HORTICULTURAL SOCIETY OF NIGERIA (HORTSON) NSUKKA - 2020

THEME:

SUSTAINABLE HORTICULTURE PRODUCTION SYSTEM INTENSIFIED

38th Annual Conference

25 - 31 OCTOBER, 2020

HALL OF FAME UNIVERSITY OF NIGERIA NSUKKA

PROCEEDINGS OF THE THIRTY-EIGHT ANNUAL CONFERENCE OF THE HORTICULTURAL SOCIETY OF NIGERIA (HORTSON)

25 - 31 OCTOBER, 2020

Printed by:
Chenglo limited
No.6, Plot 1123 ECA Moneke Crescent
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A PUBLICATION OF
HORTICULTURAL SOCIETY OF NIGERIA (HORTSON)

CONTENTS

INFLUENCE OF INTEGRATED NUTRIENT MANAGEMENT ON PRODUCTIVITY OF PEPPER (*Capsicum annum* L.) IN MINNA, NIGERIA

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ABSTRACT

The production of hot pepper (Capsicum annuum L.) can be largely affected by the quality of soil among other biotic and abiotic constraints. Furthermore, organic fertilizers serve as alternatives to chemical fertilizers and can be combined to reduce the adverse effect of mineral fertilizers on the soil. This experiment was therefore carried out to explore the potential effect of combined application of NPK and organic fertilizer on the growth and yield of hot pepper. Treatment combinations were 100 % Recommended Dose (RD) NPK, 75 % RD NPK + 25 % RD Organic Fertilizer, 50 % RD NPK + 50 % RD Organic Fertilizer, 25 % RD NPK + 75 % RD Organic Fertilizer, 100 % RD Organic Fertilizer and the Control replicated four times. The result revealed that pepper plants that received 75 % RD NPK + 25 % RD Organic Fertilizer exhibited early flowering, shorter days to fruiting, highest number of fruits per plant and heavier fruits per plant. This study suggests that for improved pepper production, the combined application of 75 % RD NPK + 25 % RD Organic Fertilizer is therefore recommended in this agro-ecology of Nigeria.

Keywords: *Capsicum annuum, NPK, organic fertilizer, Soil, Recommended dose*

INTRODUCTION

Pepper (*Capsicum annum* L.) is an essential commodity grown across the world and available in all local markets in Africa which provides a source of income for farmers. Nigeria has the highest production of pepper in Africa with about 748559 tonnes being cultivated on 92,377,000 hectares (FAO, 2017). This crop is commonly used as spice for cooking to add flavour to food, medicinal purpose and also to generate income through foreign exchange (Adama *et al.*, 2019). It is of high nutritional value specifically as a good source ascorbic acid, phenolic and carotenoids compounds which helps to prevent diseases like cancer and diabetes (Nwose, 2009). The demand for pepper has increased greatly in recent times which has given it more economic significance, this demand has led to the increased use of mineral fertilizers to boost production. Nutrients are required for proper rooting, growth and development of plants (Tittonel *et al.*, 2008). The application of organic fertilizer in pepper production can increase the growth rate of the vegetative organs accompanied by enhanced development of the generative ones.

Several factors have contributed to the low yield of pepper in the country. These constraints include low production inputs, lack of improved pepper varieties, inadequate knowledge on production and management systems, poor extension services, poor marketing system and presence of diseases (Delelegn, 2009). Soil fertility management is one of the most yield limiting factors for pepper production in Africa (Alemu and Ermias, 2000). In Nigeria, pepper production is faced with poor soil fertility management resulting in low yield levels (Ali *et al.*, 2015). The indiscriminate use of mineral fertilizers results in soil, water and environmental pollution consequently affecting animals and human beings. Due to the cost of mineral fertilizers, small holder farmers cannot sustainably afford to keep production high with the recommended fertilizer dose (Yadav *et al.*, 2019). Therefore, if pepper production is to be made sustainable for small holder farmers; emphasis must be placed on replenishing soil fertility via alternative means. The adoption of developed integrated management strategies will improve mineral fertilizer use and reduce the environmental pollution in agriculture. But, there are limited studies on fertility management of pepper in Niger State, Nigeria with regard to the influence of combined application of NPK and organic fertilizers on the growth and yield of hot pepper.

