather parameters, annual rainfall and average temperatures, this was obtained from the World Bank climate data portal, while sugarcane yield was obtained from Food and Agricultural Organization statistics database. The dataset spanned for a period of fifty-eight-year (1961-2018). The yield of sugarcane showed different variations over the period, with yield showing an increase in the first 14 years (1961-1975), and then showed a decreasing trend at a decreasing rate in the following 14 years (1976-1990), and then started decreasing at an increasing rate in the next 16 years (1991-2007) and in the last 10 years (2008-2018) the sugarcane yield was at a constant trend. The analysis of the observed weather records showed an increase in average temperatures and a decrease in annual rainfall in the observed fifty-eight-year period. The regression analysis of this study concluded that temperature was not significant and rainfall was significant at 1% level. The sugarcane trend was significant at 1%, and it showed that a point percentage change in the independent variables caused a percentage change of 0.017 in sugarcane yield in the long run. The adjusted R^2 of 0.373 indicated that 37.3% of the dependent variable (yield) was explained by the independent variables.
Keywords: *Climate change, Rainfall, Temperature, Sugarcane, Yield*

INTRODUCTION

In Southern Africa, where livelihoods and economies are extremely susceptible to weather fluctuations, climate extremes provide a significant challenge to resilience (United States Agency International Development, 2016). Climate change is likely to have negative impacts upon agricultural production, food security and economic development, especially in developing countries (Hannah *et al.,* 2005). Sugarcane is a climate vulnerable crop. The climate change, though, a very slow phenomenon is now accelerated due to natural as well as enormous human activities disturbing the composition of the atmosphere. The predictions of various climatic models for probable rise in temperature, rainfall show alarming conditions in the coming decades. As sugarcane is very sensitive to temperature, rainfall, solar radiations etc., a significant effect on its production and sugar yield is therefore, expected in future (Srivastava & Mahendra, 2012). The global production of sugarcane is anticipated to be significantly impacted by climate change, particularly in poorer nations due to their limited adaptive capacity, increased susceptibility to natural disasters, and inadequate forecasting and mitigation techniques. Increases in the frequency and intensity of extreme weather circumstances brought on by climate change may have had a detrimental impact on sugarcane production and will likely continue to do so (Zhao & Li, 2015).

Relative to the overall Swazi economy, the sugar industry is quite significant as reflected in the following statistics, sugarcane growing accounting for 74% of total agricultural output, employment in sugarcane growing contributing 35% to total agricultural wage employment, sugar milling employment compromising of 18% of total manufacturing wage employment, the sugar industry output (i.e. sugarcane growing plus milling) contributing 13% to GDP, sugar industry employment compromising 17% of total private sector wage employment and 10% of national formal sector employment and sugar exports contributing 16% to total export earnings (Swaziland Sugar Association, 2015). Therefore, it's critical to contribute to our understanding of the likely future climate, the distribution of impacts across various regions, the direct and indirect effects of these changes, and the best ways to adapt in order to lessen any potential negative effects on Eswatini's sugarcane production.

METHODOLOGY

The study was the Kingdom of Eswatini, a small, land-locked Kingdom in South-Eastern Africa. The Kingdom is bordered in the North, West and South by the Republic of South Africa and in the East by Mozambique. The country has an area of 17,364 square kilometers, and it has four distinct geographical regions, and also four has four ecological regions which consists of the Highveld in the North and West, with mountainous scenery and high rainfall, sloping east, through the intermediate Middleveld, to the dry, hot, and relatively flat Lowveld. The data used in the study was secondary data, information was collected from Food and Agricultural Organization statistics database (1961-2018). Data on monthly temperature and rainfall was obtained from the World Bank climate data portal (1961-2018).

Analytical techniques

Both descriptive such as mean and standard deviation, graphs and inferential (multiple regression analysis) statistics was used to analysed the set objectives of the study.

Multiple Regression Analysis Equation:

$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + u$ ……………………………….(eqn 1)

Where:

Y_i = is yield (dependent variable)

β_0 = is the intercept

$\beta_{x\,=}$ slope of the coefficient

X_1 = average temperature

X_2 = annual rainfall

U = random error term

RESULTS AND DISCUSSION

Table 1 shows the descriptive statistics of the study. It shows that there were fifty-eight observations, which represents a period of fifty-eight years from year 1961 to 2018. The descriptive statistics describes the relationship between the dependent variable which is yield and the independent variables which are rainfall and temperature. The mean rainfall recorded was 807.81mm, the mean temperature was 20.15^{0}C and the mean yield recorded was 100.49 tonnes per hectare. The standard deviation value for rainfall was 167.77 mm, which is high (as a rule of thumb, a standard deviation >=1 indicates a relatively high variation, while a standard deviation <1 can be considered low) . This means that the values of the data are spread out over a wider range. Standard deviation for temperature was 0.51^{0}C, which is low. This means that the values of data set tend to be close to the mean (also called the expected value) of the set. Standard deviation for yield was 10.47 tonnes per hectare, which is high. This means that the values of data are spread out over a wider range. The minimum and maximum of rainfall were 524.78 mm and 1510.85 mm respectively. The minimum and maximum of temperature were 19.28^{0}C and 21.26^{0}C respectively. The minimum yield was 55.82 tonnes per hectare which was observed in the year 1963 and the maximum yield was 120.56 tonnes per hectare recorded in the year 1970. The median values for rainfall, temperature and yield were 787.34 mm, 20.16^{0}C and 120.56 tonnes per hectare respectively.

Table 1: Descriptive Statistics

Statistics	Rainfall	Temperature	Yield
Mean	807.81	20.15	100.49
Standard Deviation	167.77	0.51	10.47
Minimum	524.78	19.28	55.82
Median	787.34	20.16	99.23
Maximum	1510.85	21.26	120.56
No. of Observations	58	58	58

Source: Own computations of output from R

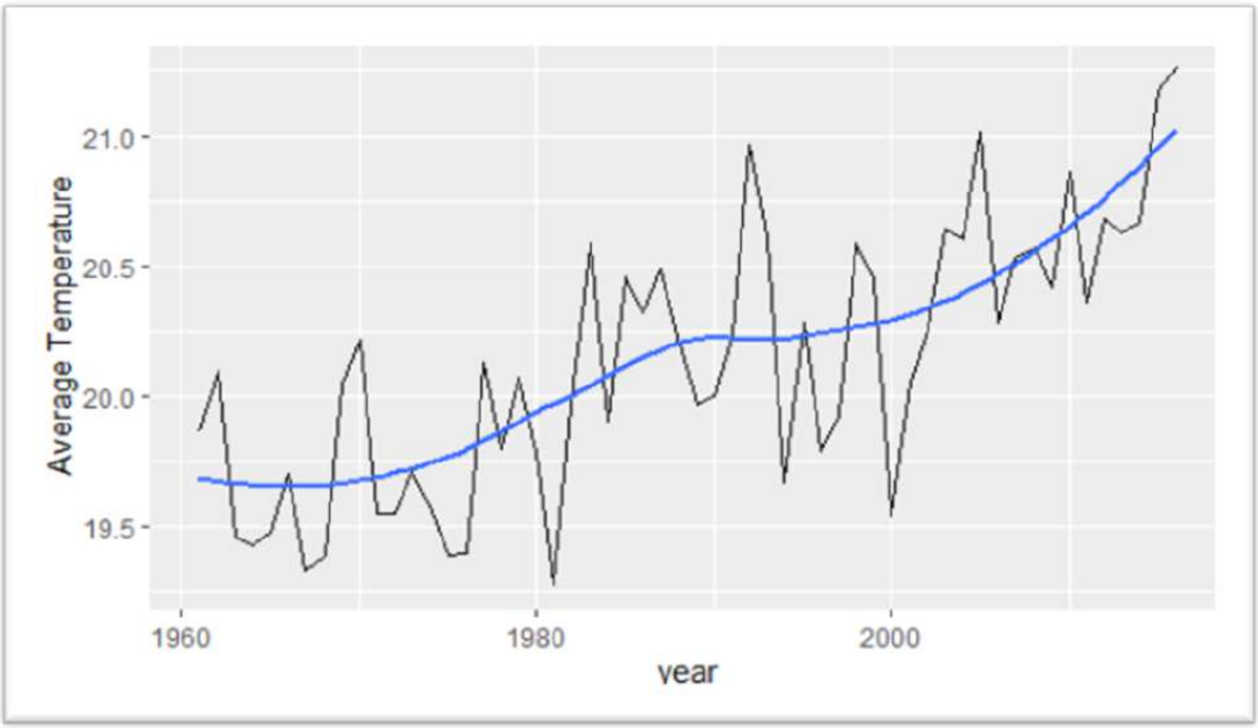

Figure 1: Trend graph of Temperature

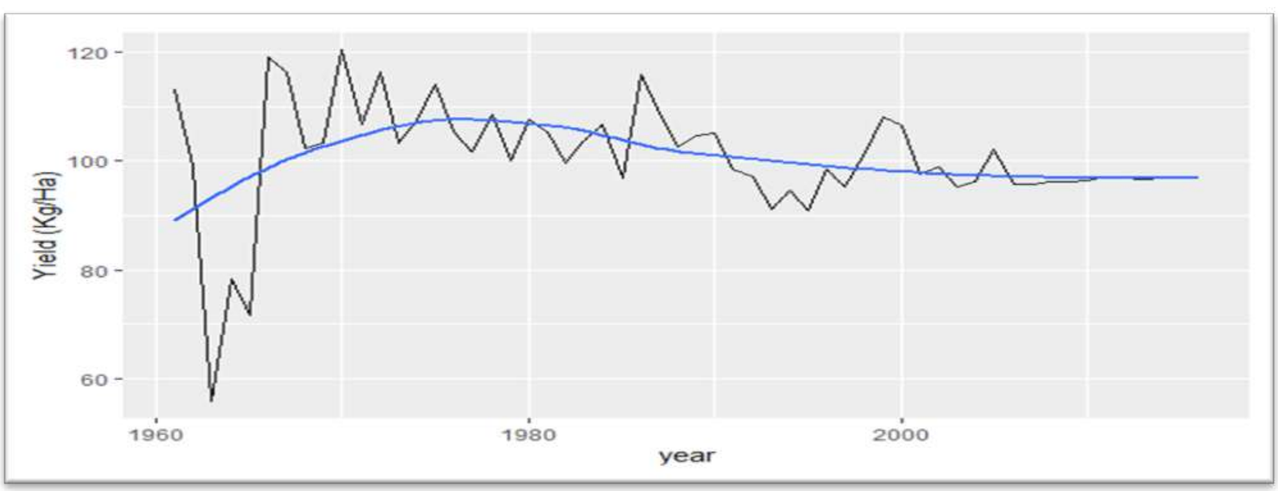

Figure 2: Trend graph of Sugarcane yield

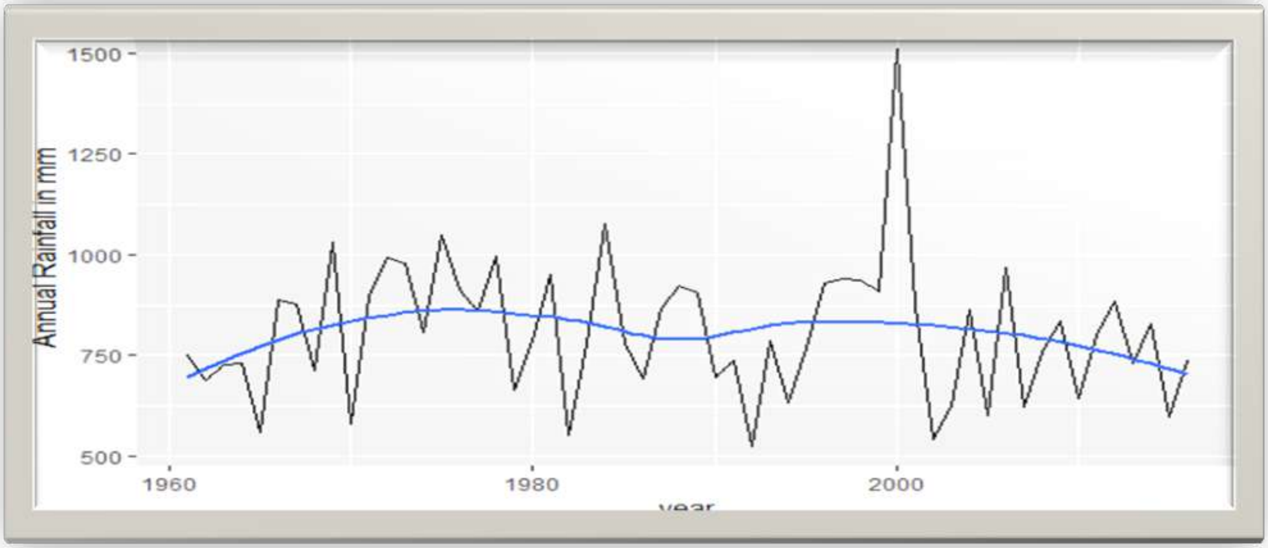

Figure 3: Trend graph of Rainfall

Table 2 presents the results of a regression analysis of yield as the dependent variable and rainfall and temperature being independent variables. The results of the regression analysis are shown as output in natural form (1) and in Log form (2). Results from the Log form (2) were used to make interpretations. This is done to improve linearity between the dependent and independent variables. It improves validity of statistical analyses. The regression analysis results indicated that temperature is not significant with a negative coefficient (-1.870). A point percentage change in rainfall leads to a 0.867 percentage change in sugarcane yield with a standard error of 0.276 at 1% significant level. The sugarcane trend is significant at 1%, showing the rate of change of the model, a point percentage change in the independent variables causes a percentage change of 0.017 in sugarcane yield in the long run. The constant intercept of (-0.529) indicates that holding all explanatory variables (rainfall and temperature) constant, the sugarcane yield is negative, the sugarcane yield decreases by 0.569.
The R^2 figure of 0.407 indicates that 40.7% of the variation in sugarcane yield was explained by the independent variables (rainfall and temperature) included in the model. Yield is determined by many independent variables which were not included in the regression model which include labour, fertilizers, pesticides and capital stock, and this can explain the low R^2.

