EFFECT OF POULTRY MANURE AND INORGANIC FERTILIZER ON THE PERFORMANCE OF MAIZE (ZEA MAYS. L) AND SELECTED PHYSICAL PROPERTIES OF SOILS OF IGBARIAM SOUTHEASTERN NIGERIA.

NWEKE, I.A, NSOANYA, L.N.
DEPARTMENT OF SOIL SCIENCE ANAMBRA STATE UNIVERSITY, ULI.
Ikechukwunweke48@yahoo.com

ABSTRACT.
This study examined the effect of poultry manure and NPK (20:20:20) fertilizer on the growth, grain yield of maize and soil physical properties on a Typic Tropaqualf in Igbariam South Eastern Nigeria. The experiment was laid out in a randomized complete block design (RCBD) with four treatments via 12 kg/plot poultry manure (PM), 1.2 kg/plot NPK fertilizer equivalent to 200 kg/ha, 6 kg poultry manure + 0.6 kg NPK/plot thoroughly mixed (PNPK) and Co kg/plot (control). The results of the study indicated significant differences between the treatments in agronomic and soil parameters measured. The value of the grain yield varies from 0.12 tons/ha – 1.17 tons/ha, while the plant height values of 49.62cm – 159.765cm were observed with the highest value 1.17 tons/ha and 159.75cm recorded in PNPK treated plots. The PNPK had the highest gravimetric moisture content value (22.40), soil hydraulic conductivity value (10.40cmhr^{-1})and aggregate stability value (23.99) but showed least value in % dispersion ratio (0.60) The poultry manure/NPK fertilizer (PNPK) improved the growth and grain yield of maize and soil physical properties of the studied soil.

Keywords: Poultry manure, NPK fertilizer, maize performance soil physical properties.

INTRODUCTION

Mineral nutrients are a natural requirement for crop growth as Crops require the supply of minerals for good yield. In agricultural production, minerals are supplied to the crops as manure. The manure which can be inform of organic waste (that originate from both livestock waste and crop residues) or mineral fertilizer. Thus, both the organic manure and mineral fertilizer are common forms of soil amendments that are routinely used in agricultural soils. The use of organic manure as a nutrient source often improves soil conditions and quality, thereby enhancing the long term in sustainability of agriculture (Khaleed et al., 1981, Laird et al., 2001). The influence of organic manure on soil properties however, depends on the origin, age, amount, type and size of added organic material as well as climatic conditions such as temperature and rainfall (Nelson and Oades, 1998, Grubinger, 1999, Lampkin 2000).

There are also various reports of mineral fertilizer in the enhancement of crop productivity as well as reports on the preference of mineral fertilizer in the growth and productivity of crops. Though with its attendant problems, such as high solubility that leads to faster leaching of nutrients (Lampkin, 2000; Rembialkowska, 2003) and the cost and non-availability in most of the tropics that automatically limit the use by the poor resource farmers. The alternative organic fertilizer cannot meet crop nutrient demand over large area because of unlimited availability, low nutrient composition and high labor requirement (Tolera et al., 2005). On the other hand post harvest use of crop residues for soil management is low due to other uses such as construction, feeding, fencing, fuel wood and as source of income (Tenaw et al., 2006). This calls for combined use of organic fertilizer and inorganic fertilizer approaches. Thus, research effort on the complementary use of organic manure and mineral fertilizer for sustainable crop production in tropical soils has intensified. However, little or no data is available regarding the effects of poultry manure and NPK (20:20:20) fertilizer on soil physical properties and crop yield in the study area. The main objective of this study was to evaluate the effects of poultry manure and NPK (20:20:20) fertilizer on growth and grain yield of maize and soil physical properties on a Typic Tropaqualf in Igbariam Southeastern Nigeria.

