



RESPONSE AND PERFORMANCE OF MAIZE (ZEA MAYS) TO SOIL AMENDMENT IN ASABA, DELTA STATE, NIGERIA

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ABSTRACT

Response of maize to soil amendment was carried out in degraded oxisol of Asaba, Delta State Nigeria using early OBA super 2 hybrid maize. This was planted in July and harvested in September during the 2016 and 2017 cropping seasons at the Agronomy Teaching and Research Farm, Delta State University, Asaba Campus. Four levels of poultry droppings and 200 kg⁻¹ of NPK 20:10:10 were applied in a randomized complete block design (RCBD) and, replicated three times. Growth parameters assessed were plant height, leaf area and plant girth while stover, weight of 1000 grains and grain yield were measured at harvest. Soil chemical properties were determined during the second season harvest. Data was subjected to analysis of variance and means were separated with Duncan's Multiple Range Test (DMRT) at 5% level of probability using the ... (name of software used). Results showed that NPK 20:10:10 had the best in first season but second season, poultry droppings at 10.0 t ha⁻¹ had the best and was significantly higher than NPK 20:10:10 in leaf area, plant girth and stover yield but not significantly higher in plant height, 1000 grains weight and grain yield. This further improved the potential of poultry droppings for sustainable production than NPK 20:10:10. The study confirmed that poultry droppings could be an alternative source of plant nutrients on sustainable production bases on degraded acidic oxisols.

Keywords: *alternative to mineral fertilizer, soil amendment, soil fertility, maize and organic waste*

INTRODUCTION

Use of mineral fertilizer in crop production is often seen as source of nutrient for crops without looking at the side effects on soil properties such as acidification, nutrient imbalance and trace element deficiencies (Asadu and Nweke, 1999), as a result its use unsustainable. Soils where mineral fertilizers have been applied for crop production were lower in most major nutrients most especially micronutrient (Asadu and Nweke, 1999). Agriculture practice based on intensive use of the fertilizers is likely to be prone to mismanagement that leads to environmental degradation. Agricultural growth is a necessity for economic development but the growth must be achieved on a sustainable bases not to jeopardize or destroy the natural resources. This must also be equitable if it is to contribute to the alleviation of poverty and food insecurity.

Increased use of mineral fertilizers in Nigeria is hampered by unfavorable ratio between cost of cereal grains and fertilizers, poor nutrient use efficiencies unstable government policy faced by many smallholder farmers. There is however, no doubt that sustainable intensification of crop production will require larger inputs of mineral fertilizer (Vanlanwe *et al.*, 2001). Nutrient source that is cheap and affordable will play significant role in soil fertility maintenance.

Agricultural wastes are major sources of organic inputs when incorporated into the soil and serve as a store of nutrients (Adediran *et al.*, 2003). Organic residues application increases soil organic matter, improve the aggregate stability and enhance water retention capacity. The repeated application has long lasting positive effects on physical and chemical properties (Spaccini *et al.*, 2002). Organic manure is reported as a source plant nutrient for sustainable crop production. Hence, the objectives of the study is to evaluate the effect of soil amendment on soil chemical properties and yield of maize

MATERIALS AND METHODS

The field experiment was conducted 2016 and 2017 sowing season, at the Teaching and Research Farm, Delta State University, Asaba Campus. Located at latitude 06° 14'N and 06° 49'E of the equator. The annual temperature and rainfall are 23.8 °C - 37.3 °C and 1500 - 2000 mm respectively (Asaba Meteorological Station, 2015). Clearing was done manually with hoe and cutlass and weeds and shrubs were removed and marked out after tilling. Maize seeds (OBA super two- hybrid) were obtained from ADP, Ibusa, Delta State. Poultry dropping was obtained from Teaching and Research Farm and was applied at four levels (0, 5, 10 and 10 t ha⁻¹) while NPK

20:10:10 was applied at 200 kg ha⁻¹ in randomized complete block design (RCBD), replicated three times. Soil chemical properties were evaluated after the second planting season while maize growth and yield were determined at both seasons. Growth and yield data collected were analyzed, using analysis of variance, means differences were separated with DMRT at 5% levels of probability.

