RESPONSE OF GROWTH AND YIELD OF MAIZE (*ZEA MAYS* L.) TO LIME, INORGANIC AND ORGANIC FERTILIZER IN MOKWA, NIGER STATE OF NIGERIA

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ABSTRACT

Proper integrated nutrient management is essential for plant growth, yield efficiency and soil health maintenance. A field trial was conducted to investigate the effect of lime, inorganic and organic fertilizer on growth and yield of maize on farmers' field at Rabba, Mokwa, Local government area of Niger State. The field trial was conducted in the year 2021 (rainy season). The treatments consisted of lime, organic, and inorganic fertilizer combinations: T^1: control (no input), T^2: 300 kg ha^{-1} of NPK (OCP special blended NPK micro nutrient fortified fertilizer), T^3: 0.5 t ha^{-1} Agric.- lime + 300 kg ha^{-1} NPK (OCP special blended NPK), T^4: 0.5 t ha^{-1} Agric.- lime + 5 t ha^{-1} cow dung (organic) + 300 kg ha^{-1} NPK (OCP special blended NPK), T^5: 5 t^{-1} ha of cow dung + 300 kg ha^{-1} NPK (OCP special blended NPK), arranged in Randomized Complete Block Design (RCBD) with three farmers' field as replicates. The gross plot size was 6 m x 6 m (36 m^2). The leaf area, husk with cob weight, cob weight and grain yield were measured as at when due. The results showed that maize were significantly improved with application of lime, inorganic fertilizer and organic manure with respect to all parameters taken as compared to the control which had the lowest growth and yield parameters across the farmers field in the study area, therefore the application of 0.5 t ha^{-1} Agric.- lime + 300 kg ha^{-1} NPK (OCP inorganic blend) + 5 t ha^{-1} cow dung recorded the highest yield of maize in the study area.

Key words: Agric. - lime, OCP inorganic blend, Cow dung, Growth, Yield.

INTRODUCTION

Maize (*Zea mays* L.) is one of the important cereal crops in the world that provides essential nutrients for lactating mother for the sustainability of the baby and availability of vitamin A (contributes to the maintenance of normal skin, normal vision and normal function of the immune system). It is the third most important cereal crop after sorghum (*Sorghum bicolor*) and millet (*Pennisetum glaucum*) in Nigeria and it is a major staple food that is used as fodder and industrial material with its production at both subsistence and commercial levels in the country (Eleweaya *et al.,* 2005). Maize required a fertile soil to do well. Cultivation of maize in Niger State is being affected by numerous number of factors such as soil acidity, inherent low fertility, imbalance nutrition management, unavailability of the right germplasm, flooding, weed infestation, insecurity, farmers - herdsmen crises, land tenure system, which limit the yield of crops in the state. Likewise modern crop production system is facing a sustainability problem due to indiscriminate use of chemical fertilizer and pesticides (Hidayatullah, 2015) that has resulted in depletion of soil organic carbon, decline in crop productivity and deterioration of nutrient content in the soil. In addition, the continuous and indiscriminate use of chemical fertilizers without organic sources leads to gradual decline of organic matter content and a change on native N status of the soil (Amanullah, 2016). Therefore adequate N sources (organic and

mineral) and rates are very important to increase yield and reduce the cost of production and environmental pollution (Fu *et al.,* 2014; Pei *et al.,* 2015). However, chemical fertilizer is associated with decline in some soil properties and crop yields over time and causes serious land problems, such as soil degradation (Hepperly *et al.,* 2009). Integrated use of inorganic fertilizers with organic manures is a sustainable approach for efficiency nutrient usage which enhances efficiency of the chemical fertilizer while reducing nutrient losses (Schoebitz and Vidal, 2016). Farmer's attention hence needs to be drawn to the synergy which results from the combination of organic and inorganic fertilizer to combat food security challenges without soil health deterioration, hence ensuring bumper harvest. This study was designed to determine the influence of combined application of Agric. - lime, inorganic and organic minerals on the growth and yield of maize in the study area.