	Dependent variable:	
	log(yield)	
	(1)	(2)
Rainfall	0.0003^{***}	
	(0.0001)	
Temperature	0.077	
	(0.051)	
log(rain)		0.867^{***}
		(0.276)

log(temp)		-1.870
		(3.323)
Trend	-0.002	0.017^{***}
	(0.001)	(0.005)
Constant	2.890^{***}	-0.529
	(1.044)	(10.868)
Observations	58	57
R^2	0.127	0.407
Adjusted R^2	0.078	0.373
Residual Std. Error	0.113 (df = 54)	0.367 (df = 53)
F Statistic	2.612^{*} (df = 3; 54)	12.103^{***} (df = 3; 53)
Note:	$^{*}p^{**}p^{***}p<0.01$	

Source: output from R

CONCLUSION

General conclusions can be made on the basis of the analysis of sugarcane yield, average temperatures recorded and annual rainfall received over the fifty-eight-year period (1961-2018). From observing the line graphs that were presented, it can be seen that, firstly, sugarcane yield is somewhat at a constant trend with an average yield of 96 t/ha in the last 10 years of the years under review (2008-2018). Temperature is increasing with the highest peak being at 21.26^0C average temperatures recorded in 2016. The annual rainfall has been declining in the last fifty-eight years. From this, it can be concluded that the increasing temperatures cause water scarcity to also increase. The sugarcane crop demands more of the now scarce water resource because of the increasing temperatures which cause less rainfall which is useful for irrigation.

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EXPLORING THE DRIVERS OF ADOPTION OF ORGANIC FARMING AMONG URBAN VEGETABLE GROWERS: A CASE OF LAGOS STATE, NIGERIA

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ABSTRACT
The consumption of organic product has been of assistance in the management of non-communicable disease and in the promotion of good health and extended life span. This study therefore analyses the drivers of adoption of organic farming among urban vegetable growers in Lagos State, Nigeria. Data were collected from the sampled respondents (farmers) in the selected communities of the study areas through a structured questionnaire with interview schedule. The study sampled a hundred and eighty-three urban vegetable growers in the study area. Both descriptive and inferential statistics (Logit regression model) was employed in analysing the data obtained. The findings of the study showed that average age of the farmers as 49.3; household size of 5; farm size of 0.13 hectares and farming experience of about 21 years. Logit model result showed that farm size, age, education, experience and household size were significant factors that affect the adoption of organic farming, the implication of these from the finding is that increase in the level of any of the explanatory variables with positive sign will have a positive effect on the likelihood of adoption of organic farming by the farmers. However, urban vegetable growers should be encouraged in order to increase organic productivity.
Keywords*: Agriculture, Logit, Organic, Urban, and Vegetable*

INTRODUCTION

Agriculture, one of Nigeria's primary economic sector makes a substantial contribution to the country's development. The government gives this industry top emphasis and attention before the advent and exploration of crude oil. Researchers believe that Nigeria might achieve the much-needed economic independence through organic agriculture at a time when people around the world are yearning for sustainable farming practices that protect the environment and give people access to wholesome food. Rapid output and productivity growth is essential for the agricultural sector to sustainably serve this pivotal role (Onche, 2010). The market for organic vegetable farming is predicted to grow at a compound annual growth rate (CAGR) of 4.9% from $7.41 billion in 2020 to $7.77 billion in 2021 (Baskaur, et al., 2021). This growth is primarily attributable to companies returning to business and adjusting to the new normal while recuperating from the COVID-19 impact, which had previously resulted in preventive control measures like social distancing, remote work, and the closure of commercial activities that created operational challenges.

Organic foods are becoming more popular and attracting higher premiums from consumers, providing a great opportunity to increase farmers' income and food security (Mishra et al. 2018; Yu et al. 2018). In promoting and enhancing food safety, sustainable agroecosystem, including biodiversity, biological cycles, and soil biological activity, organic agriculture (OA) is a comprehensive production management system that recognizes the need for locally adapted systems due to regional conditions and prioritizes the use of management practices over the use of off-farm inputs. This is achieved by fulfilling any specific function inside the system by cultural, biological, and mechanical processes whenever possible, rather than with synthetic materials. The goal of organic farming is to increase the soil's biological fertility so that crops may absorb the nutrients they require from the soil's constant turnover. This releases the nutrients in a form that is compatible with plant needs.

Low yield constrained adoption of OA when compared with the yields from conventional, intensive agriculture. This yield shortfall could be made up by increasing the organic land area (Seufert et al. 2012). There has been extensive research to identify the factors that improve farmers' adoption of OA (Adesope et al. 2012; Haris et al. 2018; Azam and Shaheen 2019; Liu et al. 2019; Cakirli and Theuvsen 2020; Hou et al. 2022). But little have been done as regards this in Lagos – an urban city where urban agriculture is gain momentum. It is on this note that this study

METHODOLOGY

The study was carried out in Ojo Local Government Areas in Lagos State. It is inhabited by mainly Aworis communities in the Riverine Area of Ojo Local Government includes Irewe, Taffi Hausa, Taffi Awori Itogbesa, Popoku while in the upland, settlements include Ojo, Ira, Ajangbadi, Sabo-Oniba,Ilufe, Igbede, Agric, Arufa, Olugbemi, Muwo and others. The Ojo indigenes are mainly farmers, mat weavers, fishermen, hunters and petty traders. The study employ multistage sampling procedure to select the respondents. The study selected 6 communities and 183 respondents were sampled from these communities who primarily engage in vegetable production. Structured questionnaire was administered to farmers in the study area through the use of interview schedule to obtain data. The primary data collected was then subjected to statistical analysis. Both descriptive and inferential statistical tools were used in the study to examine the set objectives of the study.

Logit model

Logit regression model is a binary response model and it was used to analyze determinants of adoption of organic farming among the vegetable growers in the study area. The dependent variable was binary as we have vegetable growers that adopt OA and those that never adopt. As the probability model, the probability increases (from zero to 1), the odds also increase from 0 to infinity. And if β is 'large' then as X increases the log of the odds will increase steeply (equation 1). The explanatory variables use in this study include: Farmers' personal information, farm specific variables and production information that influences adoption of OA. The mathematic model was presented in equation 1 below:

$$\log\left(\frac{\pi}{1-\pi}\right) = \alpha + \beta X \quad \text{...(1)}$$

And the explicit model is thereby expressed as:

$Y = \alpha + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + e$

Where, X_1= Gender (dummy); X_2= Farm size (hectares); X_3= Age of respondents (years); X_4=Experience (years); X_5= Household size (Number of people); X_6=Social organization (dummy); X_7 = Education (years) and X_8= Occupation (dummy);

RESULTS AND DISCUSSION

The summary statistics of some of the variables used was presented in Table 1. The table revealed that the average age of vegetable farmers in the study area stood at about 49 years, having average farm size of 0.13 hectare, the average family labour stood at 43.33 mandays and hired labour at 18.68 manday. The average years of education stood at 14.88; implying that most of the vegetable farmers had formal education and had at least secondary school education. The household size has a mean value of about 5 persons; implying hat most of the vegetable growers' household were moderate and this has serious implication on the well being of the household members.

Table 1: Summary Statistics

Variables	Description	apriori expectation	Mean (Std. Dev)
Age	Years	+/-	49.31(12.97)
Farm size	Hectare	+	0.13(0.008)
Family labour	Size of labour in Manday	+	43.33(10.23)
Hired labour	Size of labour in Manday	+	18.68(6.11)

Gender	Dummy; 1 = male; 0 = female	-	0.53(0.46)
Education	Years of schooling	+	14.88(2.36)
Experience	Years	+	21.25(9.23)
Occupation	Dummy; 1 = veg. farming; 0 = otherwise	+/-	0.07(0.01)
Social Organization	Dummy; 1 = Member 0 = Non-member	+	0.22(0.09)
Household size	Number of people eating from the same pot	+/-	5.21(1.34)
Dry season vegetable production	Dummy; 1 = Yes; 0 = No	+/-	0.13(0.07)
Wet season vegetable production	Dummy; 1 = Yes; 0 = No	+/-	0.28(0.08)

Source: Field Survey, 2023

Table 2 revealed that 78.14% of the vegetable growers adopted green manure crop selection and sowing timing. About 62% adopted crop residue management to check major pest and disease. For the selection of seed treatment with bio fertilizer for vigour growth, most (53.55%). Vermicompost application receive no adoption from more than 93% of the respondents when more than 77% of the respondents failed to adopt Vermicompost preparation method. Other, organic farming activities adopted include: Seed treated with bio fertilizer for disease control (87.98%), Seed treated with bio fertilizer for vigor growth (53.55%). The result implied that most of vegetable growers in the study area are aware of most of the OA activities and quite number of them practice them.

Table 2: Adoption of Organic Farming among vegetable growers

Variables	**Yes**	**No**
Adoption of green manure crop selected and sowing time	143(78.14)	40(21.86)
Crop residue managed properly to check major pest and disease	114(62.29)	69(37.70)
Seed treated with bio fertilizer for vigour growth	98(53.55)	85(46.45)
Seed treated with bio fertilizer for disease control	93(50.82)	90(49.18)
Sown resistant varieties for pest/disease control	161(87.98)	22(12.02)
Organic/solid waste management	167(91.26)	16(8.74)
Practiced crop rotation and shallow ploughing for weed control.	117(63.93)	66(36.06)
Vermicompost preparation method	42(22.95)	141(77.05)
Vermicompost application	11(6.01)	172(93.99)
Bio fertilizers purchased from authorized source	54(29.51)	129(70.50)
Adopted indigenous/traditional method for proper storage	127(69.40)	56(30.60)

Source: Field Survey, 2023

Determinants of Adoption of Organic Farming

Table 3 examines the determinants of adoption of organic farming. The empirical estimation of the Logit analysis result as presented in Table 3 reveals a log likelihood of -57.56424. Table 26 reveals that farm size with odd ratio of -0.217 is negatively significant determinant of adoption of organic farming among vegetable growers in the study area. It shows that the higher the farm size, the less likely the respondents will adopt organic farming. Age is also a significant factor in the determinants of the adoption of organic farming among small scale farming in the study area. The coefficient of age (-0.596) is negative which shows that the older respondents are less likely to adopt organic farming, than the younger ones. Also, the coefficient of Education positively drives adoption of organic farming. Implying education directly influence the adoption of organic farming and therefore indicated that the higher the educational level of the respondents, the higher they likely adopt organic farming

Furthermore, the result revealed that farming experience positively related to adoption of organic farming among small scale vegetable farmers in the study area. The result in the table implies that the higher the experience of the farmer, the more likely they will adopt organic farming. And lastly, household size with positive sign and significant at 5% level of confidence; implies that the greater the household size, the more likely the farmers will adopt organic farming and vice versa. Due to drudgery nature of OA practices, vegetable farmers with larger households' size are likely to have more hands for labour utilization.

Table 3: Parameter estimates of adoption of Organic Farming among vegetable growers

Variables	Odd ratio	t-value
Constant	4.270	2.72
Farm size	-0.217	-1.85*
Family labour	0.299	-1.06
Hired labour	-0.161	-0.78
Gender	0.579	0.87
Age	-0.596	-2.33**
Education	0.518	-2.85***
Experience	0.163	2.27**
Occupation	-0.219	-0.50
Social Organization	0.467	0.91
Household size	0.106	2.42**
Log livelihood = -57.564		
Chi^2 = 10.31		

Source: Field Survey, 2023

The result presented on Table 4 shows the constraints faced by vegetable growers in the study area. The result revealed that 92.34% of the respondents indicated that land availability is a major constraint to vegetable production in the study area. More that 64% of the respondents also identify flooding as the major challenge in vegetable production in the study area. Since the study area is a riverine area of Lagos, so the chance of being flooded is high. Also, more than 56% of the vegetable growers claimed pest attack or infestation s another problem with vegetable production, meanwhile 42.07% identify theft as their challenges, a smaller proportion (16.94% and 13.66%) claimed that land abuse and unstable market are the major challenges with vegetable production in the study area respectively.

Table 4: Distribution of Respondents based on problem faced in Vegetable Production

Problem	Frequency	Percentage
Pest Attack	103	56.28
Theft	77	42.07
Land unavailability	169	92.34
Flooding	118	64.48
Land Abuse	31	16.94
Unstable market	25	13.66

Source: Field Survey, 2023
* Response > 100% due to multiple choice responses

CONCLUSION

The study explores the drivers of adoption of organic farming in urban area using Lagos as a case study. The study employed a multistage sampling procedure to selected 183 vegetable growers in Ojo Local Government area of the state. Based on the findings deduced from the study area, it is concluded that: most of the vegetable growers in the study area were middle-aged people having at least secondary school education, though, they were operating a small scale enterprise.

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NON-ADOPTION OF POST-HARVEST MANAGEMENT PRACTICES BY COCOA FARMERS IN ETUNG LOCAL GOVERNMENT AREA, CROSS RIVER STATE, NIGERIA

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ABSRACT
The study on the non-adoption of post-harvest management practices by cocoa farmers in Etung Local Government Area, Cross River State, Nigeria was carried out to identify the types of post-harvest management practices mostly adopted by the cocoa farmers, identify factors affecting the non-adoption of post-harvest management practices and highlight constraints affecting the non-adoption of post-harvest management practice by the cocoa farmers. Two hundred and thirty one (231) cocoa farmers were randomly selected from ten (10) wards of the Local Government Area. Descriptive statistics, binary logistic regression model and Likert scale rating were used as statistical tools to achieve the objectives of the study. The study addressed five research questions and objectives, and tested one hypothesis, which was stated in the null form as "there is no significant difference in the adoption of post-harvest management practices by cocoa farmers in the study area". The study adopted multi-stage purposive random sampling procedure to selected two hundred and thirty one respondents from the ten council wards in the area. Primary source of data was obtained with the aid of a structured questionnaire administered to respondents by the researcher. Data obtained were analyzed using descriptive statistics such as frequencies, percentages, mean and inferential statistics like independent t-test. The result from the study revealed that majority of the cocoa farmers practiced mostly pod breaking, fermentation, drying, and packaging while storage was less adopted. The result equally revealed that lack of labour, poor access to credit facilities and farm inputs, climatic factors, lack of extension agents, fluctuations of market prices of cocoa, wide spread of pests and diseases among others were the major constraints in the non-adoption of post-harvest management practices in the area. This therefore recommends that more attention should be paid to post-harvest management practices by cocoa famers in Etung Local Government Area as only 60% adoption of the highlighted practices were recorded, also, there should be deliberate effort to sensitize, enlighten or educate cocoa farmers on the significance of packaging and storage as integral parts of post-harvest management. The number one constraint faced by farmers is unsatisfied price of beans dictated by buyers. To cub this, farmers' association in the study area should enact strict rules restraining members from accepting any ridiculous pricing from the marketers with punitive measure melt on defaulters. Lastly, further research work should explore possibility of assessing the various drying techniques that farmers in Etung Local Government Area of Cross River State Nigeria are presently practicing.
Keywords: *Constraint, descriptive statistics, management practices, non-adoption, post-harvest.*

INTRODUCTION
Cocoa quality is determined by the post-harvest stage, which includes fermentation, drying, and oxidative processes (Vera-Montenegro, Baviera-Puig and Garcia-Alvarez-Coque, 2014). Postharvest losses in cocoa can range from diseases to unpicked pods, spillage, and germinated beans. Research on cocoa

fermentation processes is inconclusive, and adoption varies based on regional and production practices (Amoah, 2013, Papalexandratou et al., 2013). To ensure fine quality cocoa, postharvest management is crucial. Other factors determining post-harvest technology include cost and adoption ability. Processing factors can influence the transfer and adoption rate of technologies, and if not properly managed, can affect the quality and quantity of the processed product (Ekum, 2017). Postharvest loss, which can be up to 80% of total production (Fot, 2013), is a significant issue in Africa, with losses ranging between 20% and 40% (Abass, Ndunguru, Mamiro, Alenkhe, Mlingi and Bekunda, 2014). These losses impact the lives of millions of smallholder farmers, impacting food volumes and trade-in values. The World Bank reports that sub-Saharan Africa loses food grains worth about USD 4 billion annually (Zorya, 2011). The sustainability of cocoa production is critical, especially in rural communities where it provides income and employment. Good Agricultural Practices (GAPs) are technical recommendations and guidelines that address environmental, economic, and social sustainability for on-farm processes, resulting in safe and quality food and non-food agricultural products.