The pH was done on a 1:2 soil-water suspension. Organic carbon was determined using the Walkley Black method. Exchangeable bases- K, Ca, Mg and Na were extracted by ammonium acetate extraction method. The Ca and Mg were determined by Atomic Absorption Spectrophotometer (AAS) while K and Na were read using Flame Photometer. The available P was extracted using Bray-1 extracting solution and further reading was carried out colometrically. Total N was determined by the digestion method.

RESULTS AND DISCUSSION

Nutrient status of the site before sowing is shown on Table 1. The soil was loamy sand, slightly acidic with low organic matter, total N, available P, exchangeable bases and ECEC. The soil fertility is low for maize production. The nutrients are less than the critical level required for crop production while the soil pH of 6.11 is moderate for crop production, so there is need for soil amendment.

Table 2 shows the effects of poultry dropping levels and NPK on soil chemical properties after harvest. Poultry dropping increased the soil pH, the increase correlated with levels of application and is attributed to its decomposition that neutralized soil acidity (Okonkwo, 1991), why NPK reduces soil pH. The soil organic carbon, total N, available P and exchangeable bases in soils treated with poultry droppings improved over the NPK and control treated soils. Poultry droppings mineralizations served as readily available nutrients and also form of humus (Ali *et al.*, 2007). The movement of part of organic nitrogen to organic matter pool led to the high N observed in soil treated with poultry droppings and correlated with higher levels of poultry droppings applied. Increase exchangeable bases were affected by the decomposition of poultry dropping serving as agents for salts in soil (Ali *et al.*, 2007). Low nutrients soil treated with NPK was due to high rate of NPK mineralization that releases the nutrients and easily leached by heavy precipitation (Onwudike, 2010).

The values of maize growth parameters at maturity are shown in Table 3, the NPK produced significantly tallest plant in first year but in second year, the manure at 10.0 t ha⁻¹ produced the tallest plant though not significantly taller than NPK, and this was higher than the lower levels. Leaf area of

NPK treated plants in first year was significantly better than poultry droppings but in second year, 10.0 t ha⁻¹ of the manure had the widest maize leaves and was significantly bigger than the lower levels but not wider than the NPK treated plants. Plant girth of NPK and 10.0 t ha⁻¹ were not significantly different in first year but in second year, 10.0 t ha⁻¹ were significantly bigger than the NPK and the lower levels.

Table 4 shows the yield parameters of maize after harvest. NPK produced significantly highest stover yield in first year while 10.0 t ha⁻¹ of poultry droppings produced the highest Stover yield of 39.4 t ha⁻¹ in second year. Also, NPK treatments had the highest grain weight in first year. In second year, 10.0 t ha⁻¹ had the highest grain weight and was significantly higher than NPK. The highest grain yield was produced by NPK in first year and was significantly higher than other treatment. The control treatment grain yield was 2.3 and 2.0 t ha⁻¹, 10.0 t ha⁻¹ grain yields was 5.1 and 5.7 t ha⁻¹ while NPK treatment grain yield was 5.6 and 5.6 t ha⁻¹ in both years, respectively.

Results shows that levels of poultry droppings and mineral fertilizer significantly increased the yield

of maize compared to control. The fast growth rate observed in plants treated with mineral fertilizer might be due to early release of its nutrient for crops use. The poor result obtained from the control was indication that no significant production could be made without fertilizer application. Poultry droppings released nutrients into the soil during decomposition, improving soil fertility and increase in growth and yield of maize. At the two years of study, the mean yield were in order of NPK 20:10:10 > 10.0 t ha⁻¹ > 5.0 t ha⁻¹ > 2.5 t ha⁻¹ of poultry droppings > and control treatment.