MATERIAL and METHODS

The experiment was carried out at the Teaching and Research farm of the Department of Crop Science and Horticulture in the Faculty of Agriculture, Anambra State University, Igbariam Campus, and Anambra State of Southeastern Nigeria. The experimental site lies on latitude 06^0 14'N and longitude 06^0 45'E. The rainfall pattern is bimodal between April and October, with a mean annual rainfall of 1268.4mm. The dry season falls between November and March. The relative humidity (RH) of the study area is moderately high all the year round with the highest RH of 85% during the wet season and the lowest 64%

occurring during the dry season. The temperature range is between 21^{0c} - 35^{0c}. The soil is of the sandy clay loam textural class, hydromophic and poorly drained, classified as Typic Tropaqualf (FDALR, 1985).

Land Preparations and Treatments Applications.

The site ($256.5m^2$) was manually cleared and debris removed. After clearing the plots were laid out as randomized complete block design (RCBD) with four replicates. Plot size was 3x4m and the buffer zone between replicates was 1m and 0.5m between plots. The levels of the treatments were no treatment or control (co), 12 kg/plot poultry manure (PM), 1.2 kg/plot NPK (20:20:20:) equivalent to 200 kg/ha and 6 kg pm+0.6 kg NPK/plot (PNPK). Maize variety orba super II was used as a test crop.

The treatment 12 kg poultry manure was spread evenly on the designated plots and worked into the soil during tillage operation, seven days before sowing. The NPK fertilizer and the through mixed poultry manure and NPK (PNPK) was applied to their respective designated plots two weeks after planting by ring method. Two grains of maize were planted per hole at a spacing of 70cm x 25cm. This was thinned down to one plant per hill two weeks after germination. The field was kept relatively weed free throughout the period of the experiment.

Composite soil samples collected from top 0-20cm in the study site before application of treatments were air dried and analyzed for their nutrient contents (Table 1). At the end of the study, soil samples were collected from respective plots and used for the determination of the physical properties of the soil. The soil physical parameters determined were bulk density as described by Blake and Hartage (1986). Total porosity calculated from bulk density. Aggregate stability was determined using the wet sieving method described by Kemper and Rosenau (1986). Hydraulic conductivity was determined by the method of Landon (1991). Gravimetric moisture content was determined by the method of Black (1965) and dispersion ratio by the method of Middleton (1930). Particle size distributing of the soil was determined using Bouyoucous hydrometer method as described by Gee and Bauder (1986) and the textural class of the soil was determined using textural triangle.

Ten maize plants were randomly selected and tagged. These were used to measure leave area index at 30 and 60 days after planting, number of cobs per plant and plant height measured at maturity. The harvested cobs from the tagged plants were sun dried and the shelled grain yield was reported at 12 % moisture content.

Data collected from the study were subjected to analysis of variance test based on (RCBD) according to Steel and Torrie (1980). LSD at 0.05 was used to compare treatment means.

Table 1 Initial properties of the soil before treatment application.

Parameter	Unit	Value
Coarse sand	gkg^{-1}	10%
Fine sand	"	34%
Silt	"	42%
Clay	"	11%
Textural class	"	sandy clay loam
Bulk density	gcm^{-3}	1.10
Total porosity		50.70%
Gravimetric moisture Content		20.77
Dispersion ratio		0.77%
Aggregate stability		18.01
Hydraulic conductivity	$cmhr^{-1}$	4.49

RESULTS

EFFECT OF POULTRY AND NPK ON THE AGRONOMIC PARAMETERS

The result of the study on Table 2 show significant increase in maize height relative to the control. The application of PNPK gave the highest height value of 159.25cm relative to other treatments. The order of increase in plant height was PNPK>PM>NPK>CO. however the maize height at PNPK and PM as well as NPK and PM were statistically similar.

The number of cob/plant indicated that the PNPK gave the highest number of cobs per plant of 1.77. There was an increase in the number of cobs/plant relative to control. The values ranged between 0.55 – 1.77 and the order of increase in number of cobs/plant was PNPK>PM>NPK>CO. The percentage increase

relative to control was 68.93 % for PNPK, 62.07 % for PM and 48.60 % for NPK.