The Food and Agriculture Organization (FAO) warns that by 2050, the agricultural sector must produce 50% more food than in previous years in sub-Saharan Africa and South Asia to meet global food demand. With a projected population of 9.1 billion by 2050, 70% extra food production is needed (Godfray, *et al*, 2010; Hodges, Buzby and Bennett, 2011). However, one-third of the food produced, worth $1 trillion, is lost during postharvest operations. Researchers suggest adopting best postharvest management practices, such as new technologies and strategies, to reduce postharvest losses (FAO, 2013). This study aims to determine the post-harvest management practices of cocoa farmers in the Etung Local Government Area, Cross State, Nigeria. The research focuses on identifying the socio-economic characteristics, types of post-harvest management practices, and factors affecting their adoption. The study also analyzes socio-economic factors influencing non-adoption of post-harvest management practices and highlights the constraints faced by farmers. The hypothesis testing shows no significant difference in the adoption of post-harvest management practices. The study's significance lies in providing empirical data on post-harvest management practices, which could guide policy formulation and implementation.

MATERIALS AND METHODS

Study Area

Etung Etung Effraya carried out Afangideh Etung Etung Ikom Boki Ikom Akampka Ejagham Etung 1500mm Government Etung with its capital. Etung Okwongwo Oban is one of the eighteen local government areas of Cross River State. It is located in the central part of the state and lies between latitudes 5000°00°4° N and 6000°05° N and extends between longitudes 80°00°5° E and 9000â 05ââ E (Okongor, Afangideh and Obong, 2013). The Etung Local Government Area borders the Ikom and Boki Local Government Areas to the north, the Cameroon Republic to the east and Ikom to the west in the south of the Akampka Local Government Area. It also has a land area of 903.22 km2 (Ministry of Lands and Survey, 2008). It is inhabited by the Ejagham speaking people. Etung lies in the equatorial zone with average annual rainfall between 1500 mm and 3000 mm. During the rainy season, the average daily maximum temperature is 29 °C. While the daily maximum temperature during the dry season is 350°C. The Etung Local Government Area is part of the Cross River Rainforest, which today represents an important part of what remains as Nigeria's tropical forest (Okongor et al., 2013). The forest in Etung includes: (a) Okwongwo Division and (b) Oban Division of Cross River National Park. This ecological zone has the highest species composition of rare and endangered plants including trees, shrubs, herbs etc. in Nigeria. The predominant crops include cocoa, banana, plantain and Arvengia.

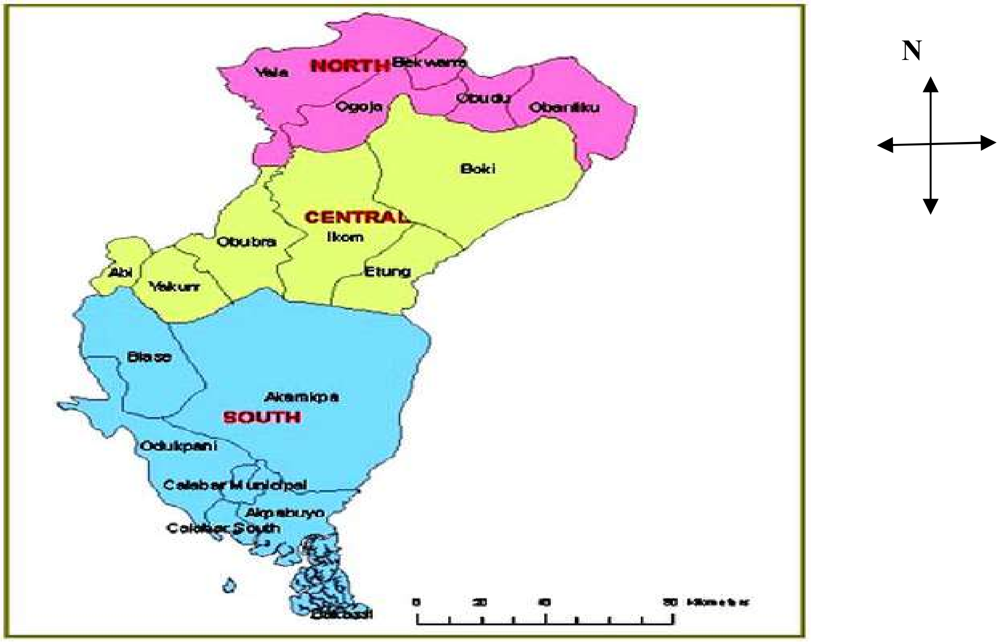

Fig. 1: Map of Cross River showing the study area, Etung Local Government Area
Source: Ministry of Lands and Survey, Etung Local Government land mass, 2008.

Population and sampling technique for the study

The population for this study consists of 2310 registered cocoa farmers in all ten (10) local government areas in Etung Local Government Area. A multi-stage purposive random sampling technique was used to select a total of two hundred and thirty-one (231) cocoa farmers using a proportionality ratio of 10% from the three thousand three hundred and ten (2,310) cocoa farmers registered with the Cocoa Farmers Association of Nigeria (CFAN), Cross River State Branch.

Table 1: Selection of sample size/respondents

Wards	Sample frame	Sample size
Abia	180	18
Abijang	40	4
Agbokim Obi	180	18
Ajassor	620	62
Bendeghe/Ekiem	180	18
Effraya	70	7
Etomi	460	46
Itaka	210	21
Mkpot	40	4
Nsofang	330	33
Total(10)	**2310**	**231**

Instrument of data collection, validity and administration of the research instrument, the main instrument for data collection is the questionnaire which was based on the objectives of the study to obtain information from the respondents. The instrument for this research, the questionnaire, was validated by my supervisor and other experts in the Department of Agricultural Economics and Extension and relevant corrections were strictly implemented. The instrument was then applied to sample participants in the study area with the help of two research assistants to improve speed and accuracy.

Measurement of Variables

The Likert four-point scales called Rating, namely; extremely severe, severe, moderately severe and non-severe were used to determine the limitations in post-harvest management practices by cocoa farmers in the local government area. It was also used to determine the extent to which each of the restrictions represents a restriction on cocoa production in the study area. To determine which of the variables was considered a critical impact or limitation, the variable mean of 2.50 was used. This was achieved by summing the assigned score to get ten and dividing the result by four (i.e. 4+3+2+1 = 10/4=2.50). Therefore, any variable with a mean of 2.50 and above was considered critical, while variables with less than 2.50 were considered not to have such a critical impact on the restriction. This method was used to address objective (V) of the research.

Data analysis

From the survey, the data was subjected to both descriptive and inferential analysis, to enhance its interpretation and discussion. Specifically, objective i, ii, iii and v were analyzed using descriptive statistics such as mean, tables, percentages and standard deviation. Objective iv was analyzed by using binary logistic regression. The implicit model of the multinomial regression is given as:

$Y = f(X_1 + \ldots X_n + u)$

Where:

Y = dependent variable (adoption of postharvest management practices: 1= adopted, 0= otherwise)

X_1 = age (years)

X_2 = sex (male=0, female=1)

X_3 = education (educated=0, 1=otherwise)

X_4 = years of farming experience (years)

X_5 = household size (number)

X_6 = size of farm (Ha)

X_7 = marital status (married =0, 1= otherwise)

u = error term; Objective V was achieved by using a four-point the Likert scale technique.

RESULT AND DISCUSSION

Socio-economic characteristics of respondents

The findings of analyzed data on socio-economic characteristics of the respondents in Etung Local Government Area are presented in Table 2.

Table 2: Distribution of respondents based on their socio-economic characteristics

Variables	Response categories	Frequency	Percentages	Mean
	<20	0	0.00	
	21-29	6	2.6	
Age (years)	30-39	38	16.5	
	40-49	83	35.9	
	>50	104	45.0	47 years old
	Total	**231**	**100**	
	Male	171	74.0	
Sex	Female	60	26.0	
	Total	**231**	**100**	
	Single	27	11.7	
Marital status	Married	203	87.9	
	Widowed	1	0.4	
	Total	**231**	**100**	
	No formal	5	2.2	

Educational qualifications	education			
	Primary	29	12.5	
	Secondary	64	27.7	
	Tertiary	133	57.6	
	Total	**231**	**100**	
	1-10	4.5	19.5	
Years of experience	11-20	87	37.7	17years
	21-30	92	39.5	
	31 and above	7	3.0	
	Total	**231**	**100**	
	1-5	124	53.7	
Farm size (ha)	6-10	82	35.5	6 ha
	11-15	15	6.5	
	16 and above	10	4.3	
	Total	**231**	**100**	
Output (tons/ha)	0-5	197	85.3	
	5.1-10	29	12.6	3.4 tons/ha
	10.1-15	3	1.3	
	15.1 and above	2	0.9	
	Total	**231**	**100**	

Source: Field data, 2022

Table 2 shows the distribution of respondents according to their socioeconomic characteristics. The results showed that about 45% of the study's respondents were 50 years old and older. Furthermore, 35.9% of them were between 40 and 49 years old. This means that many of the cocoa farmers in Etung Local Government Area are of advanced age. This also means that these farmers have many years of practical experience in cocoa management. In contrast, 16.5% and 2.6% were between 30 and 39 and 20 and 29 years old, respectively. The results in Table 2 showed that the majority (74%) of respondents were male and 26% were female. This result suggests that cocoa farming in Etung Local Government Area is a male-dominated activity, which may be due to the strenuous nature of cocoa farming. Regarding marital status, the majority (87.9%) of cocoa farmers were married, meaning that cocoa farming is largely run by family members. In addition, 11.7% are single and only 0.4% are widowed. This result also confirms the fact that cocoa cultivation is an important source of livelihood for farmers. The education level variables showed that the majority (57.6%) of the respondents had a university degree, 27.7% had a secondary school degree, 12.5% had a primary school degree and only 2.2% had no formal qualification.

This finding showed that cocoa farmers in Etung Local Government Areas are well educated, which could promote the adoption of improved management practices in agricultural activities. The results presented in Table 2 show that 19.5% of farmers had 1-10 years of experience in agriculture, 37.7% had 11-20 years of experience, 39.5% and 3.0% had 21-30 years or 31 or more years of experience. This result implies that the respondents have been involved in cocoa farming for several years. Table 2 also shows that 53.7% of respondents had a farm size between 1 and 5 hectares, while 35.5% had a farm size between 6 and 10 hectares. The cocoa production results show that 85.3% of respondents had a production of 0-5 tonnes/ha, 12.6% had a production of 5.1-10 tonnes/ha, while only a tiny fraction of 0.9 % of them had a production of 15.1 tons/ha above per year.

Types of post-harvest management practices in Etung Local Government Area

Table 3: Frequency distribution of the respondents based on types of post-harvest management practices available Etung Local Government Area

Practices	Yes (%)
Pod breaking	99.6
Fermentation	97.8
Drying	98.7
Packaging	88.7
Storage	43.3

Source: Field data, 2022

Table 3 shows that the majority of respondents adopted four different postharvest management practices. Specifically, 99.6% of respondents identified pod cracking as a management practice used by cocoa farmers in the study area. Furthermore, most farmers, namely 97.8%, recognized fermentation as a management practice used in the study area. Furthermore, most farmers (98.7%) reported that drying is one of the post-harvest management practices adopted by farmers in the study area. Again, many (88.7%) of the respondents stated that they use packaging as a post-harvest management practice in the study area. Only 43.3% of cocoa farmers agreed that storage is a post-harvest management practice, but they do not practice it. This result could be due to high costs of storage facilities or the availability of a year-round market for disposal of cocoa beans after packaging. This suggests that the post-harvest management practices most commonly practiced by cocoa farmers in Etung Local Government Area are pod breaking, fermentation, drying and packaging, while only a very small number of farmers (43.3 %) practiced storage as a post-harvest management practice.

Post-harvest management mostly adopted by the farmers

Table 4: Frequency distribution of the respondents based on non-adoption of post-harvest management practices adopted by farmers in the area

Practices	Not practiced	Low	Medium	High	Very high	Extremely high	SD	Mean	Remark	Ranking
Drying	0	35	14	44	67	71	1.379	4.54	Mostly adopted	1st
Pod breaking	0	63	31	50	34	53	1.515	3.93	Mostly adopted	2nd
Fermentation	0	50	63	47	57	14	1.233	3.66	Mostly adopted	3rd
Packaging	10	39	109	51	15	7	1.024	3.19	Less adopted	4th
Storage	113	17	16	7	14	64	2.194	2.93	Less adopted	5th

Source: Field data, 2022

This section of the study examined the post-harvest management practices adopted by cocoa farmers in the study area. Table 4 shows that three of the postharvest management practices were largely adopted by farmers. These three post-harvest management practices used are pod cracking, fermentation and drying. This confirms the Cocoa Research Institute of Nigeria (CRIN) observation that cocoa farmers usually carry out the cracking, fermentation and drying of the pods within a few days of harvest without any delay (CRIN, 2011). However, according to the results, drying came first, breaking the pods second and fermentation third. This means that farmers are more concerned with drying as part of these management practices. On the other hand, Table 4 showed that packing and storage were less applied post-harvest management practices in the study area.

