I.J.S.N., VOL. 3(3) 2012: 628-631 ISSN 2229 – 6441

INTERNATIONAL JOURNAL OF SCIENCE AND NATURE

www.scienceandnature.org

RESPONSE AND PERFORMANCE OF MAIZE (*Zea mays*) TO SOIL AMENDMENT IN ASABA, DELTA STATE, NIGERIA

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ABSTRACT
The study was carried out to determine the response of maize to soil amendment in Asaba degraded slightly acidic oxisol. Early OBA super 2 hybrids maize was planted on the 9 and 10th of July in 2009 and 2010, and harvested on the 29 and 30th September 2009 and 2010 respectively at the Teaching and Research Farm, Faculty of Agriculture, Delta State University, Asaba Campus. Four levels of poultry droppings were applied and 200 kg^{-1} of NPK 20:10:10. The field experiment was laid out in a randomized complete block design (RCBD), replicated three times. Maize growth parameters were assessed at maturity (plant height, leaf area and plant girth) while yield performance was assessed after harvest (stover yield, weight of 1000 grains and grain yield). Also, soil chemical properties were determined after the second cropping season. The growth and yield parameters were subjected to analysis of variance and differences among means were separated with DMRT at 5% level of probability. The results showed that NPK 20:10:10 had the best performance during the first cropping season, but the second cropping season, poultry droppings at 10.0 t ha^{-1}had the best performance, was significantly higher than NPK 20:10:10 on the following parameters leaf area, plant girth and stover yield but was not significantly higher with following parameters: Plant height,1000 grains weight and grain yield. This further improved the potential of poultry droppings for sustainable production. Poultry dropping could be use as alternative source of plant nutrient for continuous sustainable production bases on degraded acidic oxisols.

KEY WORDS: alternative to mineral fertilizer, soil amendment, soil fertility, maize and organic waste

INTRODUCTION

The use of mineral fertilizer in crop production is often seen as the panacea for nutrient losses without looking at the side effects on soil properties such as acidification, nutrient imbalance and trace element deficiencies e.g. Mn (Asadu and Nweke, 1999), these make the practices unsustainable. Soils of Sub-Sahara Africa where mineral fertilizers have been applied for arable crop production were lower in most major soil nutrients than in soils where mineral fertilizers had not been applied (Asadu and Nweke, 1999). Any agriculture practice which is based on intensive use of mineral fertilizers is prone to mismanagement that leads to environmental degradation. Continued agricultural growth is a necessity for most developing countries like Nigeria. Further, this growth most be achieved on a sustainable bases so as not to jeopardize the underlying bases of natural resources, and it must 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, the lack of cash, and the poor nutrient use efficiencies faced by many smallholder farmers. There is, however, no doubt that sustainable intensification of crop production will require larger inputs of mineral fertilizer in Sub-Sahara Africa (Vanlanwe *el at*., 2001). Organic matter has a role to play in maintaining soil fertility for crop production.

In crop production, agricultural wastes are major sources of organic inputs when incorporated into the soil (Agbim and Adeoye, 1994 and Adediran *el at*., 2003) and serve as a store of nutrients in organic farm. Application of the organic residues could increase soil organic matter, buffer the soil, improve the aggregate stability and enhance water retention capacity (Spaccini *el at*., 2002). Repeated application of the organic residues on soils has long lasting positive effects on physical and chemical properties (Mbagwu and Piccolo, 1989). Akinrinde *el at*. (2000) has observed that the use of organic manure constitutes a low inputs technology for sustainable crop production in the tropics. 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 2009 and 2010 sowing season, at the Faculty of Agriculture Teaching and Research Farm, Delta State University, Asaba Campus. Located at latitude 06^0 14'N and 06^0 49'E of the equator. The annual temperature and rainfall are 23.8 ^{0}C-37.3 ^{0}C and 1500 mm-2000 mm respectively (Asaba Meteorological Station, 2009). Clearing of the site was done manually with hoe and cutlass. All the weeds and shrubs were removed from the field. The field was then marked out after tilling with hoe and spade. Maize seeds (OBA super two- hybrid) were obtained from ADP, Ibusa, Delta State. Poultry dropping which was obtained from Animal Unit, Teaching and Research Farm, Delta State University, Asaba Campus was applied at four levels (0, 5, 10 and 10 t ha^{-1}) while NPK 20:10:10 used as reference standard was applied at 200 kg ha^{-1}. The experiment was laid out 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 Walkey Black method. Exchangeable bases- K, Ca. Mg and Na were extracted by ammonium acetate extraction method of Jackson (1964). 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 & DISCUSSION