Table 2 The effect of poultry manure and NPK (20:20:20) fertilizer on the plant height, number of cob/plant, leave area index at 30 & 60DAP and maize grain yield.

Treatment	Height (cm)	Number of Cob/plant	Leave area index 30DAP	60DAP	Maize grain yield ton/ha
Co	49.62	0.55	33.06	39.39	0.12
NPK	106.07	1.07	59.41	81.62	0.28
PM	143.75	1.45	191.50	221.62	0.53
PNPK	159.25	1.77	264.76	290.24	1.17
FLSD	50.77	0.62	84.11	94.59	0.23

Co = Control
NPK = Chemical fertilizer NPK 20:20:20
PM = Poultry manure
PNPK = Poultry manure + chemical fertilizer NPK.

The values obtained for maize grain yield showed significant (P=0.05) difference among the treatments except for the values recorded at NPK and CO which was statically similar. The yield varied between 0.12ton/ha – 1.7ton/ha. The highest maize yield was obtained from PNPK with a value of 1.17 ton/ha. The value (1.17 ton/ha) was 89.74% higher than the grain yield obtained in control, 76.07% higher than the grain yield value obtained in NPK fertilizer and 54.70% greater than the yield obtained in poultry manure.

The result of the leaf area index at 30 and 90 DAP varies between 33.06-264.76 for 30 DAP and 39.39-290.24 for 60 DAP respectively. The plot treated with poultry manure gave the highest leaf area in both 30 DAP and 60 DAP, with a value of 264.76 and 290.24 respectively. This was statistically significant (P=0.05) when compared to the values obtained in control and NPK fertilizer plots. While the leave area index obtained in PM and PNPK were statistically equal.

EFFECT OF POULTRY MANURE AND NPK ON THE SOIL PHYSICAL PROPERTIES

The result of the soil analysis of the experimental site presented in Table 3 shows that there is no significance difference in soil bulk density. The highest bulk density value of 1.31g cm^{-3} was observed in NPK treated plots. The least of BD (bulk density) was recorded in control plots. The value of bulk density ranged from 1.07g cm^{-3} – 1.31g cm^{-3} and the order of increase relative to control was NPK>PM>PNPK>Co.

Data on total porosity indicated that there is significant difference (P=0.05) in the total porosity values and the value range was between 49.70 – 57.61. The total porosity of the amended plots decreased relative to control and the order of decrease was PM<NPK<PNPK<Co.

Table 3 Effect of combined use of poultry manure and NPK (20:20:20) fertilizer on the soil physical properties of the study area.

Treatment	Bulk gcm^{-3}	Total Porosity%	% Dispersal ratio	Aggregate Stability%	Moisture Content	soil Hydraulic Conductivity $Cmhr^{-1}$
Co	1.07	57.61	0.71	18.83	18.90	7.05
NPK	1.31	51.70	0.76	6.23	15.47	6.01
PM	1.28	49.70	0.71	20.51	16.55	4.70
PNPK	1.19	54.72	0.60	23.99	22.40	10.40
FLSD	NS	1.79	0.06	0.44	0.59	0.41

Co = Control, NPK = Chemical fertilizer NPK 20:20:20, PM = Poultry manure,
PNPK = Poultry manure + chemical fertilizer NPK.

The dispersion ratio of the study area also shows significant difference among the treatments at P=0.05. Although statistically the dispersion ration of control and poultry manure amended plots are equal. The least value of the dispersion ratio was observed in the combined use of poultry manure and NPK fertilizer (PNPK). The result of the aggregate stability shows significant difference among the treatments. The least value 6.23 and the highest value of 23.99 were obtained in NPK and PNPK amended plots respectively. The observed aggregate stability values in the study increase in the order PNPK>PM>Co>NPK.

