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EFFECT OF ORGANIC AND INORGANIC NITROGEN SOURCES ON SOIL PROPERTIES AND MAIZE SEEDLING NITROGEN UPTAKE

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ABSTRACT

Most Researchers have shown that organic manures are a panacea for soil fertility management in the dry savanna of Nigeria. An experiment was carried out at the Faculty of Agriculture, Bayero University, Kano in May, 2015. Two maize varieties (2009 EVDT and 2009 TZEEW) were evaluated alongside three organic N sources (cow manure, poultry manure and sheep manure) with an inorganic N source (urea). The treatments were arranged in a completely randomized design and replicated three times the experiment was conducted in experimental pots of equal height and diameter. From the result it was observed the N sources responded well to plant height at 4 weeks after sowing with the highest plant height observed with poultry manure treatment and the variety 2009 TZEEW(66 cm). There was also a significant effect for leaf chlorophyll content, with poultry manure treatments showing more chlorophyll content (41.9). From the result of the soil analysis,there were no significant difference observed among the various nitrogen sources for organic carbon, organic matter and cation exchange capacity but treatment with poultry manure shows highest organic carbon (0.95%), organic matter (1.6%) and CEC(10.6cmol(+)kg^{-1})), there was no statistical effect for soil physical and chemical properties due to the application of the organic and inorganic N sources. This may be due to the nature of the experimental pots which disrupt the soil natural condition and the slow effect of organic matter application to the soil. The experiment shows that poultry manure as an organic N source compared favorably with urea

as an inorganic N source in terms of nutrient release to maize and in improving soil properties.

Keywords: Organic N Source, Inorganic N Source, N Uptake

INTRODUCTION

Presently inefficient use of local resources in agriculture for higher crop productivity is major concern to feed ever increasing population. Declining soil fertility is also alarming for the sustainability of agricultural production at current levels. The utilization of resources available with farmers is of high importance. Such resources include green manure, compost and biochar. Locally available inorganic fertilizers supplemented with organic fertilizers have potential to increase soil fertility (Gruhn *et al.*, 2000). As reported by, Salim *et al*, (1988); that application of organic manure alone or with inorganic fertilizer helped in maintenance of physical and chemical properties of soil. Thus, strategies for increasing and sustaining agricultural productivity will have to be focused on using available nutrient resources more effectively and efficiently. Organic manures have great impact over the health of soil and its fertility, as it enhances organic matter content of soil. The application of synthetic fertilizers are expensive and farmers are unable to maintain balanced fertilizers as per requirements of the crop which have resulted in lower production than the potential demonstrated yield and thus could be termed as low fertilizer use efficiency (Ahmad, 2000). The use of inorganic fertilizers alone for maize production has not been helpful under intensive agriculture because it aggravates oil degradation (Salim et al., 2001).

The degradation is brought about by loss of organic matter which consequently results in soil acidity, nutrient imbalance and low crop yields (Olaoye Adegbesen., 1999). Response of crops to applied fertilizer depends on soil organic matter. The quantity of soil organic matter depends on the quantity of organic material which can be introduced into the soil either by natural returns through roots, stubbles, sloughed-off root nodule and root exudates or by artificial application in the form of organic fertilizer such as manure (Agboola and Omueti, 1982). Application of organic fertilizer is an important means of maintaining soil fertility status and it is also environmentally friendly. This is because nutrients contained in organic manures are released more slowly and are stored for a longer time in the soil, thereby ensuring a long residual effect (Salim et al.,2001).Inorganic fertilizer on the other hand have high concentration of nutrients and readily available to crops but its use is hampered by its inaccessibility to majority of the farmers due to high cost and infrastructural Problems in developing country like Nigeria (OkoruwaE. A., 2001). Efforts aimed at obtaining high yield of maize would necessitate the augmentation of the nutrient status of the soil to meet the crop's requirements for optimum productivity and maintain soil fertility. Increasing the nutrient status of the soil may be achieve either with the use of inorganic fertilizers such as NPK orthrough the use of organic materials such as poultry manure, farm yard manure or the use of compost and biochar. The main objective of this paper is to test the effect of organic and inorganic nitrogen sources on soil properties and maize seedling nitrogen uptake.