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MATERIALS AND METHODS

Description of the study area:

Field trials were carried out at farmer's field (on- farm) at Rabba, Mokwa Local Government Area of Niger State, situated in Southern Guinea Savannah zone of Nigeria. Three farmers field were selected. The experiment was conducted during the 2021 cropping season. The trial field was located at latitude 09^0 13 - 78^{0}" N and longitude 05^{0}' 01' 761"E, with an elevation of 117m, with mean annual rainfall of 1165.0 mm and mean annual temperature of 26.74°C.

Sources of Experimental Materials:

Pioneer Var. Oba super II was obtained from Agricultural Development project (ADP) farm center Minna, Niger State. Cow dung was collected from animal teaching and research farm Federal University of Technology Minna. OCP special blended NPK micro nutrient fortified fertilizer (11N- 22-p- 22k- $1B_2O_3$- 1zn) at 300 kg ha^{-1}, Agric. - lime at 0.5 t ha^{-1}, Urea (46 % N) at 189.13 kg ha^{-1} were all gotten from ADP Minna.

Soil Sampling and Analysis:

Soil samples were collected with a soil auger from the field randomly from 15 points in the entire field at a depth of 0- 20 cm. The collected samples were bulked and thoroughly mixed to form a composite sample. The composite soil sample was taken to the laboratory for routine analysis. The sample was air- dried, gently crushed and passed through a 2 mm sieve. The sieved soil was used for determination of soil physical and chemical properties. The soil sample was analyzed according to standard procedures as described by Agbeni (1995). Particles size distribution was determined by Bouyoucos hydrometer method, soil pH was determined in 1:2.5 soil to water and 0.1 M $Cacl_2$ using a glass electrode pH meter. Organic carbon was determined using Walkley- Black method, total nitrogen was determined by micro- Kjeldal method, exchangeable bases (Ca^{2+}, Mg^{2+}, K^{+} and Na^{+}) was extracted with IN neutral ammonium acetate (NH_4OAC) solution and amounts of potassium and Na in solution was determined using flame photometer, calcium and magnesium by sodium EDTA titration method, exchangeable acidity (H^{2+} and Al^{3+}) was determined by titrimetric method with standard sodium hydroxide (0.5 N NaOH) and Effective Cation Exchange Capacity by summation method. Cow dung was also analyzed for N, P and K content.

Treatments and Experimental Design:

Treatment consisted of:

T1 = Control (No input)

T2 = 300 kg ha^{-1} of OCP special blended NPK

T3 = 0.5 t ha^{-1} of Agric. – lime + 300 kg ha^{-1} OCP special blended NPK + Urea
T4 = 0.5 t ha^{-1} of Agric. - lime + 300 kg ha^{-1} OCP special blended NPK + 5 t ha^{-1} Cow dung
T5 = 5 t ha^{-1} Cow dung + 300 kg ha^{-1} OCP special blended NPK The experimental design was a 6 m by 6 m with 1 m apart arranged on a Randomized Complete Block Design (RCBD) with three farmer's field as replicates.

Land Preparation and Agronomic Practices:

The land was cleared manually using simple hand hoe and cutlass. Six (6) ridges were constructed manually with hoe (6 m length) with an inter- row spacing of 75 cm on each plot size of 36 m^2. Application of Agric. – lime 0.5t ha^{-1} and cow dung at 5 t ha^{-1} each was done on the field after land preparation by incorporating into the soil 2 weeks before sowing, three maize seeds were sowed and supplying was done a week after sowing, plants were thinned to one plant per stand 2 weeks after sowing. Manual weeding was done at 3 and 6 WAS to keep the experimental field weed- free. Fertilizer application of OCP inorganic blend, NPK micro nutrient fortified fertilizer (11N- 22P- 22K- 1B_2O_3- 1Zn) at 300 kg ha^{-1} was immediately done after sowing. Top dressing was done 5 weeks after sowing using urea (189.13 kg ha^{-1}) the total inorganic fertilizer (OCP and Urea) supplied was 120 kg N, 66 kg P_2O_5, 66 kg K_2O ha^{-1}.