Factors influencing the adoption of post-harvest management practices

Table 5: Results of the binary logistic regression of determinants of adoption of post-harvest management practices in Etung Local Government of Nigeria

S/N	Variables	Coefficient	Wald	Exp (B)	Sig
	Constant	4.571	6.291	96.644	0.012*
1	Sex (X_1)	-1.176	8.143	0.308	0.004**
2	Maritalstatus (X_2)	0.515	0.609	1.673	0.435^{ns}
3	Age (X_3)	-0.018	0.553	0.983	0.457^{ns}
4	Education (X_4)	0.074	0.086	0.928	0.769^{ns}
5	Household size (X_5)	0.276	0.436	0.759	0.509^{ns}
6	Farming experience (X_6)	0.026	1.033	0.974	0.309^{ns}
7	Farm size (X_7)	-0.014	0.105	0.986	0.745^{ns}
	Nagelkerke R^2	0.084			

Source: Field data, 2022 ns = Not Significant; *= Significant @ P<0.05; *= Significant @ P<0.01

Table 5 shows the results of the factors affecting non-implementation of post-harvest management practices by cocoa farmers in Etung Local Government Area. Due to the dichotomous nature of the dependent variable, this was determined using binary logistic regression. The model produced a Nagelkerke R-squared value of 0.084. This value, which is the pseudo R-squared, implies that only 8.4% of the variation in the dependent variable was explained by the adjusted independent variables. The result shows that gender (X1), age (X3) and farm size (X7) all had negative coefficients (-1.176, -0.018 and -0.014, respectively). This means that as these variables increase, the adoption of post-harvest management practices by cocoa farmers in the study area decreases. The odds ratio of these variables (0.308, 0.983, and 0.986, respectively) implies that a 1% increase in male farmers reduces the likelihood of them adopting post-harvest practices by 0.308 times. Furthermore, a 1-year increase in farmer age makes farmers 0.983 times less likely to adopt these practices, while a 1% increase in farm size makes them 0.986 times less likely to adopt post-harvest management practices -times less. This result contradicts the findings of Ewuola et al. (2010) and Wossen et al. (2013) who found that farm size has a positive association with technology adoption. On the other hand, marital status, education, agricultural orientation (full-time/part-time), and agricultural experience all had positive coefficients (0.515, 0.074, 0.276, and 0.026, respectively).

This result means that an increase in these variables consequently leads to an increase in the rate of adoption of post-harvest practices in cocoa production in the study area. Their odds ratios of 1.673, 0.928, 0.759, and 0.974, respectively, mean that married farmers are 1.673 times more likely to adopt postharvest practices. The odds ratio of education means that educated individuals are 0.928 times more likely to adopt post-harvest management practices in the study area. The odds ratio of agricultural orientation implies that farmers of this household size are 0.759 times more likely to adopt the practices, while the agricultural experience probability means that farmers with higher experience among cocoa farmers are 0.974 times more likely Likelihood of adopting post-harvest management practices production in Etung township area. However, among the adjusted variables, only gender (X1), albeit with a negative coefficient, was statistically significant at 0.01 alpha values and a P value of 0.004. This implies that gender is a crucial factor for non-implementation of post-harvest management practices in Etung Local Government Area.

Summary

The main purpose of this study was to ascertain the postharvest management practices carried out by cocoa farmers in Etung Local Government Area of Cross River State, Nigeria. The results of analysis of the socio-economic characteristics of the respondents revealed that about 45.02% of the respondents are 50 years and above, majority (74.0%) of the respondents were male. Majority (87.9%) of the respondents were married and most 57.6% of the respondents had tertiary education while only (39.8%) of the farmers had 1-10 years of farming experience. The result of cocoa output showed that (85.3%) of the respondents had an output of 0-5tons/ha. The findings also showed that majority (87.9%) of the respondents identified four different post-harvest management practices that they in the area. They are pod breaking, fermentation, drying and packaging. On the other hand, responses on the post-harvest management practices adopted by cocoa farmers in the study area showed that three of them were mostly adopted by farmers. These three adopted post-harvest management practices are pod breaking, fermentation and drying. The binary logistic regression analysis of the factors influencing the non-adoption of post-harvest management practices revealed thatsex (X1) age (X3), and farm size (X7), all had negative coefficient, while marital status (X2), education (X4), farming orientation (full time/ part time) and farming experience (X6) all had positive coefficients. However, only sex (X1) was statistically significant at 1% probability level. Information on the distribution of respondents based on constraints faced by farmers in the adoption of post-harvest management practices in cocoa farming revealed that unsatisfied price of beans imposed by buyers (ranked 1st), Lack of access to inputs (ranked 2nd), and Lack of extension agents' visitation (ranked 3rd) were the most critical constraints faced by farmers Etung Local Government Area.

CONCLUSION

The adoption of publish-harvest management practices amongst cocoa farmers in Etung nearby government location cannot be over emphasized, having a right away impact on the productiveness of the cocoa farmers. Proper adoption of these control practices can save you wastage, increase yield and in the end consequences in higher earnings for the farmers. From the take a look at, majority of the humans in Etung are dependent on cocoa production as their supply of livelihood. As a consequence, publish-harvest mismanagement can be very catastrophic and debilitating. From this look at, it can be concluded that majority of farmers adopt submit-harvest control practices along with pod breaking, fermentation and drying. Thus, those practices may have far greater developmental effect at the cocoa price chain and farmers' productivity when further harnessed.

RECOMMENDATIONS

i. More emphasis should be devoted to post-harvest management methods by cocoa farmers in Etung since only 60% adoption of the highlighted measures were documented, according to the study's findings.
ii. There should be a concerted effort to inform, educate, and sensitize cocoa farmers on the value of storage and packing as crucial elements of post-harvest management.
iii. The biggest obstacle for producers is the unfavorable price that purchasers set for their beans. Farmers should create stringent regulations prohibiting members from accepting any absurd pricing from the marketers and put a melt on defaulters to stop this.

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WATER MELON MARKETING ANALYSIS IN ORIRE LOCAL GOVERNMENT AREA, OGBOMOSO, OYO STATE

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ABSTRACT

The study examined the economic analysis of water melon marketing in Oriire Local Government Area, Ogbomoso, Oyo State. The study specifically described the socio-economic characteristics of watermelon marketers, estimated the cost and returns in watermelon marketing, identification of marketing outlets as well as describing of the constraints to watermelon marketing in the study area. A multi-stage sampling technique was employed in selecting 120 respondents for this study. Data collected were analyzed statistically with descriptive and budgetary analysis methods. This involved the use of tables, frequency counts, percentages and mean values. Inferential statistics such as multiple regression model and estimated with OLS was used for the study. Budgetary analysis Gross Margin (GM), Benefit cost ratio was used in determining of the profitability of water melon marketing. The results indicated that over 91.67% of the respondents were between the active ages of 25 and 50 years. About 98.34% had household size of between 1–10% persons. Substantive percentage (58.33%) of the respondents had no formal education. About 90% had 2– 9 years of marketing experience. The budgetary analysis results indicated that watermelon marketing had an average total revenue of #105,200, with #29, 105 as total cost of marketing, and the Gross margin was #77,869. Finally, the major problems associated with watermelon marketing identified by the respondents in the study area were lack of price regulation policy, price fluctuation, poor access to credit, poor storage, distance to market and theft of product. It recommended that both formal and informal financial institutions should be encouraged by the Government to provide financial assistance watermelon farmers so that they can expand and improve their existing business volume.

Keywords: *watermelon, marketing, budgetary, regulation farmers*

INTRODUCTION

Watermelon (*Citrullus vulgarus*) belongs to the family cucurbitaceae, extensively grown both in the tropics and temperate regions. The crop is a native of tropical Africa and has been grown in West Africa for many centuries (Sinnadurai, 1992). Watermelon is a warm season crop, which requires continuous warm temperatures during the entire growing period. The crop prefers a sandy loamy soil with pH of 5.8 to 7.2, while its cultivation in heavy textured soils results in a slower crop development and cracked fruits. The recommended fertiliser rates for higher production are 80 to 100kg/ha N, 25 to 60kg/ha P and 35 to 80kg/ha K (FAOSTAT, 2001). Worldwide, the yield of watermelon averages about 25 t/ha, varying from 5 – 60 t/ha, depending on cultivars and cultural practices. The maximum and minimum temperature for its growth ranges from about 35oC and 18oC respectively. The crop has an optimum soil temperature range of 20oC to 35oC (FAOSTAT, 2001). Warm dry spells are essential during fruit maturity to increase the sweetness of the fruit. High humidity not only decreases sweetness, but also reduces yield and tends to promote excessive vegetation growth (Sinnadurai, 1992). The length of the total growing period ranges from 80 to 110 days, depending on climate (FAOSTAT, 2001).

Watermelon (*Citrullus lanatus*) is a native of tropical Africa, where it has long been used by the wild tribes. It came to India by the fourth century AD. The sweet juicy *pulp* of the ripe fruit is eaten fresh.

Watermelon is a valuable alternative to drinking water in desert areas. Watermelon is relished by many people across the world as a fresh fruit. This is because it is known to be low in calories but highly nutritious and thirst quenching; it also contains vitamins C and A in form of the disease-fighting beta-carotene. Lycopene and betacarotene work in conjunction with other plant chemicals not found in vitamin/mineral supplements. Potassium is also available in it which is believed to help in the control of blood pressure and possibly prevent stroke (Adekunle *et al.*, 2005). Production of staple crops like cereals, yam, cassava, cash crops and some vegetables can contribute positively in Nigerian economy and result of this the problem of poverty, hunger and malnutrition could be alleviated and adequate (Mohammed, 2011). Production of exotic vegetables generates higher profit, employment and income to farmers than indigenous vegetables (Ajewole and Folayan, 2008). According to Adeoye *et al*. (2007) watermelon has an important place amongst the all exotic vegetable and sales in Ibadan Metropolis of Oyo State, Nigeria.

Research Questions

(1) What are the socio-economic characteristics of water melon marketers in the study area?
(2) What are the marketing practices of the respondents?
(3) What are the cost and returns associated with water melon marketing?
(4) What are the challenges faced by water melon marketers in the study area?

Objectives of the Study

The major objective of this study is to analyze the water melon marketing in Oriire Local Government Area of Oyo State.

Specific objectives are to:
(1). identify the socio-economic characteristics of water melon marketers in the study area;
(2) investigate marketing practices of the respondents;
(3) estimate the cost and returns associated with water melon marketing;
(4) identify the challenges faced by water melon marketers in the study area.

METHODOLOGY

Study Area

The study was conducted in Oriire Local Government Area of Oyo State. Oriire local government has her headquarter in Ikoyi-Ile. It is located around latitude $8^0 30^{'}$N of the equator and longitude $3^0 54^{'}$S of the Greenwich meridian. It is regarded as a derived savannah vegetation zone and a low land rainforest area. A fairly uniform temperature with annual mean temperature of 26^0C, lowest temperature of 24.3^0C while the highest temperature is 28.7^0C, mean annual rainfall is 1247mm it is long wet in middle March-July, heavy rain and high humidity period, short dry in August and short wet between September and October. The population of Oriire LGA was estimated to be 150628 (that of male was 76335, while female was 74293).Oriire Local Government Area is in derived savanna climatic zone where agricultural products such as yam, melon, cashew, mango, shea butter, cocoa, kola nut, palm-oil can be found. Therefore, most of the inhabitants engage in farming as their major occupation while some are hunters, traders, fish farmers, etc. In the relatively recent times charcoal production has also become a popular occupation of many households in the area. The area extends from Ipeba river along Oyo-Ogbomoso road to Doogo junction near Igbeti, Oyo state Nigeria. It covers a total estimated land area of 2,040 km^2, inhabiting over 100 communities such as Tewure, Iluju, Apiko, Saamo, Igbori, Odun-Ifa and Olokoto among many others .The population is predominantly Yoruba.

Population of the Study

The population of this study included all the watermelon marketers in Oriire Local Government Area, Oyo State.

Sampling Procedure and Sample Size

A multistage sampling technique was adopted to select respondents for this study. The first stage involved random selection of fifty Percentage (50%) of the total number of wards in the Oriire local government area. This implies that five (5) wards were selected out of ten (10) wards in Oriire Local Government

Area. The second stage involved random selection of two villages from each of the selected wards. The third stage involved selection of nine watermelon marketers from each of the ten villages, using cluster sampling technique. The sample size was 90 watermelon marketers for the study.

Method of Data Collection

The data for this study was obtained from primary source with the aid of a structured questionnaire based on the objectives of the study.

Data Analysis

Descriptive Analysis

This will involve the use of tables, Frequency counts, Percentages and mean values. This was used to analyze specific objectives 1, 2 and 4.

Budgetary Analysis

Gross Margin (GM) was used in estimating the profitability of watermelon marketing (Specific objective 3). It was calculated as difference between Total Revenue (TR) and Total variable cost (TVC).

TR was quantified as: quantity of watermelon sold × price per unit.

TVC was quantified as total cost of all variable inputs like purchase at farm gate, transportation, labour, etc.

Gross margin = Total Revenue – Total variable cost; GM = TR – TVC

Benefit cost ratio (BCR) is a ratio to determine the profitability of the watermelon.

$= \Sigma TR / \Sigma TVC$

If the BCR < 1, the business is not profitable; If the BCR > 1, the business is profitable

1. Cost and return analysis was performed as follows:
   a. Revenue: TR = P x Q, where TR = Total Revenue, P = Price of output and Q = Quantity of output
   b. Cost: TC = FC + VC, where TC = Total cost, FC = Fixed cost; and VC = Variable cost
   c. Profit: NP = TR – TC, where NP = net profit.
2. Revenue/cost ratio: R/C ratio is a ratio of total revenue to total cost used to understand the profitability of marketing operations. The criteria are as follows: R/C > 1 = profitable, R/C = 1 = neither profitable nor loss, and R/C < 1 = not profitable.

OLS Model Specifications

Inferential statistics such as the Ordinary Least Square regression (OLS) was used to test the study hypothesis. The model is thus specified below:

$Y = a + b_1x_1 + b_2x_2 + b_3x_3 \ldots\ldots\ldots\ldots\ldots\ldots\ldots.. b_6x_6$

Where: Y = Revenue from watermelon sales (₦)

X_1 = Cost of watermelon (farm gate price) (₦)

X_2 = Labour cost (₦)

X_3 = Cost of transport (₦)

X_4 = No of years spent in school

X_5 = Years of experience

X_6 = Age (years)

RESULTS AND DISCUSSION

Socio-Economic Characteristics of the Respondents

Age of Respondents

Table 1 showed that most of the sampled marketers (40.83%) were between the ages of 31-40 years of age. Furthermore, 39.17% of sampled traders lie within the age bracket of 41-50 years and 11.67% below 30 years of age. This implies that watermelon marketing enterprise in the markets sampled is dominated by middle-age farmers who are still active with the mean age of 40 years and this has effect on agricultural production, marketing and constitute the working force of the populace to accomplish the tedious task of taking watermelon from the farm gates to the markets.

Table 1: Distribution of respondents by Age

Age group	Frequency	Percentage
<=30	14	11.67
31-40	49	40.83
41-50	47	39.17
51-60	10	8.33
Total	120	100.00

Marital Status of Respondents

Table 2 indicates that most of the watermelon marketers in the study area were married (87.50%) while only 6.67% were single. This suggests that watermelon marketing in the study area is dominated by married couples. This is attributable to the fact that watermelon marketing is a profitable venture, which can serve as a reliable source of livelihood for the family.