Organic fertilizers have been proven as an affordable alternative to mineral fertilizers. The use of organic fertilizers in pepper production can help in mitigating multiple nutrient deficiencies as well as making up for decrease in soil organic matter (SOM). Organic fertilizers are gaining importance because of their low cost, no residual toxicity and capacity to enrich soil fertility in addition to high returns under favourable conditions (Yadav *et al.*, 2019). The

optimization of nutrient fertilizer (organic and inorganic) for pepper production is imperative to meet the ever increasing demand of the crop (Mebratu *et al.*, 2014). Therefore, this experiment sort to explore the potential effect of combined application of NPK and organic fertilizer on the productivity of hot pepper (*Capsicum annuum*).

MATERIALS AND METHODS

Experimental Site

Pot experiments were conducted at the screenhouse of the Department of Soil Science and Land Management, Federal University of Technology, Minna (100° 21′ N,50° 39′E, 2,419 M above sea level) in 2019. Thirty-five centimetre diameter poly-pots were filled with 8 kg loamy soil and placed on the steel stand benches for the evaluation.

Treatments and Experimental Design

The six treatment combinations were 100 % Recommended Dose (RD) of NPK, 75 % RD of NPK + 25 % RD of Organic Fertilizer, 50 % RD of NPK + 50 % RD of Organic Fertilizer, 25 % RD of NPK + 75 % RD of Organic Fertilizer, 100 % RD of Organic Fertilizer and Control (no addition of NPK or organic fertilizer). The organic fertilizer (Nnasaf ® Bioorganic fertilizer) was incorporated two weeks before transplanting at the manufacturer's recommended rate of 1.5 t ha^{-1} and NPK (15:15:15) at 200 kg ha^{-1} (NAERLS, 2013) was applied in two split doses (at two weeks after transplanting and at 50 % flowering). The treatments were laid out in a completely randomized design (CRD) and replicated four times. The crop variety used was the local accession 'Dan-Zaria' pepper ('atarodo').

Soil and Organic Fertilizer Analyses

Prior to raising the pepper nursery, soil samples were collected. Using a soil auger, representative soil samples were collected, bulked, air dried and passed through 2mm and then 0.5mm sieve-mesh; and analysed using standard laboratory procedures as described by International Institute of Tropical Agriculture (IITA, 1976). Total Nitrogen (TN) was determined using micro kjedahl wet oxidation method, soil pH was determined in 1:2.5 in water and calcium chloride and read with glass electrode pH meter while Organic carbon was determined by wet oxidation method. Available phosphorus (P) was determined by Bray -1- method, exchangeable potassium (K), calcium (Ca) and Magnesium (Mg) and sodium were determined using flame photometry. The micronutrients were extracted with hydrochloric acid and AAS was used for the determination in order to establish the nutrient status of the soil before planting. The Organic fertilizer was analysed for N, P, K and organic carbon.

Data Collection

Plant height was assessed using a meter rule to measure the plant's height from the soil surface to the tip of the topmost leaf in each pot. Assessment was made at 30, 45, and 60 days after transplanting (DAT). Number of leaves per plant was evaluated by manually counting the number of leaves on each plant in each pot and the mean was determined. Assessment was made at 30, 45 and 60 DAT. Number of branches per plant was assessed by manually counting the number of branches on each plant in each pot and the mean was determined. Assessment was made at 30, 45 and 60 DAT. Days to flowering, number of days to flowering was determined by counting the days from sowing to when one flower opens in each pot. Days to fruiting, number of days to fruiting was determined by counting the days from sowing to when one fruit is produced in each pot. Number of fruits per plant was assessed by counting the fruits produced by each plant in each pot. Fruit weight per plant was determined by measuring the weight of the mature fruits harvested from each plant in the pot using an electronic weighing machine (Model: METTLER PM2000, Switzerland).

Data Analysis

Data collected were subjected to analysis of variance (ANOVA) using the Statistical Analysis System (SAS Institute Inc., 2008). Treatment means were separated using the Duncan Multiple Range Test (DMRT) at $p \leq 0.05$ level of probability.