METHODOLOGY

The pot experiment was conducted at the old Faculty of Agriculture, Bayero university kano, located in Sudan savanna agro ecological zone of Nigeria. The treatment consists oftwo maize varieties (2009 TZEEW and 2009 EVDT),three organic nitrogen sources (cow manure, sheep manure and poultry manure) and one inorganic nitrogen source (urea) arranged in a completely randomized design and replicated three times. Each pot was filled with 40kg of top soil and 0.2kg of manure separately according to treatment allocation; the pots were 25cm in height and 33cm in diameter. A total of five plants were planted in each pot at a rate of two seeds per hole which were later thinned to one plant per stand. The two varieties (2009

EVDT and 2009 TZEEW) were sown according to treatment allocation. The plants were irrigated with a handheld watering can at 3 days interval. All the organic nitrogen sources (Cow manure, sheep manure and poultry manure were applied at the rate of 10 tons per hectare (that is 0.2 kg manure per 40 kg soil), while urea was applied at the rate of 60Kg per hectare (that is 1.2g urea per 40 kg soil).Standard agronomic practices were used to collect all data from the experimental site. The crop growth parameters measured includes, Plant height (cm) using a meter rule, Stomatal conductance (mmol /ms^2) using a leaf porometer, Canopy temperature (^{0}C) using a leaf porometer, Leaf chlorophyll content using a SPAD meter and above ground biomass. The top soil was sampled after mixing before filling the pots, soil samples were also collected after harvest from each experimental pot, the samples were dried and sieved for laboratory analysis. Soil physical and chemical analysis carried out includes, Particle size distribution. The method determine by Bouyoucos hydrometer method. Soil pH was measured both in water and in 0.01MKCl using 1: 2.5 soil/solution. The acid dichromate wet oxidation method of walkly and black as describe by nelson and Sommers (1982) was use in determination of organic carbon. Available phosphorus was determined by the Bray 1 method (Bray and Kurtz, 1945). Total nitrogen was determined by the mirco – Kjeldahl. EC was measured using glass electrode while Cation Exchange Capacity (CEC) was computed by summing up the exchangeable bases. The plant tissues were also analysed for nitrogen and phosphorus. The data collected was subjected to analysis of variance after laboratory analysis with GENSTAT version 6 statistical package.

RESULT AND DISCUSSION

Physical and Chemical Properties of the Soil used in the Experiment

The physical and chemical properties of soil used in the experiment are presented in Table 1. Soil physical properties showed the sand predominates the soil with (90.96%) while the percentage of silt and clay content was quite low. the soil was found to be sandy in texture. The soil chemical properties shows that the pH in H_2O was slightly alkaline with low cation exchange capacity, medium available phosphorus, low total Nitrogen and low organic carbon (Table 1).

Chemical Properties of Organic N Sources used in the Experiment

Table 2 presents the chemical properties of organic N sources used in the experiment. Among the three organic N sources Cow and sheep manure have higher pH than poultry manure. So also sheep manure has higher percentage organic carbon (89.2) than cow and poultry manure with organic carbon percentage of 78.9 and 68.6 respectively. It was also observed that poultry manure has higher percentage total nitrogen (0.53) and cation exchange capacity (18.1 Cmol kg^{-1}) than sheep and cow manure.

Effects of Organic and Inorganic Nitrogen Sources on Plant Height (cm) 2, 3 and 4 Week after Sowing

There were no significant difference observed among the different N sources at 2 and 3 WAS Table 3, the response of the inorganic N sources was probably because manure cannot provide immediate result with immediate application due to its slow release of nutrients and its long term effect .There was a significant difference observed among the different N sources at 4 WAS, with poultry manure showing the highest plant height of plant per pot in term of plant height. A significant interaction exists between N sources and varieties on plant height at 4 WAS as shown on table 4. The highest plant height was observed with poultry manure 2009 TZEEW while the lowest was observed with a combination of cow manure and the variety 2009 TZEEW. The height of plant is an important growth character directly linked with the productive potential of plant in term of grain yield (Omotosho and Shittu, 2007). An optimum plant height is claimed to be positively correlated with productivity of plant (Omotosho and Shittu, 2007).