Table 2: Distribution of respondents by Marital Status

Marital status	Frequency	Percentage
Single	8	6.67
Divorced	1	0.83
Widowed	2	1.67
Separated	4	3.33
Married	105	87.50
Total	120	100.00

Educational Background

Table 3 shows that 58.33% of the sampled respondents had no formal education, 26.67%% had primary school education, while only 15.00% of the sampled respondents had secondary education. This finding agrees with Adekunle et al. (2009) who reported that most marketers in Nigerian rural areas are limited in terms of formal education. Hence, many rural dwellers who are presently active participants in the market channels have little educational qualification since they could not see it as prerequisites.

Table 3: Distribution of respondents by educational status

Education status	Frequency	Percentage
No formal Education	70	58.33
Primary Education	32	26.67
Secondary Education	18	15.00
Total	120	100.00

Experience of Respondents

Table 4 reveals that 50.83% of the sampled respondents have less than 5 years of experience, while 49.17% have between 6-10years of experience. This shows that the people are moderately experienced with the mean experience of 6years in the trade, a knowledge which would enable the marketers understand the intricacies of the trade and thus know how to cut down on marketing cost while attempting to maximize profit. Also, experience has been shown to enhance more efficient use of scarce resources by small holders in Nigeria

Table 4: Distribution of respondents by Marketing Experience

Marketing experience	Frequency.	Percentage
<=5	61	50.83
6-10	59	49.17
Total	120	100.00
Mean: 5.38 years		

Household size of Respondents

Table 5 revealed that 49.17% of the respondents had household size ranging between 6-10 members and not more 5 members respectively, while only 1.67% had household size more than 10 members. The mean household size was 6members. This implies that most of the marketers in the study area had a considerable household size.

Table 5: Distribution of respondents by Household size

Household size	Frequency	Percentage
<=5	59	49.17
6-10	59	49.17
Above 10	2	1.67
Total	120	100.00

Mean: 6.00 members

Membership of Association

Businessmen and women normally belong to one marketing association or another. Table 6 revealed that high Percentage (73.33 %) of the watermelon marketers belongs to a social group association, while 26.67% of the respondents do not belong to any association.

Table 6: Distribution of respondents by members of Association

Group	Frequency	Percentage
Yes	88	73.33
No	32	26.67
Total	120	100.00

Religion of Respondents

Table 7 indicates that 52.50% of the watermelon marketers in the study area were Christians, 46.67% were Muslims while only 0.83% was a traditional worshipper.

Table 7: Distribution of respondents by their religious

Religion	Frequency	Percentage
Christianity	63	52.50
Islam	56	46.67
Traditional	1	0.83
Total	120	100.00

Marketing practices of the respondents

Table 9 reveals that 92.50% of the sampled respondents sell their watermelon to wholesalers, 60.00% of the respondents use sale agents to sell their watermelon, 60.00% also sell their watermelon to commercial city centers, 85.83% of the respondents sells their watermelon to the retailers while only 45% of the water melon marketers sampled sells to schools and organized bodies.

Table 8: Marketing sales outlet of the respondents

Sales Outlets	Frequency	Percentage
Wholesale	111	92.50
Agent	72	60.00
City sale	72	60.00
Retail sale	103	85.83
Organized body sale	54	45.00

Budgetary analysis

Marketing expenditure; Cost of Parking, Purchase cost, Labor cost, transport cost, and agent cost constituted Variable Cost with an average value of #27, 330 and with a Total Fixed Cost of #1959 The average Total revenue of #105,200. Watermelon marketing is profitable with a gross marketing margin of #76094.57 and a net margin of #76094.57

Table 9: Distribution of respondents by Budgetary Analysis

Parameters	Cost (#)	Value (#)
Total Revenue		105200
Variable cost		
Cost of parking	6575.833	
Purchase cost	5771.667	
Labor	8100	
Transportation		5858.333
Agents		1025
Total variable cost (TVC)	27330.83	
Total fixed cost	1959.184	
Total cost (TVC+TFC)	29105.43	
Gross margin (TR-TVC)	77869.17	
Net margin (GM-TFC)	76094.57	

Challenges faced by water melon marketers

Marketing of watermelon in the study area within the period of this survey is not without constraints. The major constraints observed during the study are ranked and presented in Table 4.11. Lack of price regulation policy, Price Fluctuation, Poor access to credit, Poor storage, Distance to market and Theft of product were the most prominent constraints of watermelon production in the study area.

Table 10: Challenges Associated with Watermelon Marketing

Challenges	Frequency.	Percentage	Rank
Poor storage	118	83.33	4
Price fluctuation	109	90.83	2
Poor market access	51	42.50	7
Seasonal Availability	46	38.33	8
Poor patronage	24	20.00	9
Distance to market	99	82.50	5
Theft of product	94	78.33	6
Poor access to capital	106	88.33	3
Lack of Price regulation	114	95.00	1

Summary
The broad objective of this study is to examine the economics analysis of watermelon marketing in the study area. The specific objectives were to describe the socio-economic characteristics of watermelon marketers, estimate the costs and returns in watermelon marketing, to identify the marketing outlets and describe the constraints to watermelon marketing in the study area. To achieve these objectives, primary data were collected with aid of questionnaire administered on the respondents. A multi-stage sampling technique was employed in selecting the respondents for this study. A total of 120 watermelon marketers formed the sample size for the study and each respondent was interviewed. The analytical tools used to analyze the data included, descriptive statistics and budgetary analysis. The results indicated that over 91.67% of the respondents were between the active ages of 25 and 50 years. About 98.34% had household size of between 1–10% persons. As high as 58.33% of the respondents had no formal education. About 90% had 2– 9 years of marketing experience. And 70% of the respondents were Hausa.The Budgetary analysis results indicated that watermelon marketing had an average total revenue of #105,200, with #29, 105 as total cost of marketing, and the Gross margin was #77,869. Finally, the major problems associated with watermelon marketing identified by the respondents in the study area were Lack of price regulation policy, price fluctuation, poor access to credit, poor storage, distance to market and theft of product

CONCLUSION
It may therefore be concluded that:

- **i.** the mean age of the water marketers was 40 years of age,
- ii. the level of education is low as only 33% of the watermelon marketers had a formal education
- iii. Most marketers had only 1-7 years' experience due to the newness of the crops in southwestern markets and most of the actors in the market are Northerners.
- iv. The functional outlets of watermelon sale included wholesale, retail, commercial cities and organized bodies
- v. The cost and return analysis revealed that watermelon marketing in the study area was profitable
- vi. The problems encountered by the farmers are insufficient capital, lack of proper storage facility and inefficient transport services.

RECOMMENDATIONS
Based on the findings of the study it is recommended that:
The government and non-governmental organization should make efforts towards improving rural road conditions in Nigeria, and also construct rural feeder roads that will go a long way at reducing marketing costs, reduce the damages caused by poor roads and also stabilize the price of watermelon and therefore enhance the marketing of not only watermelon, but also many agricultural products.
In order to solve the problem of financial inadequacy facing the watermelon marketers, both formal and informal financial institutions should be encouraged by the Government to provide financial assistance to them so that they can expand and

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ASSESSMENT OF INFORMATION NEED OF TOMATO FARMERS IN OYO STATE, NIGERIA

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ABSTRACT
*The study assessed the information need of Tomato farmers in Oyo Agricultural Zone of Oyo State. The study assessed the agricultural information needs (agronomic practices, economic, technical collected and legal information) of Tomato farmers in the study area. Multistage sampling technique was used to select 189 respondents for this study. Data for this study were collected with the aid of a pre-tested questionnaire. Statistical analytical tools used included descriptive and inferential statistics. Descriptive statistics used included frequency count, percentages and means while the inferential tool used was regression analysis. Majority of the respondents were male (76.7%), married (90.5%) with a mean age of 51 years and an average of 6 years in their formal education. Sources of information which was ranked highest by the farmers on Tomato were extension agent, other farmers and personal experience with Mean ($\bar{x}$) of 3.51 respectively. Storage techniques was ranked the most frequently needed technical information. The weather forecast/drought was ranked the most frequently needed legal information. The marketing of produce and farm management were ranked the most frequently needed economic information. The information seeking behaviour is motivated purposely to improve general knowledge on Tomato production (100.0%). The result of regression analysis model revealed that age of the respondents (t = 5.60***), years spent in school (t = 8.91***) and output from Tomato production (t = 2.20**) were significantly related with respondents' information needs on Tomato production. It was therefore concluded that respondents were in dire need of information on Tomato production. Training should be given to farmers especially in the areas of agronomic practices, technical, legal and economic information of Tomato production to cater for their information needs for improved performance of Tomato farmers.*
Keywords: *Assessment, Information, Need and Tomato Farmers*

INTRODUCTION

Regardless of one's level of expertise in a given industry or job, a person requires a variety of information to succeed (Abdullahi, 2015). Case (2002) described information need as an individual's or group's desire to locate and obtain information to satisfy a conscious or unconscious need. However, Ekoja (2010) explained that information needs are the information, which information seekers require to conduct their businesses and live their daily lives. The identification of information needs of a person will lead to the means of seeking for that information. Information users need information for solving problems, create awareness, recreational purposes and for up-dating of their knowledge. Information need is construed in the sense of data or a set of data specially required that will enable the user to make an appropriate decision on any related problem facing him or her at any particular time (Solomon, 2002). Information needs and seeking behaviour is for all categories of people be they urban or rural. However, Rafea (2009) reiterated that there is a general lack of relevant and accurate information on production practices, farm management, prices of agricultural produce and markets for agricultural products especially Tomato that can better the lots of farmers. This development had often times lead to pre and post-harvest losses in Tomato production leading to low returns to investment which will invariably affect the standard of living in the study area. The effect of poor post-harvest practices increases production wastages and lowers marketing efficiency. Conversely, reduction in post-harvest losses especially through adequate access to relevant information will more likely increase food availability hence, alleviation of lack of food problems. In view of the above, the objective of the study was to assess farmers' information needs on Tomato production in Oyo Agricultural Zone of Oyo State.

The specific objectives were to:-

1. describe the personal characteristics (socio-economic and enterprise) of Tomato farmers in the study area;
2. identify the available sources of information on Tomato farmers and;
3. investigate the areas of agricultural information needs (agronomic practices, economic, technical and legal information) of the Tomato farmers in the study area.

METHODOLOGY

The study was carried out in Oyo Agricultural zone of Oyo State. The population of the study included all the Tomato farmers in Oyo Agricultural Zone of Oyo State. Multistage sampling technique was used in the course of this research. Firstly, purposive sampling technique was used to select Oyo Agricultural Zone as the study area for this research since the zone is known to be high producer of Tomato due to favourable climatic condition (Babalola *et al*., 2010). Secondly, proportionate sampling technique was used to select fifty percent (50%) of six (6) blocks in the study area. This implies that three (3) blocks (Atiba, Iseyin and Afijo) were selected for this research in the study area. The third stage involved random selection of five villages from each of the selected blocks, that is, Atiba (villages selected: Agbaakin, Eleke, Falose, Iyalamu and Otefon), Iseyin (villages selected: Aba Tuntun, Aba Sule, Alagbede, Idi Igba and Igbo oloro) and Afijo (Imeleke, Laperi, Imini, Elewebe and Eleko). From the list obtained from the Oyo State ADP, Atiba LGA has an estimate of 134 households, 118 households in Iseyin and 120 households in selected villages in Afijio ADP blocks (OYSADEP, 2007).

The last stage involved systematic sampling selection i.e systematic sampling technique of one household head per household at fixed period interval of every two households. The sample size for this research was 189 Tomato farmers. Data for this research was collected from both primary and secondary sources. Primary data were collected with the aid of a pre-tested structured questionnaire. The statistical analytical tools that was used for this study included descriptive and inferential statistics. Questionnaire was analyzed through Social Science Statistical Package (SPSS). The descriptive tools used include frequency distribution, percentage, mean, standard deviation and mean ($\bar{x}$) while the inferential tool used was regression analysis model to test the hypothesis of the study.

Specification of regression model

Linear regression model was used to capture hypothesis 1. The independent variables were included in model are as follows.

$Y = f(X_1, X_2, X_3, X_4, X_5, X_6)$ ………… ……………………..(2.1)

where:

Y = (Score of information needs on Tomatoes production)

X_1 = Age (years)

X_2 = Years spent in school (years)

X_3 = Sex (1=male, dummy =0)

X_4 = Household size (actual members in the households)

X_5= Farm size of land (ha)

X_6 = Output of Tomato (kg)

RESULTS AND DISCUSSION

Personal Characteristics of Respondents

Table 1 shows the distribution of the respondents by sex. It was revealed that 76.7 percent of the respondents were male while 23.3 percent were female. The distribution therefore indicates that male farmers dominate Tomato production in the study area. The reason for dominancy of male in the Tomato production may be due to drudgery associated with farming activities. Male seem to have more access to production assets thereby motivating gender differential in the farm outputs and other inherent opportunities. The findings therefore indicates that gender may have a significant influence on adoption of some technologies. Gender affects technology adoption since the head of the household is the primary decision maker and men have more access to and control over vital production resources than women due to socio-cultural values and norms (Mignouna *et al*., 2011).

Table 1 shows the distribution of the respondents according to their marital status. Based on the distribution in the Table 4.1a, Also, 90.5 percent of the respondents were married, 5.8 percent of the respondents were single. The findings therefore indicate that majority of the respondents were married which could help boost their production level especially through unpaid labour supply from household members. This development will more likely reduce cost of production with attending increased savings. The finding conforms with the study of Oose *et al*. (2015) found that majority (86.9%) of their respondents were married. The mean age of the respondents was found to be 51 years which implies that most of the respondents were still active enough to participate in Tomato production. This finding agreed with Bamigboye and Kuponiyi (2013) which opined that majority (65.0%) of their respondents were within the age group of 40 and 59 years

The respondent mean years of schooling was 6years. The findings therefore revealed that most of the respondents had formal education although majority had low level of education. It is envisaged that this which will help boost adoption of improved technologies especially in Tomato production and storage for quality productions and high premium. The present finding is in line with previous studies (Mignouna *et al*., 2011) which opined that education level of a farmer increases his ability to obtain; process and use information relevant to adoption of a new technology. Similarly, Invwieri (2007) opined that, rural people (farmers) who are mainly illiterate require access to appropriate information to be able to make decisions and participate fully in the national development processes, including agriculture.