RESULTS AND DISCUSSION

Plant height

Application of 100 % RD NPK had taller plants (33.4 cm) but comparable with plots given combined application of different ratios of NPK and organic fertilizer and 100 % RD of organic fertilizer (Table 1). But the application of 0

% of NPK + 0 % of Organic fertilizer (Control) had the shortest pepper plants (27.8 cm). The practice of application of NPK, organic fertilizer or the combination of the fertilizers increased plant height of pepper in this study. The increase in growth of pepper was due to availability of adequate nutrients required for plant growth. This finding is in agreement with the work of Gopal *et al.* (2018) who reported that the growth of pepper was significantly enhanced by N given that other nutrients such as P, K and other micro nutrients are not deficient. Plants treated with nutrients grew taller than untreated plants resulting in better access to sunlight and increased accumulation of photo-assimilates (Olatunji *et al.*, 2015).

Number of leaves

The pepper plants treated with 50 % RD NPK + 50 % RD Organic fertilizer produced the highest number of leaves per plant (58 leaves). This was at par with leave number recorded for 75 % RD NPK + 25 % RD Organic fertilizer application and plants where 100 % NPK was applied (Table 1). Similarly, the application of 25 % RD NPK + 75 % RD Organic fertilizer, 100 % RD Organic fertilizer and 0 % NPK + 0 % Organic fertilizer produced lesser number of leaves across the period of evaluation. The lowest number of leaves (23) was observed in pepper plants which received 0 % NPK + 0 % Organic fertilizer application. This corroborates the findings of Law-Ogbomo and Remison (2008) where, Nutrient uptake and utilization from fertilizer application significantly improved plant leaf production. The increased leaf production in pots with 75 % RD of NPK + 25 % RD of Organic fertilizer and 50 % RD of NPK + 50 % RD of Organic fertilizer connotes the greater photosynthetic activities in these plants as the leaves are plant parts for photosynthesis. Thus, the higher the number of leaves produced, the better the use of available sunlight (Olatunji *et al.*, 2015).

Number of branches

All the treatments showed significant variations ($p \leq 0.05$) in the number of branches produced by each plant (Table 1). At 30 Days after Transplanting (DAT), 50 % RD of NPK + 50 % RD of Organic fertilizer produced highest number of branches per plant (8 branches), this trend was maintained at 45 and 60 DAT where 15 and 23 branches per plant was recorded. The lowest number of branches were recorded in pots with (0 % of NPK + 0 % of Organic fertilizer). The result suggests that pots applied with NPK and organic fertilizer supplied nutrients which were readily absorbed by plant roots for vigorous plant growth. This agrees with the findings of Olatunji *et al.* (2015) and Law-Ogbomo and Egharevba (2010) who reported an increase in growth of pepper with the application of soil amendments.

Days to flowering

There was significant difference ($p<0.05$) among the treatment combinations with respect to the number of days to flowering (Table 2). The application of 75 % RD of NPK + 25 % of RD Organic fertilizer had the earliest number of days to flowering (96 DAT) compared to the application of 100 % RD of Organic fertilizer and 0 % of NPK + 0 % of Organic fertilizer which took more days to flower (108 DAT). The early flowering observed in 75 % RD of NPK + 25 % RD of Organic fertilizer and other treatments with fertilization can be attributed to the efficient nutrient uptake which translated into enhanced morphological and vegetative growth (Jilani *et al.*, 2009).

Days to fruiting

There was no significant difference in the number of days to fruiting (Table 2) across the evaluated treatment combinations however, 75 % RD of NPK + 25 % RD of Organic fertilizer (109 DAT) produced fruits earlier than other nutrient combinations. Plants without nutrient application (0 % of NPK + 0 % of Organic fertilizer) took longer duration to fruit supporting the findings of Dauda *et al.*, 2008 where the supply of plant nutrients and improvement in the soil properties resulted in the synthesis of more photo-assimilates which is used in fruit production.

Number of fruits

The number of fruits per plant varied significantly ($p<0.05$) across nutrient combinations (Table 2). The application of 75 % RD of NPK + 25 % RD of Organic fertilizer produced the highest number of fruits per plant (5 fruits) which is comparable to 100 % RD of NPK and 50 % RD of NPK + 50 % RD of Organic fertilizer application only where 4 fruits were produced per plant. The other nutrient combinations produced an average of 2 fruits per plant. The variation in the number of fruits produced could be due to the agronomic practices. Treatments with optimum

doses of organo-mineral fertilizer combinations better supplied plant nutrients which improved soil properties, soil aggregate stability and led to increased growth. This is in consonance with the findings of Olatunji *et al.*, 2015 who reported the use of organo-minerals as plant nutrient sources for sustainable pepper cultivation.