Data Collection at Growth Stage:

Data were collected on the following parameters on 8 tagged plants per plot size of 36 m^2 at 6, 8, 10 and 12 WAS. The leaf length and width of the plant tagged were measured using measuring tape multiply by 0.75 (i.e., leaf factor) and was expressed in centimeter square (cm^2). Day to 50 % tasselling was taken at 7 WAS (when half of the plants had tasseled) by visual observation.

Data Collection at Harvest:

The cobs were harvested manually at crop maturity when 90 % of the cobs in the experimental plots turn from green to straw colour (brownish yellow) at about 90- 95 days after sowing. Number of cobs on tagged plants was counted and the average was calculated and recorded at harvest. Dry cobs with husk and dehusk cobs were weighed using manual weighing balance (scale) which was expressed in kg ha^{-1}. Grain yield of the plant tagged was weigh using manual weighing balance and been expressed in kg ha^{-1}.

Data Analysis:

The data collected were subjected to statistical analysis using GENstat 11^{th} edition (2000).
Treatment means were separated using Duncan Multiple Range Test (DMRT) at 5 % level of probability.

RESULTS AND DISCUSSION:

The results of cow dung analysis are shown on Table 1. The result revealed that, cow dung contain 2.52 Nitrogen (%) , 0. 04 Phosphorus (%) and 0.39 Potassium (%).The results of the routine analysis are shown on Table 2. It revealed that the soil pH was moderately - acidic in nature. The soil organic carbon was very low (4.77 – 5.74 %) likewise the percent nitrogen was moderately. However it was noted that the available phosphorus was low. The exchangeable Ca was low in location 1, 2 and very low at location 3. Exchangeable Mg was moderate at locations 1, 2 and low at 3 (1.80, 1.40 and 0.50) respectively. K was low (0.16, 0.22 and 0.14), while Na was moderate at location 1, 2 and low at

location 3 (0.40, 0.47 and 0.18), the soil texture is sandy loam in nature. The available micronutrients analyzed (Zinc, Molybdenum and Boron) were all very low in the study sites. Hence, the need for an integrated nutrient management system, to argument the limiting nutrients in the soil and to improve and sustain maize growth and yield in the study area. The widest leaves produced with the application of OCP inorganic blend + Urea, Agric. – lime + OCP + Urea, Agric. – lime + OCP + Cow dung + Urea and Cow dung + OCP + Urea could be attributed to improvement of soil physical and chemical properties of the soil and the supply of sufficient nutrient required for optimum growth of maize. This finding is in conformity with Dasog *et al.*, (2012) who reported that balanced application of NPK fertilizers with farm yard manure (FYM) and lime improve sustainable crop productivity and growth of maize. Amit and Auwal (2017) also reported that significant increase in leaf area were observed due to the effect of integrated nutrient management more than sole application of recommended dose of fertilizer. Grain yield is the end result of many complex morphological and physiological processes during the growth and yield development of crop. The heaviest cobs and highest grain yield produced with the application of Agric. – lime + OCP inorganic blend + Cow dung + Urea could be attributed to its multifaceted potential for the improvement of plant performance and resource efficiency while also enabling the protection of the environment and resource quality, this is also in line with khan *et al.*, (2008) report. The result is in line with those reported previously (Nagassa *et al.,* 2005 and Shah *et al.,* 2009) who revealed that grain yield was significantly affected by fertilizer in combination with farm yard manure likewise Ayoola and Makinde (2009) observe increased nutrient use efficiency with the combination of inorganic and organic manure.