Table 1: Distribution of Respondents according to their Personal Characteristics (n = 89)

Personal Characteristics	Frequency	Percentage	Mean
Sex			
Male	145	76.7	
Female	44	23.3	
Marital Status			
Single	11	5.8	
Married	171	90.5	
Widowed	5	2.6	
Separated	2	1.1	
Age (Years)			
Less or equal to 30	18	9.5	
31-40	38	20.1	
41-50	47	24.9	
51-60	33	17.5	
Above 60	53	28.0	**51 years**
Years spent schooling (years)			
No Formal Education	39	20.6	
1-6	97	51.3	6 years
7-12	43	22.8	
Above 12	10	5.3	
Household Size			
1-5	71	37.6	
6-10	93	49.2	7 people
11-15	25	13.2	
Farm Size	182	96.3	

≤1.0-3.0	7	3.7	1.83ha
3.1-≥5.0			
1-50	59	31.2	
51-100	118	62.4	71.9 baskets
101-150	12	6.3	

Sources of information on Tomato production

Table 2 presents the distribution of respondents by sources of information on the Tomato production. Based on the frequency of use of sources of information on Tomato production, extension agent, other farmers and personal experience were ranked highest with a Mean ($\bar{x}$)of 3.51 respectively. The findings therefore indicate that most respondents utilized diverse media to access information on Tomato production but with varying level of utilization. This may be due to the fact that these sources of information are more readily accessible, reliable with local content characteristics and that the authenticity of these sources had been tested over years. The finding is in concordance with that of Bitagi and Akor (2011) which analyzed information availability and Agricultural Productivity of Rural Farmers in Niger State and found that rural farmers in Niger State obtained information about farming activities from within themselves.

Table 2: Distribution of respondents according to available sources of information on Tomato farmers

Sources	Availability		Frequency of use of sources of information	
	Frequency	Percentage	$\bar{x}$	Rank
Extension agent	143	75.7	3.51	1st
Radio	68	36.0	3.46	6th
Other farmers	154	81.5	3.51	1st
Television	63	33.3	2.68	11th
Friends/relative	72	38.1	3.46	6th
Personal experience	189	100.0	3.51	1st
Cooperatives	86	45.5	3.48	4th
Cell phones	79	41.8	3.47	5th
IITA	64	33.9	3.05	9th
Input suppliers	67	35.5	3.43	8th
Printed materials	56	29.6	2.94	10th
Religious organizations	26	13.8	1.93	12th

$\bar{x}$ - Mean

Agricultural information needs on Tomato production

The agricultural information need was categorized into four according to information needs on Tomato production. This aspect was divided into agronomic practices information, technical information, legal information and economic information. Similarly, Ballantyne (2009) opined that types of information needs (agricultural information inclusive) revolved around scientific/technical, commercial and legal information. Table 3 indicates that site selection, ploughing/tillage, adequate plant spacing and fertilizer application rate were the major agronomic practices information needs of the farmers with mean score of 3.0 were the most frequently sought. This is similar to the findings of Deribe (2020) who found that the most sought information by farmers was on crop production. Furthermore, the findings, Opara (2008) claimed that farmers all over the world require a range of information from the weather, loans, soil, seeds, farming mechanisms, control and management, harvesting, storage, marketing, sale, investments and repayment of loans. Storage techniques was ranked the most frequently needed technical information ($\bar{x}$ =2.99). Storage loss had always been a major bottleneck to agricultural development especially perishable crop like Tomato, so there is great need for technical information on storage to enhance income realizable from Tomato production. This corroborates Ugboma (2010) in a study on access to agricultural information by fish farmers in the Niger Delta region of Nigeria, where it reveals that 98 percent of fish farmers studied preferred scientific/technical information According to Demiryureket *al.* (2008) technical information is considered as a basis for material and intellectual sources in different societies and any society which is able to access more information automatically has more potentiality.

Furthermore, weather forecast/drought ($\bar{x}$ =2.59) was ranked the most frequently needed legal. Other legal information needs on Tomato production include environment use rules ($\bar{x}$ =2.37), food quality and safety ($\bar{x}$ = 2.10) and information on land use policies/rules ($\bar{x}$ =2.02). The findings therefore indicate that weather forecast/drought was ranked the most frequently needed legal information. This implies that farmers need this information in order to schedule their cropping season appropriately. Marketing of produce and farm management were ranked the frequently needed economic information ($\bar{x}$ =2.71) which include price control, price of fertilizers, price of seeds, and sale of agricultural products. Maru (2008) and Renwick (2010) in separate studies carried out in India and the Caribbean respectively reported that economic information that is related to production, productivity, profit enhancement, commodity price, food quality, safety and labeling information.

Table 3: Distribution of respondents by agricultural information needs on Tomato production (n = 189)

S/N	Information Needed	Mean	Rank
	Agronomic practices information		
1	Site selection	3.00	1st
2	Clearing operation	2.94	10th
3	Ploughing/tillage	3.00	1st
4	Nursery operation	2.99	5th
5	Planting operation	2.99	5th
6	Fertilizer application	2.99	5th
7	Weed control	2.99	5th
8	Pest/disease control	2.99	5th
9	Adequate plant spacing	3.00	1st
10	Fertilizer application rate	3.00	1st
	Technical information		
1	Harvesting methods	2.97	3rd
2	Storage techniques	2.99	1st
3	New seed/seedlings	2.98	2nd
4	Use of machines and other equipment	1.50	16th
5	Farm mechanization	2.94	8th
6	Visiting farmers	2.96	6th
7	Organizing field meeting with farmers	2.92	9th
8	Holding scheduled meetings with farmers	2.96	6th
9	Organization of field days	2.97	3rd
10	Organization of method demonstrations	2.97	3rd
11	Organization or result demonstrations	2.70	13th
12	Organization of method/result demonstration	2.43	14th
13	Organization of research/extension linkage workshops	2.71	10th
14	Farmer training programmes	2.31	15th
15	Distribution of pamphlets, leaflets	2.71	10th
16	Organization of audio-visual shows	2.71	10th
	Legal information		
1	Information on land use policies/rules	2.02	4th
2	Environment use rules	2.37	2nd
3	Food quality and safety	2.10	3rd
4	Weather forecast/drought	2.59	1st
	Economic information		
1	Price control	2.70	3rd
2	Locating potential market to sell products	2.70	3rd

3	Credit facilities	2.69	5th
4	Farm management	2.71	1st
5	Marketing of produce	2.71	1st
	Mean		

Categorization of agricultural information needs of farmers on Tomato production

Based on the results in Table 4, about 9.5 percent of the respondents required agricultural information on Tomato production at high level, 60.9 percent of the respondents needed agricultural information on Tomato production at moderate level while 29.6 percent of the respondents need agricultural information on Tomato production at low level. The findings revealed that most of the respondents still fall within moderate level of agricultural information on Tomato production which therefore require intensive sensitization on importance of adequate information so as to boost Tomato production.

Table 4: Categorization of agricultural information needs of farmers on Tomato production

Categorization		Frequency	Percentage
High	$> \bar{x} \pm SD = 103.44$	18	9.5
Moderate	$\bar{x} \pm SD = 103.44$ to 89.06	115	60.9
Low	$< \bar{x} \pm SD = 89.06$	56	29.6
Total		189	100.0

Hypotheses for the study

Table 4 shows the summary of Regression analysis (Exponential function) of the relationship between respondent' personal characteristics of Tomato farmers and their information needs. It was revealed that age of the respondents (t = 5.60***), **y**ears spent in school (t = 8.91***) and output from Tomato production (t = 2.20**) were significantly related with respondents' information needs on Tomato production. The relationships were positive which implies that increase in the significant variables of the respondents will bring about an equivalent increase in the respondents' information needs on Tomato production. For instance, increase in the age of the farmers will afford them better understanding of Tomato production and marketing and this will increase their information needs on Tomato production which will invariably improve output of Tomato production. This is similar to the findings of Ogunleye et. al. (2012) who found that age influences training needed by farmers. Moreover, education brings about exposure and acquisition of improved knowledge especially Tomato production and this will help increase need for information on Tomato production which will translate to improved output from Tomato production and better income level for the farmers. Also, as the output from Tomato production is increasing, farmers will tend to seek more information on processing and marketing of Tomato production. Though size of farm is positive but not significantly related to information need in Tomato production. This finding is contrary to the report of Abu *et al*. (2011) found that the farm size is significant in impacting farmers' information need on Tomato production. The adjusted R-square for the relationship was found to be 0.9873 which implies that the independent variables had 98.7% influence on the dependent variable. The value vividly indicates that age, years of schooling and output from Tomato production are strong determinants of information needs of Tomato farmers in the study area. Since there is a significant relationship between the dependent and the independent variables for this study, the null hypothesis is therefore rejected while the alternative hypothesis is accepted. Therefore, there is significant relationship between personal characteristics of Tomato farmers and respondents' information needs on Tomato production.

Table 5: Summary of regression analysis of the relationship between personal characteristics and information needs on Tomato production

Personal characteristics	Coef.	Std. Err.	t-value	P>|t|	Decision
Age	0.0099426	0.001777	5.60***	0.001	S
Years spent in school	0.0339519	0.0038115	8.91***	0.001	S
Sex	0.004238	0.004822	0.76	0.375	NS
Household size	0.0001669	0.0091982	0.02	0.986	NS
Farm Size	0.0170284	0.021198	0.80	0.423	NS
Output of Tomato	0.0024141	0.0010961	2.20**	0.029	S
Constant	1.989911	0.0222752	89.33	0.000	

R-squared = 0.9879, Adj R-squared = 0.9873, S = Significant, NS = Not Significant
**Significant at 5% level; ***Significant 1%

CONCLUSION AND RECOMMENDATIONS

On the basis of the major findings of this study, it was observed that age of the respondents, years spent in school and output from Tomato production were significantly related with respondents' information needs on Tomato production while the information seeking behaviour is motivated purposely to improve general knowledge, improve yield of crop, access reliable and timely information and to improve the quality of decision making. It was therefore concluded that respondents were in keen need of information on Tomato production.

Based on the findings and conclusion of the study, the following recommendations are necessary:

1. Since years of schooling is an important determinant of information seeking behavior, there is adequate need to expose Tomato farmers by extension agents to necessary information on Tomato production especially through diverse media in order to enhance their decision making profile as a result of their exposure to outside world.
2. Agricultural Extension organizations should provide training to farmers in the areas of agronomic practices, technical, legal and economic needs of Tomato production to cater for their information needs for improved overall performance of Tomato farmers.
3. Tomato farmers should be motivated by government in the area of price control and buy off of products when price is unfavourable so as to increase their level of production for national development.

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EXAMINING THE ADOPTION OF SUSTAINABLE LAND MANAGEMENT TECHNOLOGIES AMONG CROP FARMERS: A RURAL SOCIOLOGY AND HORTICULTURAL EXTENSION PERSPECTIVE

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ABSTRACT
Factors such as population growth, deforestation and poor farming techniques have been pointed out as the major causes of increased growth in human activities, overgrazing, deforestation, and the use of inappropriate farming practices. Consequently, this research aims to assess the adoption of land management technologies by crop farmers in Offa Local Government, Kwara State Nigeria. A quantitative analytical study was conducted using a Multistage Sampling Technique involving 120 farmers in Kwara state. The collected responses were analyzed using descriptive statistics. The analysis revealed intercropping (98.3%), crop rotation (99.2%), bush fallowing (99.2%), cover cropping (97.5%), whereas strip cropping (3.3%), terracing (9.2%), and contour ploughing (14.2%). This implies that there is high level of awareness of sustainable land management technologies in the study area. which will aid extension agents in making Farmers adopts this method. Extension agents should be made available to the crop farmers in other to help guide the farmers on the use of sustainable land management technologies.
Keyword: *Adoption, Sustainable Land, Management Technologies, Horticultural Extension, Kwara State.*

INTRODUCTION

One out of every three people on earth in some way or the other affected by land degradation per average, latest estimates indicates that nearly 2 billion hectares of land worldwide are already degraded, some irreversibly (FAO, 2010). Factors such as population growth, deforestation and poor farming techniques have been pointed out as the major causes. Human growth has resulted in increased human activities and land demand, which triggered overgrazing, deforestation and use of inappropriate farming practices (Semgalawe, 1998; Senkodo, 2009). To rescue this situation, the adoption of sustainable land management practices seems to be the best way. Estimate put 300,000 to 400,000 hectares of forest that are cleared every year to meet the demand for farming land, timber, poles and firewood (Semgalawe, 1998; Senkondo, 2009).

Sustainable land management has been defined as the adoption of appropriate land management practices that enables land users to maximize the economic and social benefits from the land while maintaining or enhancing the ecological support functions of the land resources (FAO, 2009). It is the key point for improving land resources resilience and productivity within the context of the potentially devastating effects of climate change in sub-Saharan Africa, bringing the needs of agriculture and environment, with the twin objectives of maintaining long term productivity (quality, quantity and diversity) of goods and services. The major goal of sustainable land management therefore is to develop economically viable agro-ecological system and to enhance the quality of the environment.

The practices include Diversified cropping systems (strip cropping, and mixed intercropping). Integrated agro-forestry practices with the cropping system and soil erosion control structures and practices that is contour farming and grass barriers (Roberts *et al* 2008). These practices are a key mechanism for effecting change in the sustainable use and management of land resources (Webb, 2004). Unsustainable land management practices can threaten biodiversity and increase the release of Carbon especially through destruction of forests as well as impacting adversely on water resource management. On the other hand, they present opportunities for enhancing the livelihoods of the poor and fostering inclusive growth as well as for achieving environmental goals (UNCCD and FAO, 2009).

RESEARCH PROBLEM

Soil erosion remains the most common environmental degradation or ecological problem in Nigeria. This phenomenon which results from the impact of climatic factors, particularly rainfall, and wind is exacerbated by uncertainties arising from climate change effect that occurs both where it directly affects crops or plants where they are growing, and off-site with environmental consequences that manifest as pollution of natural water, impairment of air quality by dust or emission of radio-active gases. Other effects include damage to infrastructure, citation of water ways and reservoirs as well as, increased cost of water treatment.

It has also been observed that information about sustainable and relevant sustainable land management technologies is not readily available to farmers in Nigeria generally, making informed choice about the best possible sustainable land management technologies to be adopted for best result has become difficult due to the fact that most farmers are not informed, government policy do not favor some sustainable land management technologies while some sustainable land management technologies are too expensive to be adopted. It is estimated that millions of metric tonnes of soil are lost to water and wind erosion annually (Souleman et al, 1993). Available statistics in Nigeria shows that over 300gullies existed in Abia state, 270 in Anambra state, 200 in Enugu state, and 250 in Imo state (Ugoriji, 1995). In the light of the above, the question that readily comes to mind is what has been happening to the researches on land management in the study area. Therefore, it is important for the crop farmers in the area to know about the different sustainable land management technologies that can combat this erosion problem and adopt these technologies. It is also pertinent to know the socio-economic and limiting factors associated with the adoption of sustainable land management technologies in the study area

RESEARCH OBJECTIVES

The general objective of this study is to assess the adoption of land management technologies by crop farmers in the study area.

The specific objectives of this study include:

1. ascertaining the level of adoption of the land management technologies
2. determining the constraints militating against the adoption of sustainable land management technologies by the respondents in the study area.