Table 3 also showed significant difference in the moisture content among the amended plots in the study area. The control plots show the least value of 18.90. The highest value was obtained in the PNPK amended plots. The soil hydraulic conductivity was statistically significant (P=0.05). The value ranged between 4.70 $cmhr^{-1}$ - 10.40 $cmhr^{-1}$ and the increase was in the order PNPK>Co>NPK>PM.

DISCUSSION

The tallest plant observed in plots treated with PNPK showed an indication of positive interaction between organic and inorganic fertilizer, this synergistic effect resulted in improved nutrient release and uptake by the maize plant leading to higher growth recorded in PNPK plots. The result agreed with the findings of Makinde, (2007), Ayola and Makinde, (2007) who reported better height of maize treated with organo-mineral fertilizer. The result obtained in plots treated with poultry manure could be attributed to the lower levels of nutrients especially nitrogen and phosphorous inorganic fertilizer available for plant growth and their slow release as well as non-synchronization of nutrient released within the period of growth of the available short term crop like maize. This is why it becomes paramount important to improve the efficiency of organic fertilizer in arable crop production through fertilization with mineral fertilizer. Organic fertilizer with a low nutrient content reduces growth as well as the crop yield (Lampkin, 2000; Masuda et al, 2002).

The reason for the increased cob number in plots treated with mixtures of poultry manure and NPK fertilizer (PNPK) could be due to more photosynthetic activities of the plant on the account of adequate supply of Nitrogen in the PNPK plots. Maize cob is an attribute of yield and therefore, better development of maize cob will be an index of good yield as it contributes to grain yield per cob and grain size. Rajeswari et al (2007) made similar observation when they found significant increase in the Maize cob with increase rate of nitrogen fertilizer from different sources, organic and inorganic fertilizer inclusive. Also, Nyamangara et al. (2003) reported that organic waste (composted manure) application enhanced the use efficiency of mineral nitrogen fertilizer by crops when organic fertilizer and inorganic fertilizer are applied together.

The broad leaves and number observed in PNPK plots for both 30 DAP and 60 DAP compared to other treatments was a good indication of combined effect of poultry manure and NPK fertilizer. This significance influence on the leave area index was a good omen, because as the number of leaves increase, more light was intercepted and photosynthesis rate enhanced, resulting in high grain yield. Leaves are the main organ of photosynthesis, any reduction in leaf number results in lower yields. Olawuyi et al, (2010) and Rajeswari et al, (2007) made similar report on maize when they reported highest leaf area per plant and leaf area index on the combined rates of compost with inorganic fertilizer.

The yield of any crop depends on the quality of the treatment applied and correct placement. The differences in yields between organic and inorganic fertilizers are small and do not always favor organic or inorganic cropping system as was observed in the yield result presented in Table 2. However, the decline in yield observed in organic manure treated plots may be due to lower fertilizer application rates and/or slower nutrient release, that is mineralization as well as nutrient uptake (Warman, 2000). The yield level result obtained in the NPK fertilizer treated plots could be attributed to the differences in nutrient reserve in the soils. According to Tisdale and Nelson (1975), crop response to fertilizer application is affected by nutrient reserve in the soil and response tends to be more in soil with very low nutrient status than those with high reserve.

However, the combination of organic and inorganic fertilizer (PNPK) was found to give better yield result (Table 2). The increase in grain yield components can be due to the synergistic effect of combination of organic and inorganic fertilizer that enhanced nutrient release and availability improved nitrogen and other macro and micro elements absorption by the maize plant. Jablonska (1990) had similar result when he repoted that combined use of organic manure and nitrogen resulted in higher yield of tomato, egg plant, pepper and chili than either nitrogen fertilizer or organic sources used alone. Also Zakaria and Vimala (2002) reported higher yield of Cucumber and Cabbage in green manure, palm oil mill effluent combined with NPK fertilizer as compared to the yield of those plants treated with green manure or palm oil effluent alone.