The treatment combinations might have led to the restoration of soil fertility thereby sustaining crop productivity via the availability of organic matter, major and micronutrients enhancing nutrient use efficiency and favouring the physical, chemical and biological status of the soil. This is confirmed by Golla (2020) who reported that the increase in grain yield of maize might be due to improved physical and chemical properties of the soil through the application of organic manure and adequate quantities and balanced proportions of plant nutrients supplied to the crop by the integrated nutrient management as per needed during the growth period resulting in favorable increase in yield attributing characters which ultimately led towards an increase in economic yield of maize. This study also confirmed that grain yield was significantly higher under integrated nutrient management than unfertilized and chemical fertilizer alone. According to Kakraliya *et al.*, (2017), wheat yield with synthetic fertilizer (NPK) 42 % more compared with control (unfertilized), and further increased with the use of organic and inorganic fertilizer along with bio- fertilizers.

Table 1: Cow dung analysis.

Nitrogen (%)	Phosphorus (%)	Potassium (%)
2.52	0.04	0.39

Table 2: Soil routine analysis per farmer's field.

Soil properties	Location 1	Location 2	Location 3
pH	5.7	5.8	6.0
Organic Carbon (%)	4.77	4.77	5.74
Total Nitrogen (%)	0.62	0.53	0.52
Available P (mg kg^{-1})	4.82	7.00	9.24
Exchangeable Cation (cmol kg^{-1})			
Ca	2.00	3.50	3.40
Mg	0.80	3.70	1.00
K	0.16	0.18	0.09

Na	0.35	0.30	0.29
Particle size Distribution (g kg^{-1})			
Sand	858	858	838
Silt	30	10	20
Clay	112	132	142
Textural class	LS	LS	SL

Table 3: Effect of organic and inorganic nutrient management on maize number of leaf area

	Leaf area (cm^2)			
Treatments	**6 WAP**	**8 WAP**	**10 WAP**	**12 WAP**
Control	267.18b	339.38b	424.06b	72.81b
OCP/Urea	436.56a	546.25a	592.29a	154.69a
Agric.- lime/OCP/Urea	448.75a	46.50a	626.50a	138.44a
Agric.- lime/OCP/Cow dung/Urea	435.94a	545.31a	639.71a	169.38a
Cow dung/OCP/Urea	457.81a	560.00a	597.56a	132.50a
SE±	25.10	28.20	16.99	34.39

Table 4: Effect of organic and inorganic nutrient management on maize yield

Treatments	**weight of dry husk plus cob (plant^{-1})**	**weight of dry cob (plant^{-1})**	**grain yield (kg ha^{-1})**
Control	138.88c	74.07c	277d
OCP/Urea	388.88b	296.29b	14814c
Agric.- lime/OCP/Urea	444.44b	342.59b	19444b
Agric.- lime/OCP/Cow dung/Urea	564.81a	490.74a	2592a
Cow dung/OCP/Urea	444.44b	361.10b	1759bc
SE±	21.32	21.32	8.78

Conclusions

From the results of this study, it was concluded that the application of OCP special blended NPK + Urea, Agric. - lime + OCP special blended NPK + Urea, Agric. – lime + OCP inorganic blend + Cow dung + Urea and Cow dung + OCP special blended NPK + Urea significantly produced similar taller plants, highest number of leaves and largest leaves than the control, which had the shortest plants, lowest number of leaves and smallest leaves in Raba, Mokwa local government. The application of Agric. – lime + OCP special blended NPK + Cow dung + Urea produced heaviest cobs and highest grain yield compared with the control which had the lightest cobs and lowest grain yield on the farmers field in the study area.

Recommendations

Based on the context of this study, it is recommended that farmers in Raba, Mokwa local government area of Niger State of Nigeria should adopt:

(i) The application of OCP special blended NPK /Urea, Agric. - lime/OCP special blended NPK /Urea, Agric.- lime/OCP inorganic blend/Cow dung/Urea and Cow dung/OCP/Urea for increased growth of maize in case the objective is to produce fodder crop.

(ii) While the application of Agric. - lime/OCP special blended NPK /Cow dung/Urea for higher yield and yield attributes of maize for grain production.

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