Table 1: Physical and Chemical Properties of Soil in the Experimental Site

Soil Properties	Soil without amendment
Physical Properties	
Sand (%)	90.96
Silt (%)	4.16
Clay (%)	4.88
Textural Class	Sandy
Chemical Properties	
pH in H_2O	7.60
EC (mS/cm)	100
Organic Carbon (%)	2.6
Total Nitrogen (%)	0.105
Available Phosphorus(mg kg^{-1})	14.06
CEC	5.20

Effect of Organic and Inorganic N Sources on Chlorophyll Content, Canopy Temperature and Stomatal Resistance of Maize Varieties

Table 5 shows the effect of organic and inorganic N sources on chlorophyll content, canopy temperature and stomatal resistance, it was observed that a significant difference exist for chlorophyll content among the N sources with poultry manure having the highest chlorophyll content and the control having the lowest. The interaction of N sources and varieties for chlorophyll content was also found to be significant as shown on table 6, where the combination of poultry manure and 2009 EVDT gave the highest chlorophyll content which was at par with poultry manure and 2009 TZEEW.

Table 2: Chemical Properties of Organic N Sources used in the

Chemical Properites	Cow manure	Sheep Manure	Poultry manure
pH in H_2O	8.2	8.1	7.3
EC (mS/cm)	1217	8720	6810
Organic Carbon (%)	78.9	89.2	68.6
Total Nitrogen (%)	0.18	0.35	0.53
Available Phosphorus(mg kg^{-1})	41.4	21.1	26.2
CEC	9.0	7.4	18.1

Experiment

Table 3: Effect of Organic and Inorganic N Sources on Plant Height (cm) at 2, 3 and 4 weeks after Sowing

Treatments	Plant Height (cm)		
	2 WAS	**3 WAS**	**4 WAS**
N Sources			
Control	7.8	13.5	25.2b
Cow manure	7.3	15.1	23.2b
Sheep manure	7.5	21.8	38.6a
Poultry manure	7.6	19.0	51.4a
Urea	10.5	20.7	27.2b
SED	1.75	3.41	3.71
Varieties			
2009EVDT	7.5	18.1	30.2b
2009TZEEW	8.8	17.9	35.9a
SED	1.11	2.16	2.35
Interactions			
NxV	NS	NS	*

Means in a column followed by the same letter(s) are not significantly different at 5% level of probability using SNK Test.

Table 4: Interaction of N Source and Maize Variety on plant Height at 4 WAS

Treatments	Maize Varieties	
	2009 EVDT	2009 TZEEW
N Sources		
Control	24.7ab	25.7ab
Cow manure	25.8ab	20.7c
Sheep manure	39.2b	37.9b
Poultry manure	36.4b	66.0a
Urea	25.0ab	29.4ab
SED	5.25	

Means in a column followed by the same letter(s) are not significantly different at 5% level of probability using SNK Test. The application of different N sources was observed to have no significant effect on the stomata resistance and canopy temperature.

Table 5: Effect of Organic and Inorganic N Sources on Chlorophyll Content, Canopy Temperature and Stomatal Resistance of Maize Varieties.

Treatments	Chlorophyl content	Leaf temperature	Stomatal resistance
N Sources			
Control	15.9c	38.2	266
Cow manure	14.8c	39.5	340
Sheep manure	22.1b	41.3	181
Poultry manure	41.9a	40.1	214
Urea	25.9b	38.4	264
SED	2031	1.14	88.2
Varieties			
2009EVDT	24.3	39.7	264
2009TZEEW	23.9	39.2	242
SED	1.45	0.72	55.8
Interactions			
NxV	*	NS	NS

Means in a column followed by the same letter(s) are not significantly different at 5% level of probability using SNK Test.

Table 6: Interaction of N Source and Maize Variety on Chlorophyll Content

Treatments	Maize Varieties	
	2009 EVDT	2009 TZEEW
N Sources		
Control	17.9bc	13.9bc
Cow manure	12.6bc	16.9bc
Sheep manure	19.6b	24.5b
Poultry manure	46.5a	37.4a
Urea	26.9b	26.9b
SED	3.26	

Means in a column followed by the same letter(s) are not significantly different at 5% level of probability using SNK Test.