CONCLUSION

Results obtained from this study showed that both the different levels of poultry droppings and mineral fertilizer significantly increase the yield of maize yield compared with the control. Poultry droppings (10.0 t ha⁻¹) performed better than mineral fertilizer in the second cropping season. The poultry droppings could be used as alternative source of nutrient in Asaba and its environment for continuous and sustainable maize production on degraded acidic oxisols.

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Table 1: Soil Physical and Chemical Properties before planting

Parameter	Nutrient Status
pH (H ₂ O) 1:2	6.11
Organic matter (gkg ⁻¹)	2.11
Total Nitrogen (gkg ⁻¹)	0.10
Available P (mgkg ⁻¹)	5.84
Exchangeable bases (cmolkg ⁻¹)	
K	0.50
Mg	1.41
Ca	2.42
Na	0.53
Exch. Acidity	0.07
ECEC	4.93
Particle Size (gkg ⁻¹)	
Sand	751
Silt	174
Clay	75
Textural Class	Sandy loam

Table 2: Effects of different levels of poultry droppings and NPK 20:10:10 on soil chemical properties after two cropping seasons of maize

Levels	pH	Organic M	Total N	Available P	Exchangeable bases (cmolkg ⁻¹)			
	(H ₂ O 1:2)	(gkg ⁻¹)	(gkg ⁻¹)	(mgkg ⁻¹)	K	Ca	Mg	Na
0 t ha ⁻¹	6.00	1.79	0.08	5.40	0.40	1.20	1.01	0.40
2.5 t ha ⁻¹	6.66	3.21	0.13	7.02	0.63	2.54	2.52	0.73
5.0 t ha ⁻¹	6.71	4.64	0.15	8.34	0.74	2.65	2.67	0.77
10.0 t ha ⁻¹	7.10	6.81	0.18	10.73	0.88	2.54	2.69	0.82
NPK20:10:10	5.98	1.89	0.09	8.76	0.40	1.19	1.05	0.32

Table 3: Mean value of growth parameters of maize at maturity

Levels of application	Plant Height(cm)		Leaf Area(cm ²)		Plant girth(cm)	
	2016	2017	2016	2017	2016	2017
0 t	120.1e	114.3d	461.3e	451.5e	1.2c	1.1d
2.5 t	136.2d	150.6c	620.5d	656.3d	1.4b	1.5c
5.0 t	158.7c	170.6b	720.3c	733.6c	1.6ab	1.7ab
10.0 t	200.4b	226.2a	801.8b	889.4a	1.7a	1.9a
NPK20:10:10	221.4a	223.3a	865.4a	860.6b	1.8a	1.8b

Treatments within each column with the same letters are not significantly different. (P< 0.05) DMRT

Table 4: Mean value of yield parameters of maize after harvest

Levels of application	stover yield(t ha ⁻¹)		Wt of 1000grain		Grain yield(t ha ⁻¹)		mean
	2016	2017	2016	2017	2016	2017	
0 t	16.8e	15.3e	203.1e	189.4c	2.3e	2.0d	2.2d
2.5 t	20.7d	23.5d	270.1d	179.4c	3.0d	3.9c	3.5c
5.0 t	22.9c	25.7c	281.5c	301.6b	4.3c	5.1b	4.7b
10.0 t	25.8b	39.4a	311.6b	341.0a	5.1b	5.7a	5.4a
NPK20:10:10	36.8a	36.6b	338.3a	330.5a	5.6 a	5.6a	5.6a

Treatments within each column with the same letters are not significantly different. (P< 0.05) DMRT

Legend

- 0 t ha⁻¹ – without poultry droppings.
- 2.5 t ha⁻¹ – 2.5 ton of poultry droppings per hectare
- 5.0 t ha⁻¹ – 5.0 ton of poultry droppings per hectare
- 10.0 t ha⁻¹ – 10.0 ton of poultry droppings hectare
- NPK20:10:10- 200 kg⁻¹