The nutrient status of the experimental site before planting is shown on Table 1. The soil was loamy sand, slightly acidic and low in organic matter, total N, available P, exchangeable K, Mg and Ca, it also had low ECEC, the fertility is low for crop production especially maize. The total N of 0.10 gkg^{-1} is less than the critical level of 1.5 gkg^{-1} (Enwezor *et al*., 1988), while the available P of 5.84 mg kg^{-1} is also less than the critical level of 8-10 mg kg^{-1}, the soil pH of 6.11 is moderate for crop production (Kamprath, 1970), so there is need for soil amendment. Table 2 shows the effects of the levels of poultry droppings and NPK on soil chemical properties after harvest. Poultry dropping increased the soil pH after harvest, the increase also correlated with the levels of application; this could be attributed to its decomposition that neutralized soil acidity (Okonkwo, 1991), why application of NPK led to low soil pH. The organic carbon, total N, available P and exchangeable bases in soils treated with different levels of the poultry droppings improved over the NPK and control treated soils, this could be due to mineralization of poultry droppings which served as a source of readily available nutrients and also accumulated in 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. According to Nwaugo *et al*. (2008), the breakdown of little protein content in the poultry droppings produced NH_3, consequently increases soil pH, and this made conditions favourable for alkaline phosphates activities, this could led to increased available P after harvest.

TABLE 1: Soil Physical and Chemical Properties before planting

Parameter	Nutrient Status
pH (H_2O) 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 (2009 and 2010)

Levels	pH (H_2O 1:2)	Organic M (gkg^{-1})	Total N. (gkg^{-1}	Available P. ($mgkg^{-1}$)	Exchangeable bases ($cmolkg^{-1}$) 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

The increase in the quantities of exchangeable cations could be affected by the decomposition of poultry dropping which serves as solubilizing agents for salts in the soil (Ali *et al*., 2006). The low total N, available P and exchangeable bases in soil treated with NPK could be attributed to high rate of mineralization of the fertilizer that makes its nutrient readily available and also, can easily be leached out as could be affected by heavy precipitation (Onwudike, 2010). The mean value of growth parameters of maize at maturity are reflected on Table 3. NPK treatment produced significantly tallest plant in 2009 but in 2010, 10.0 t ha^{-1} of poultry droppings produced the tallest plant though not significantly taller than NPK treated plants, but it was significantly taller than the lower levels of poultry droppings. Leaf area of NPK treated plants in 2009 was significantly better than any of the levels of poultry droppings but in 2010, 10.0 t ha^{-1} had the widest maize leaves, significantly wider than the lower levels of poultry droppings, but was not significantly wider than the NPK treated plants. Plant girth of NPK and 10.0 t ha^{-1} were not significantly different in 2009 but in 2010, 10.0 t ha^{-1} treated plant girth were significantly bigger than the NPK and the lower levels poultry droppings treatments.

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

Levels of application	Plant Height (cm)		Leaf Area (cm^2)		Plant girth (cm)	
	2009	2010	2009	2010	2009	2010
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 of both year
	2009	2010	2009	2010	2009	2010	
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
PK20:10:10	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^{-} – 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}

Table 4 shows the mean value of yield parameters of maize after harvest. NPK produced significantly the highest stover yield in 2009 while 10.0 t ha^{-1} of poultry droppings produced the highest Stover yield of 39.4 t ha^{-1} in 2010, was also significantly higher than the lower levels of application. Also, NPK treatments had the highest grain weight in 2009, significantly higher than all the levels of poultry droppings. In 2010, 10.0 t ha^{-1} had the highest grain weight, significantly higher than both the NPK treatment and the lower levels of poultry droppings. Highest grain yield was produced by NPK treatment in 2009, it was significantly different from all the levels of poultry droppings and control treatment. The control treatment grain yield was 2.3 and 2.0 t ha^{-1}, 10.0 t ha^{-1} grain yield was 5.1 and 5.7 t ha^{-1} while NPK treatment grain yield was 5.6 and 5.6 t ha^{-1} in 2009 and 2010 respectively. Results from this study show that the different levels of poultry droppings and mineral fertilizer significantly increased the yield of maize compared with the control. The fast growth rate observed in plants treated with mineral fertilizer might be due to early and persistence release of nitrogen for crops since it had immediate release of its nutrient at early state. This was in line with study by Shortal and Webharlt (1999). 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. The increased soil fertility led to significant increase in growth and yield of maize. In addition, improvement of the physical properties of the soil, supplying both macro and micronutrient not contained in mineral fertilizer (Mbagwu and Ekwealor, 1990). Across the two years of study, the mean yield of the soil amendments were in the 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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