HYPOTHESIS

There is no significant relationship between the level adoption of sustainable land management technologies and the constraints militating against its adoption

JUSTIFICATION OF THE STUDY

It has been observed that there are no studies done on assessing the impact of adoption of sustainable land management strategies in the community. If crop farmers know the impacts of practicing sustainable land management (SLM), it will enable the sustainability of land management practices in Offa local government. In addition, this study will build the strong base to farmers whether offered sustainable land management technologies are worthwhile undertaking or not. Furthermore, study findings will contribute in policy reforms especially on the land conservation.

METHODOLOGY

Study area

The study was carried out in Offa Local Government, Kwara State, Located in central Nigeria with latitude 8.15° North and longitude 4.72° East and 436 meters elevation above the sea level and with population of about 113,830 inhabitants. The population of the study comprised of all crop farmers in Offa local government area.

Sampling procedure

There are 12 wards in Offa local government, thus multistage random sampling technique was used for data collection. First, 5 wards were randomly selected from the 12 wards in the local government area and then a total of 24 crop farmers were randomly selected from the list of crop farmers from each of the 5 randomly selected wards making a total of 120 crop farmers which were interviewed.

Data collection method

Both primary and secondary data were collected for this study. Primary data was collected through the administration of a well structured interview schedule to the selected crop farmers. Information included in the instrument was guided by the objectives of the study. While secondary data was obtained from proceeding reports, textbooks, journals and the internet.

Data analysis

The data for this study was analyzed using both descriptive and inferential statistics. The descriptive statistics used for this study included frequency counts, percentages and mean. Chi-square was the inferential statistics used to test the hypothesis.

RESULTS AND DISCUSSIONS

Table 1: Distribution of respondents according to their level of adoption of sustainable land management technologies, n=120

Sustainable land management technologies	Frequency (%) Always	Frequency (%) Often	Frequency (%) Occasionally	Frequency (%) Not at all	Weighted mean score	Rank
Intercropping	100 (83.3)	5 (4.2)	15 (12.5)	_____	2.71	1st
Crop rotation	78 (65.1)	34 (28.3)	7 (5.8)	1 (0.8)	2.58	2nd
Bush fallowing	13 (10.8)	74 (61.7)	32 (26.7)	1 (0.8)	1.83	3rd
Cover cropping	18 (15.1)	56 (46.7)	41 (34.2)	5 (4.2)	1.72	4th
Use of fertilizer	2 (1.7)	15 (12.5)	62 (51.7)	41 (34.1)	0.82	5th
Mixed farming	3 (2.5)	8 (6.7)	43 (35.8)	66 (55.0)	0.57	6th
Mulching	3 (2.5)	2 (1.7)	28 (23.3)	87 (72.5)	0.34	7th
Strip cropping	_____	1 (0.8)	2 (1.7)	117 (97.5)	0.03	8th
Contour ploughing	_____	1 (0.8)	2 (1.7)	117 (97.5)	0.03	8th
Terracing	_____	_____	2 (1.7)	118 (98.3)	0.02	10th

Table 2: Distribution of the respondents according to the constraints militating against the adoption of sustainable land management technologies, n=120

Constraints	Frequency (%) Very severe	Frequency (%) Severe	Frequency (%) Mild	Frequency (%) No a constraint	WMS	Rank
High cost of production	105 (87.5)	12 (10)	2 (1.7)	1 (0.8)	2.84	1st
Insufficient extension service	30 (25%)	75 (62.5)	5 (4.2)	10 (8.3)	2.57	2nd
High labor cost	85 (70.8)	32 (26.7)	2 (1.7)	1 (0.8)	2.67	3rd
Unavailability of credit	31 (25.8)	73 (60.8)	14 (11.8)	2 (1.6)	2.12	4th
Unavailability of labor	_____	9 (7.5)	61 (50.8)	50 (41.7)	0.66	5th
Inadequate knowledge of modern technique	_____	1 (0.8)	42 (35.0)	77 (64.2)	0.37	6th
Low produce price	_____	2 (1.7)	32 (26.7)	86 (71.6)	0.30	7th
Insufficient land availability	_____	4 (3.3)	7 (5.9)	109 (90.8)	0.13	8th
Transportation problems	_____	_____	11 (9.2)	109 (90.8)	0.09	9th

CONCLUSION

The study concludes that high cost of production, insufficient extension service, high labor costs and unavailability of credit facilities were the major problems affecting the adoption of sustainable land management technologies.

By using chi-square the study found that we have enough evidence to reject the null hypothesis that states that; there is no significant relationship between the level adoption of sustainable land management technologies and the constraints militating against its adoption because majority of the constraints have significant relationship with the level of adoption of sustainable land management technologies.

RECOMMENDATIONS

Sustainable land management practices are of great important for their significant positive impacts to our daily life. This has been observed from economic analysis and findings of this study.

First, the crop farmers should form financial organizations among themselves to help them generate money in other to solve their problem of high cost of production, high labour cost and unavailability of credit.

Second, crop farmers should develop low income methods of land management; this will act as a backup mechanism for those low income farmers to adopt land management technologies.

Finally, extension agents should be made available to the crop farmers in other to help guide the farmers on the use of sustainable land management technologies.

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MEDIA ADVOCACY FOR MATERNAL HEALTH: A GENDERED ANALYSIS OF NEWSPAPER COVERAGE IN NIGERIA"

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ABSTRACT
Shockingly, an estimated 53,000 women lose their lives annually, equating to one woman succumbing to maternal-related issues every ten minutes. This alarming statistic translates to approximately 800 women losing their lives for every 100,000 live births. This study therefore aims to investigate the media advocacy of maternal health news in the print media. A quantitative analytical study of 370 articles of the three newspapers were collected. The collected responses were analysed using descriptive statistics. The analysis revealed that news on maternal mortality had the highest percentage of 49.5%, followed by 20.5% news on pregnancy-induces high blood pressure in the selected newspapers. The least dominant news types were news on malaria (0.5%) and lack of quality health care formal providers (1.1). News reporters (28.4%) dominated sources of information often quoted. Other sources quoted were (research Institutes which had 1.6%, government official 19.5%, NGOs 13.0%, university scientist 4.9%, health personnel 9.5%, residents and victims 2.4%, international organisations 10.0%, in the three selected newspapers. This implies that there is high level of awareness of maternal health condition. These conditions could be addressed through simple ways like creating awareness and improving education on the problems causing it.
Keyword: *Media Advocacy, Gendered analysis, Maternal health, Newspaper coverage, Nigeria*

INTRODUCTION

Maternal ill-health occurs as a result of complications of pregnancy and childbirth. About 53,000 women die every year, which means one woman dying every ten minutes. This means about 800 women die in every 100,000 live births. Many people do not readily appreciate this disaster because the deaths do not occur together or in one place. They occur silently in the many different communities in Nigeria. (Maternal Health Fact Sheet, 2007). They die from complications during pregnancy and delivery, which include: excessive bleeding (or haemorrhage), infections, pregnancy-induced high blood pressure leading to convulsions, unsafe abortion, anaemia, malaria, and obstructed labour. The World Health Organization (WHO) estimates that over 500,000 women and girls die from complications of pregnancy and childbirth each year, worldwide, with approximately 99% of these deaths occurring in developing countries. According to Ogunjuyigbe and Liasu, A. (n.d.); and WHO (2007) for every woman that dies from pregnancy-related causes, 20 – 30 more will develop short- and long-term damage to their reproductive organs resulting in disabilities such as obstetric fistula, pelvic inflammatory disease, a ruptured uterus.

Maternal health is very important because childbearing is a key part of women's lives which occurs mainly in the adolescent and adult years. This is also their most productive time when women strive to fulfil their potential as individuals, mothers and family members, and also as citizens of a wider community. Poor maternal health can have significant negative impact on the family and society as it is a major determinant of the health of children and can also have huge costs on families in emotional, health and economic terms. Direct medical costs, loss of income and other economic contributions, potentially put the family in economic distress. The risk of a woman dying as a result of pregnancy or childbirth during her lifetime is about one in six in the poorest parts of the world compared with about one in 30,000 in Northern Europe. Such a discrepancy poses a huge challenge to meeting development goals set form time to time.

The need for media involvement in promotion of healthcare is pertinent considering the poor state of the Nigerian health sector, with the country ranking below global and African regional average across various health indices (World Health Organisation, 2014). Maternal and child healthcare (MCH) is an important developmental issue affecting every constituency in Nigeria, though with wide disparities across the geographical regions and social strata (National Population Commission & IFC International, 2014). Media serve as health reformer that has the power of bringing buried topics to the spotlight. By highlighting these ignored issues and neglected segments, media helps to bring public health to the policy agenda. Newspapers are enduring and very popular print media organ. This is because it can be read and re-read at convenience, thus, allowing for a fuller and better understanding of mass media contents. Newspapers also help the process of information exchange between those searching for information and also support new behaviours (Albrecht *et al*, 1989; Lightfoot, 2003). In essence, the newspapers are potent and fundamental tools for technology transfer in the aid of agricultural and rural development and associated issues that affect the rural populace such as maternal health.

In spite of increasing in maternal death, it appears Nigeria's media; especially the newspapers are not doing enough to bring this to limelight. This is probably due to competing demand for much news worthy issues and even paid advertorial to fulfil the commercial purpose of the prints media. It is in light of the aforesaid that this study investigated the pattern of reporting coverage of rural maternal health news in the Nigerian newspapers to empirically validate series of concerns emanating from this trend and consequently chart ways to improving the current level of reportage of maternal health news in Nigerian newspapers. In doing this the study investigated specifically types of maternal health news covered and the sources quoted in the Nigeria newspapers.

MATERIALS AND METHODS

Three out of ten widely read newspapers were randomly selected for the purpose of data collection and analysis for this study. Pre-test showed that the three selected daily newspapers report maternal health news routinely. Also, they were most widely read thereby having a wider coverage in Nigeria as noted by Nigeria Press Council (2010). All newspaper editions reporting maternal health news in the Punch, the Guardian and the Nigerian Tribune newspapers constituted the population for this study. Articles that were selected for the research include; news articles, feature article and culled articles. The unit of analysis for this study was individual article reporting maternal health news in the selected newspapers. Descriptive statistics (frequencies and percentages) were used to arrange and describe the data collected while inferential statistics such as chi-square (x^2) were used to test for relationship and (ANOVA) were used to test for differences between study variables.

RESULTS AND DISCUSSION

From the analysis of the reviewed maternal health news reported in the Punch, Guardian and the Nigerian Tribune newspapers, eight frames emerged: education, awareness, government intervention, advertisement, innovation, blame, punishment and criticism. Results in Table 1 show the type of news that was reported by the newspapers within the study's time frame. This result shows that the types of news that were reported as a result of maternal health was maternal mortality (49.5%) and on pregnancy-induces high blood pressure (20.5%). Out of the various news types that are reported, news about maternal mortality had the highest percentage in the three newspapers which had 49.5% and this was followed by pregnancy-induces high blood pressure news had 20.5%. Infection had 14.6% news, lack of awareness had 5.7%, unsafe abortion had 5.4%, Haemorrhage had 1.4%, inaccessible/transportation had 1.4%. News type with the lowest percentage is news that reports on malaria and lack of quality health care formal providers. Malaria had 0.3% in Punch, 0% in Guardian and 0.3% in the Nigerian Tribune. The Guardian newspaper did not report news on malaria. The Nigerian Tribune newspaper as well did not give any report on news pertaining to lack of quality health care formal providers.

News about maternal mortality which had the highest percentage (49.5%) in the three newspaper comprises of maternal death/morbidity, Female Genital Mutilation (FMG), child labour/child abuse, sexually transmitted diseases and HIV, unsafe abortions/unwanted pregnancies, Forced and early marriage, under nutrition of the girl child are conditions that could lead to maternal death. These conditions could be addressed through simple ways like creating awareness and improving education on the problems causing it.

Table 1: Showing the news types that were reported by the three newspapers.

News type	Newspapers			Total
	Punch	Guardian	Tribune	
Malaria	1 (0.3)	0 (-)	1 (0.3)	2 (0.5)
Infections	10 (2.7)	27 (7.3)	17 (4.6)	54 (14.6)
Unsafe abortion	8 (2.2)	9 (2.4)	3 (0.8)	20 (5.4)
Maternal Mortality	57 (15.4)	71 (19.2)	55 (14.9)	183 (49.5)
Lack of awareness	10 (2.7)	8 (2.2)	3 (0.8)	21 (5.7)
Haemorrhaged	3 (0.8)	2 (0.5)	3 (0.8)	5 (1.4)
Lack of quality healthcare formal providers	2 (0.5)	2 (0.5)	0 (-)	4 (1.1)
Pregnancy- induced high blood pressure	39 (10.5)	14 (3.8)	23 (6.2)	76 (20.5)
Inaccessible and transportation system	1 (0.3)	1 (0.3)	3(0.8)	4 (0.3)
Total	131 (35.4)	134 (36.2)	105 (28.4)	370 (100)

The sources quoted in the reported maternal health news:

The results in Table 2 indicate sources used in reporting maternal health news by the newspapers included in this study. This result shows that the newspaper obtained information from two (2) major sources which are news reporters having a total of 28.4% and government official having a total of 19.5%. Government official group comprised of any position within the government that was hired or appointed while, the news reporter reporting an event or loss of live/ maternal death that is caused by maternal health challenges and factors. The highest sources of information that were mostly quoted are the news reporters which had 28.4%, and this was followed by Government official (19.5%) in the selected newspapers. Sources from research Institutes and residents and victims are sources of information with the lowest percentage 0.3% and 1.1% respectively. The Punch newspaper had the highest percentage (11.1%) sources of information from the news reporters. while The Nigerian Tribune had the highest percentage (7.3%) sources of information from Government official. The Nigerian Tribune had the lowest percentage source of information from the research institute (0.3%) and university scientist (1.1%) respectively. This result shows that major source of information used by the three newspapers is news reporters and Government officials which is not a reliable source because the public always prefer information from reliable sources such as experts and university scientist.

Table 2: Sources for maternal health news in the newspapers

News Sources	Newspapers			Total
	Punch	Guardian	Tribune	
Government Official	22 (5.9)	23 (6.2)	27 (7.3)	72 (19.5)
NGOs	9 (2.4)	26 (7.0)	13 (3.5)	48 (13.0)
University Scientists	6 (1.6)	8 (2.2)	4 (1.1)	18 (4.9)
Research Institutes	4 (1.1)	1 (0.3)	1 (0.3)	6 (1.6)
News Reporters	41 (11.1)	39 (10.5)	25 (6.8)	105 (28.4)
Health Personnel	18 (4.9)	7 (1.9)	10 (2.7)	35 (9.5)
Residents and Victims	3 (0.8)	4 (1.1)	2 (0.5)	9 (2.4)
International Organizations	9 (2.4)	16 (4.3)	12 (3.2)	37 (10.0)
Researchers	19 (5.1)	10 (2.7)	1 1 (3.0)	40 (10.8)
Total	131 (35.4)	134 (36.2)	105 (28.4)	370 (100)

CONCLUSION

The study concludes as follows:

- Maternal mortality was the highest news type that was mainly reported.
- The major source of information reported on maternal health news are the news reporters and government officials.