Therefore in sustainable low input cropping systems where nutrient depletion is inevitable, supplementary organic manure with mineral fertilizer like NPK might be the key to attaining sustainable crop yield in tropical agriculture. Somare et al, (2003) and Kiani (2008) made similar suggestion when they reported higher yield in crops treated with combination of solid waste compost and Mineral fertilizer and increase in wheat yield treated with organic manure and mineral N-Fertilizer respectively.

The observed higher bulk density in the treatment plots relative to control plots might be as a result of break down of manure application forming the component of the soil or because of

increase in soil compaction by various means such as rain drops impact at the later stage of the study (Anikwe, 2000). The result obtained generally showed that the soil bulk density is less than 1.31gm cm^{-3} which is a positive indicator as it helps in easing root penetration, proliferation and development. It encourages downward movement of water through old root channels (Obi, 2000). The non-significant effect of poultry manure/NPK fertilizer (PNPK) on soil bulk density could be due to short term farming period of the study, Judith et al. (2009) made a similar observation when they found out that the application of cattle manure and mineral fertilizer does no significantly increase the bulk density and total porosity under short term farming period.

The lower total porosity relative to control plots indicates that the treated plots maybe better aerated than the untreated plots. Though the treatment application to the study site significantly increased the soil bulk density and decreased total porosity relative to the control plots respectively, their effect seemed to be strongly linked to the nature and type of manure applied or short term farming period could be responsible for the kind of result obtain in total porosity of the soil. Rasool et al. (2008) reported that long term application of farm yard manure significantly increased soil total porosity compared with chemical fertilizer. The result of the dispersion ratio could be attributed to the kind of manure applied, Mba et al. (2010) reported significant (P=0.05) increase in soil dispersion ratio in amended plots relative to control. The increased aggregate stability following manure application could be as a result of cementing effects of organic matter in soil particles. High level of organic matter, good colloidal nature of the soil and most importantly aluminum ions promote high soil aggregate stability (Trembley and Levy, 1993). Also, Mbagwu (1989) noted that organic matter from wastes bound smaller aggregates into larger ones of which was essential for good production of good tilth (Harries et al., 1966). While the result obtained in fertilizer treated plots might be due to rapid breakdown in soil organic matter, as NPK fertilizers stimulates the activities of soil microbes leading to rapid breakdown in soil organic matter content of the soil. The high gravimetric moisture content observed in plots amended with combined poultry manure and NPK fertilizer maybe due to changes in the specific surface area of the soil material as a result of mixing the two manure (PNPK). It might as well be influenced by the colloidal and hydrophobic nature of the poultry manure. Mbagwu and Ekwelor (1990) reported improvements in soil moisture content due to incorporation of wastes. Significant improvement in moisture content and nutrient that translate to higher yield in Savannah soils treated with sheep and goat wastes were equally reported by Aliyu, (2003).

The increase in hydraulic conductivity observed in mixed manure (PNPK) maybe as a result of higher pores in the plots amended with PNPK manure. Higher saturated hydraulic conductivity indicates better water transmission and hence reduction in waterlogging. This is good result as the study area is prone to water logging due to the mixed manure (PNPK), many plant nutrients react very well and to a great extent influenced maize growth and yield. Hydraulic conductivity influences the need for fertilizer (especially mixed) as such as application becomes necessary in soil productivity and crop growth.

CONCLUSION

The result of this study showed that the combination of poultry manure and NPK (20:20:20) fertilizer on the growth, yield of maize and soil physical properties was significant. The result indicated that it is more economical and cost effective to obtain a good level of maize production by farmers in the study area. The integration of organic fertilizer with NPK fertilizer increases the potentials of the applied fertilizer which resulted in the increase of grain yield of maize as well as improvement in physical parameters of the soils of the study area

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