Fruit weight

Pepper plants that received 75 % RD of NPK + 25 % RD of Organic fertilizer application recorded the heaviest fruit weight per plant (21.5 g) compared to other treatments except in plot given the application of 100 % RD of Organic fertilizer which had the lightest fruits (4.5 g) per plant. The increased fruit weights observed in fruits with fertilization can be attributed to the N content of the treatment and plants' uptake of the available nutrients. This supports the findings of Olatunji *et al.* (2015) where pepper that received fertilizer application recorded significantly different fruit weight compared to those that did not receive fertilizer application.

CONCLUSION

Based on the finding of this study application of 75 % RD NPK + 25 % RD Organic fertilizer can enhance pepper production in this environment, and a further field evaluation of this application is suggested.

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Table 1: Effect of combined application of organic and mineral fertilizer on plant height, number of leaves per plant and number of branches per plant of 'Dan-Zaria' pepper in Minna, Nigeria

Treatment	Plant height (cm)			Number of leaves per plant			Number of branches per plant		
	Days After Transplanting			Days After Transplanting			Days After Transplanting		
	30	45	60	30	45	60	30	45	60
100 % RD NPK	12.3^{ab}	22.0^{ab}	33.4^{a}	8^{ab}	15^{ab}	43^{ab}	5^{ab}	11^{ab}	20^{a}
75 % RD NPK + 25 % RD Organic Fertilizer	16.6^{a}	25.9^{a}	30.8^{ab}	12^{a}	20^{a}	46^{ab}	7^{ab}	13^{ab}	20^{a}
50 % RD NPK + 50 % RD Organic Fertilizer	16.3^{a}	25.9^{a}	31.6^{ab}	12^{a}	23^{a}	58^{a}	8^{a}	15^{a}	23^{a}
25 % RD NPK + 75 % RD Organic Fertilizer	15.6^{a}	27.4^{a}	32.6^{ab}	8^{ab}	17^{ab}	33^{b}	6^{ab}	13^{ab}	15^{b}
100 % RD Organic Fertilizer	14.8^{ab}	21.0^{ab}	30.5^{ab}	9^{ab}	15^{ab}	25^{b}	7^{ab}	12^{ab}	14^{b}
0 % RD NPK + 0 % RD Organic Fertilizer	10.5^{b}	18.0^{b}	27.8^{b}	5^{b}	9^{b}	23^{b}	3^{b}	8^{b}	14^{b}
±SE	1.4	2.1	1.5	1.7	2.9	6.9	1.5	1.7	1.6

Means with dissimilar alphabet letter along the row differ significantly ($p \leq 0.05$) according to Duncan's Multiple Range Test (DMRT)

Table 2: Effect of combined application of organic and mineral fertilizer on Days to flowering, days to fruiting, number of fruits per plant and fruit weight per plant of Dan-Zaria pepper in Minna, Nigeria

Treatment	Days to flowering (no.)	Days to fruiting (no.)	Number of fruits per plant	Fruit weight per plant (g)
100 % RD NPK	103^{ab}	114^{a}	4^{ab}	19.8^{ab}
75 % RD NPK + 25 % RD Organic Fertilizer	96^{b}	109^{a}	5^{a}	21.5^{a}
50 % RD NPK + 50 % RD Organic Fertilizer	98^{ab}	111^{a}	4^{ab}	15.1^{ab}
25 % RD NPK + 75 % RD Organic Fertilizer	99^{ab}	113^{a}	2^{b}	9.3^{ab}
100 % RD Organic Fertilizer	108^{a}	121^{a}	2^{b}	4.5^{b}
0 % RD NPK + 0 % RD Organic Fertilizer	108^{a}	124^{a}	2^{b}	6.3^{ab}
±SE	3.6	5.3	0.9	4.7

Means with dissimilar alphabet letter along the row differ significantly ($p \leq 0.05$) according to Duncan's Multiple Range Test (DMRT)