RECOMMENDATIONS

Based on the findings of the study, the following recommendations are made:

- The Nigerian newspaper industry should give more prominence to maternal health news and also increase their frequency of reportage in the selected newspapers.
- Other frames of malaria, lack of quality healthcare formal providers, and inaccessible and transportation system should also be accorded due coverage.
- The media should provide an open forum to reflect different public views, including those of economically poor people, to create awareness to the public more about the importance of maternal health coverage.

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TEMPERATURE VARIATIONS AND THE EFFECTS ON COFFEE YIELD IN NIGERIA

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ABSTRACT
Coffee (C.arabica and C.robusta) in Nigeria has declined production due to climate change. Data of 1961-2021 from FAOSTAT consisting area(ha), yield (kg/ha) and annual temperature(^{0}C) was analysed using least squares regression. Results showed 861.8kg/ha average yield from 4201.4ha mean area in 61 years. The temperature/annum decreased by 0.0007^{0}C for 11 years and increased by 0.0200^{0}C for 50 years at 0.6380 and 0.0014 R^2 respectively. The coffee yield/annum for 11 years temperature decrease by 63.6%, 27.3% and 9.1% in the 60s, 70s and 80s and for 50 years increase by 4%, 14%, 18%, 20% and 44% in the 60s, 70s, 80s, 90s and 2000s was 14.2kg/ha and 20.9kg/ha respectively. The correlation was inverse (-0.318) between yield and temperature decrease and direct (0.713) with temperature increase. The coffee yield and temperature was inverse (-0.058, -0.649) respectively in the 60s and 80s. To enhance coffee yield, temperature threshold should be maintained through good agricultural practices in the plantations.
Keywords: *Temperature variations, Coffee yield, Nigeria, climate change, FAOSTAT*

INTRODUCTION

Coffee (*Coffee arabica and Robusta coffee*) is a perennial woody tree crop. It is a shade-loving tree that well-known for helping to preserve the ecology **(**Akinpelu *et al.,* 2021**)**. The coffee berry or cherries contain the seeds, often known as coffee beans. The coffee plant is indigenous to Africa, with its origin linked to Ethiopia, Central Africa, and West Africa **(**Ayoola *et al*., 2012**;** ICC, 2015**)**. Coffee grows between the latitudes of 25°N and 25°S, but commercial growing requires peculiar environmental conditions **(**Ogundeji *et al*., 2019**)**. Nigeria has a land area of around 923,769 km^2, although only about half of it is currently cultivated (Onwusiribe *et al.,* 2022). In 2019, the land area utilised for coffee growing was expected to be 10 km^2, whereas in 1981, the land area used for coffee farming was 60 km^2. Agriculture in Nigeria is mainly influenced by the weather, with possible irrigation areas ranging from 1.5 to 3.2 million hectares. The coffee-producing states in Nigeria include Bauchi, Kwara, Plateau, Taraba, Cross River, and Osun; however, there are also temperate zones in Nigeria that can support coffee production. Nigeria's low coffee output is due to a combination of factors, including poor farming practices, low mechanisation, limited access to funding and inputs, and the effects of the climate **(**PwC, 2017**;** Mohammed *et al.,* 2013**;** Ayoola *et al.,* 2012**)**. Temperature, rainfall, sunlight, wind, and soils are crucial in coffee production, but the needs vary depending on the cultivated varieties **(**Ayoola *et al*., 2012**)**.

The changing climate in the tropics, particularly in terms of altered rainfall patterns and extended dry spells in most parts of Nigeria, has led to soil water balance changes, flooding, drying up of water bodies, and desert encroachment. Due to delayed rainfall in some of the producing regions, coffee production in Nigeria was expected to decline in the 2020/21 farming season **(**Bjornlund *et al*., 2020**;** Malhi *et al.,* 2021). In addition, the increase in the incidence of pests and diseases that harm the coffee tree, such as parasitic nematode, coffee berry borer, leaf rust, coffee berry disease, brown eyespot, and coffee wilt disease, is linked to climate variations **(**Gizaw *et al.,* 2021**;** Ogundeji *et al.,* 2019**)**. The majority of small-scale coffee producers are abandoning their farms due to climate change and production issues outside the farmers' control. These conditions impact the productivity of most small-scale coffee farmers, lowering their income. Longer drought spells and interrupted flowering cycles are two examples of climate change impacts on coffee, resulting in decreased quantity and quality of coffee harvested **(**Gizaw *et al.,* 2021**;** Ogundeji *et al.,* 2019**)**. Coffee will go extinct unless suitable climate change mitigation and adaptation methods are implemented, which include conservation, monitoring, and seed preservation **(**Ogundeji *et al.,* 2019**;** Duke & Cornell, 2019**)**.

According to Kollipara (2014)**,** the issue of global warming and other climate change effects must be treated as an emergency, or the land area suitable for coffee farming will decline by 50%, affecting global coffee output. Given the importance of coffee worldwide, the output decline in Nigeria in past decades occasioned by low prices on the international market, limited access to production factors, and the effects of climate change posed the most significant challenge. For example, in 1966, Nigeria produced 4000 tonnes of coffee, but in 1967, it only produced 1712 tonnes due to political unrest that hindered access to production assets. In 1969, Nigeria produced 4776 tonnes of coffee, whereas, in 1979, Nigeria produced 3200 tonnes. Recently in 2019, the output of coffee was 1117, which declined from 2400 tonnes recorded in 2010 **(**FAO, 2021**).** Land, capital, output and input prices, and climatic factors are all important factors influencing the short run and long run coffee production **(**Nchare, 2007**).** These factors make small-scale coffee farmers more vulnerable to postharvest losses of more than 50% **(**Kasso & Bekele, 2018**;** Baca *et al.,* 2014**).** The research is aimed at proposing climate change mitigation strategies to enhance optimum coffee yield.

MATERIALS AND METHODS

Data on area harvested (ha), yield (kg/ha) and temperature (^{O}C) in Nigeria was sourced from the database of Food and Agricultural Organisation Corporate Statistical Database (FAOSTAT); the duration was 61 years (1961 - 2021). The data were analysed using least squares regression.
The least squares line method uses a straight line
$Y = a + bx$
to approximate the given set of data, $(x_1,y_1), (x_2,y_2), \dots, (x_n,y_n)$, where $n \geq 2$
Where 'a' stands for the intercept and 'b' stands for the slope; x and y are the variables. The slope is equivalent to variation in coffee yield and temperatures per year (Kadioglu, 1997). To measure the association between the variables, correlation analysis was done.

RESULTS AND DISCUSSION

Temperature variations and coffee yield statistics

Table 1 states the inter annual coffee yield statistics from the 60s to 2000s while Table 2 shows the cumulative yield statistics during the periods of temperature variations.

Table 1: Coffee inter annual Yield Statistics

Variables	Inter Annual Yield Statistics									
	60s		70s		80s		90s		2000s	
	Yield (kg/ha)	Temp (^{0}C)	Yield (kg/ha)	Temp (^{0}C)	Yield (kg/ha)	Temp (^{0}C)	Yield (kg/ha)	Temp (^{0}C)	Yield (kg/ha)	Temp (^{0}C)
Minimum	183.3	0.0136	499.5	0.0928	500.0	0.2923	882.4	0.0004	1133.3	0.4378
Maximum	666.7	0.4743	500.2	0.8040	523.3	1.0181	1198.1	1.1465	1439.4	1.4368
Mean	408.8	0.1776	500.0	0.2958	502.6	0.5217	1005.2	0.6570	1284.1	1.0319
Standard deviation	160.8	0.1596	2.1492	0.2663	77.7	0.2214	1007.8	0.3183	699.2	0.2821
Correlation Analysis	-0.649		0.143		-0.058		0.502		0.073	

Table 2: Coffee cumulative yield statistics

Variables	Cumulative Yield Statistics			
	Yield Statistics at temperature decrease (60s – 80s)		Yield Statistics at temperature increase (70s – 2000s)	
Minimum	183.3	0.0136	333.3	0.0004
Maximum	755.9	0.4743	1439.4	1.4368
Mean	465.3	0.1710	949.1	0.7333
Standard deviation	163.0	0.1380	358.7	0.3918
Correlation Analysis	-0.318		0.713	

As shown on Table 1, throughout the 61 years of observation, coffee yield was minimum (183.3kg/ha) in the 60s at mean surface temperature of 0.1776 ^{0}C and standard deviation of 160.8kg/ha while in the 2000s, the yield was maximum (1439.4kg/ha) at a mean surface temperature of 1.0319^{0}C and standard deviation of 699.2 kg/ha. There is an inverse correlation between coffee yield and temperature in the 60s (-0.649) and 80s (-0.058) while in the 70s, 90s and 2000s, the correlation was positive (0.143, 0.502 and 0.073 respectively). Considering the coffee cumulative yield statistics (Table 2) throughout the individual years of temperature decrease (60s – 80s) as well years of increase (70s – 2000s), it can be observed that yield was minimum (183.3kg/ha) at a mean temperature of 0.1710^{0}C and standard deviation of 163.0kg/ha in the individual years of 60s to 80s while the maximum yield (1439.4kg/ha) at mean temperature of 0.7333^{0}C and standard deviation of 358.7 kg/ha was observed in the individual years of 70s to 2000s. There is an inverse correlation (-0.318) between temperature and coffee yield during the periods of temperature decrease and positive correlation (0.713) between both variables during the years of temperature increase.

Regression analysis of coffee yield Trend

Figures 1 and 2 shows the trend in coffee yield during the 11 years of temperature decrease and 50 years of increase respectively.

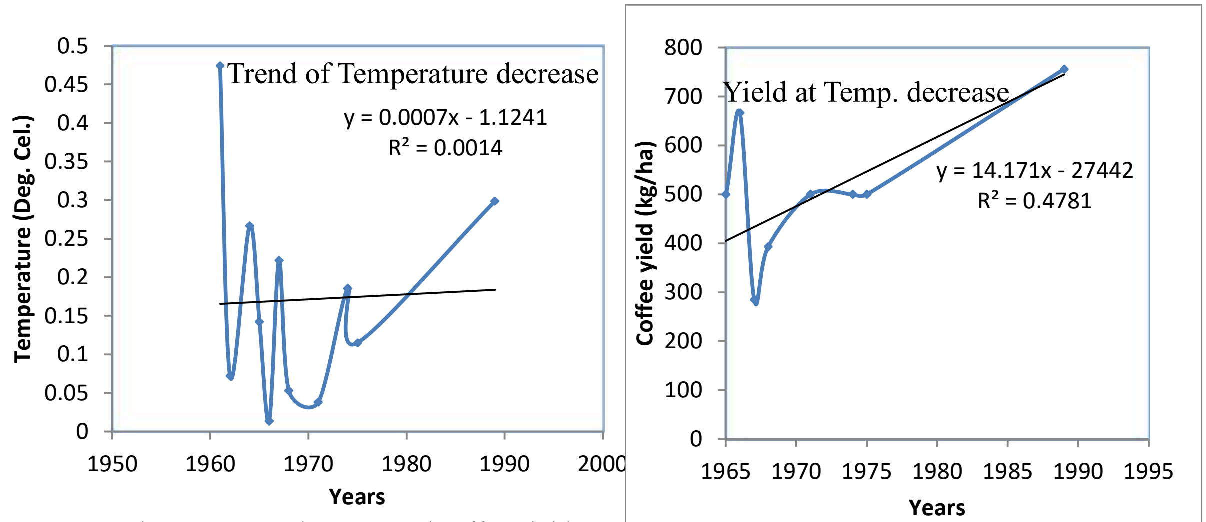

Figure 1: Annual temperature decrease and coffee yield

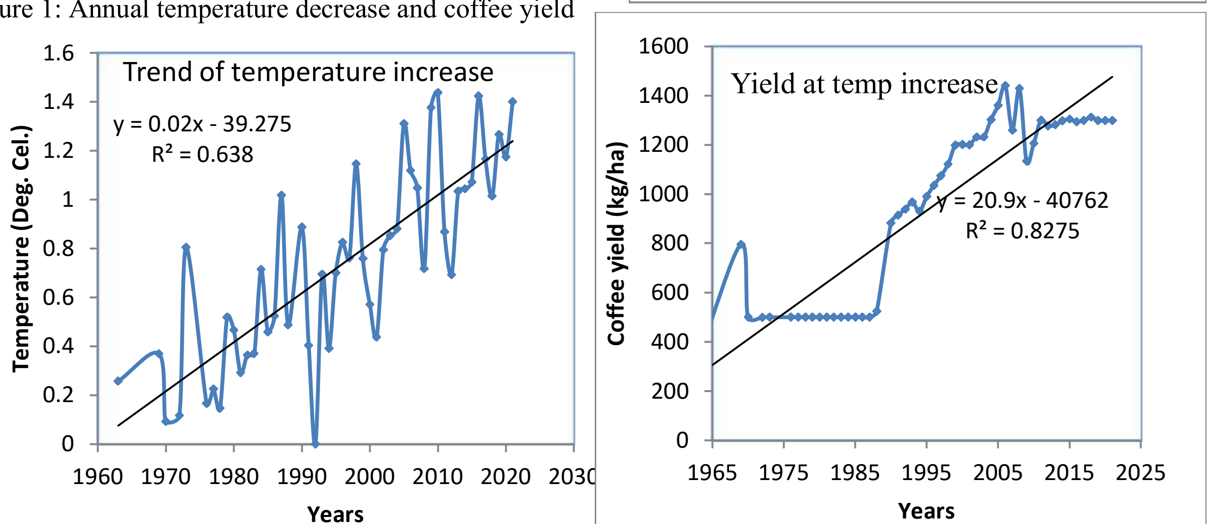

Figure 2: Annual temperature increase and coffee yield

The results presented in Figures 1 and 2 revealed an annual temperature of increase 0.0200^{o}C at R^2 value of 0.6380 and 0.0007^{o}C decrease at the R^2 of 0.0014. There was increase of coffee yield of 20.9kg/ha per annum during the 50 years of temperature increase while the yield decreased by 14.2kg/ha in 11 years of temperature decrease. The R^2 values were 0.8275 and 0.4781 respectively.

CONCLUSION

Nigeria has a land area of around 923,769 km^2 but only about 60 km^2 is utilised for coffee cultivation and yield has been affected by climate change. The result obtained revealed 82% of temperature increase in 50 years and 18% decrease in 11 years at R^2 value of 0.6380 and 0.0014 respectively. During the period of temperature increase, the coffee yield increased by 20.9kg/ha per annum at R^2 values were 0.8275 while the yield decreased by 14.2kg/ha at R^2 value of 0.4781 when there was temperature decrease. The decrease in yield can be mitigated by the use of standard cultural practices and other standardisation practices by coffee farmers inorder to produce efficiently and meet the demands of the international coffee market.

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