Effect of Organic and Inorganic N Sources on Particle Size Distribution of Soil

Table 7 shows the effect of organic and inorganic N sources on particle size distribution, it was observed that there were no significant differences among the various N sources for sand, silt and clay; there was no much change in particle size distribution due to application of the organic and inorganic N sources. The ratio between clay and silt is not wide indicating that soil is not highly weathered a similar observation was made by Iken and Amusa (2004)

Table 7: Effect of N Sources and Variety on Particle Size Distribution .

Treatments	Particle Size Distribution (%)		
	Sand	**Silt**	**Clay**
N Sources			
Control	91.3	3.4	5.3
Cow manure	91.5	3.1	5.5
Sheep manure	91.8	3.9	4.3
Poultry manure	91.6	3.9	4.5
Urea	91.1	2.9	6.0
SED	0.596	0.775	1.116
Varieties			
2009EVDT	91.3	3.4	5.3
2009TZEEW	91.6	3.4	5.0
SED	0.377	0.490	0.706
Interactions			
NxV	NS	NS	NS

Effect of Organic and Inorganic N Sources on Soil pH and EC

Table 8 shows the effect of organic and inorganic N sources on soil pH and electrical conductivity, the soil from all treatment was founded to be slightly acidic in reaction. The mean value of pH in the treatment are 6.6-7.9 in KCL and 7.6-7.4 in water with lower value in poultry treatment and higher value in control treatment both in water and (KCl) respectively . According to Eleweanya et al, (2005) state that pH, between 6.5- 8.4 is at normal range, therefore pH is normal. The mean value of electrical conductivity (EC) were found to be 0.1 -0.3 in the different treatment and according to Teal et al., (2006) the range limit of EC in soil <4 ds/m in alkaline soil. However no significant difference observed, poultry treatment composed of higher EC .

Table 8: Effect of N Sources and Variety on pH (water and KCL) and EC .

Treatments	pH (H_2O)	pH (KCL)	EC (dS/m)
N Sources			
Control	7.6	7.2	0.1
Cow manure	7.4	6.6	0.1
Sheep manure	7.5	7.0	0.2
Poultry manure	7.4	6.9	0.3
Urea	7.5	6.9	0.2
SED	0.148	0.188	0.053
Varieties			
2009EVDT	7.5	6.9	0.2
2009TZEEW	7.5	7.0	0.2
SED	0.093	0.119	0.034
Interactions			
NxV	NS	NS	NS

Means in a column followed by the same letter(s) are not significantly different at 5% level of probability using SNK Test.

Effect of Organic and Inorganic N Sources on Soil Organic Carbon, Organic Matter and CEC

From table 9, there were no significant difference observed among the various N sources for organic carbon, organic matter and cation exchange capacity. Treatment with poultry manure shows highest organic matter content, organic carbon and CEC. According to Esu et al (1990), the CEC range in the soil is found to be <6 at low concentration , 6-12 at medium concentration and > 12 at high concentration from the result obtained, CEC therefore is medium with higher value in poultry treatment

Table 9: Effect of Organic and Inorganic N Sources on OC, OM and CEC .

Treatments	OC (%)	OM (%)	CEC (cmol/Kg)
N Sources			
Control	0.71	1.2	6.6
Cow manure	0.79	1.4	9.4
Sheep manure	0.73	1.3	6.5
Poultry manure	0.95	1.6	10.6
Urea	0.71	1.2	8.6
SED	0.156	0.269	4.29
Varieties			
2009EVDT	0.70	1.2	8.4
2009TZEEW	0.85	1.5	8.3
SED	0.098	0.170	2.71
Interactions			
NxV	NS	NS	NS

Means in a column followed by the same letter(s) are not significantly different at 5% level of probability using SNK Test.

Effect of Organic and Inorganic N Sources on Total Nitrogen In soil, Total Nitrogen in Plant Tissue, Available Phosphorous in Soil and Total Phosphorus in Plant Tissue.

From the (Table 10) the mean value of total nitrogen were found to be 0.1-0.2% the treatment . There was no significant different observed in total nitrogen of the plant tissue. Compare with the total nitrogen in soil , poultry treatment revealed high value of nitrogen while in the total N in soil, control treatment observed high value of nitrogen. According to KARI (2005) ,the ranges limit of the total N In soil are 0.01 . low, 0.1- 0.2 medium and 0.2 high. Therefore the total N in control was found to be high, treatment was found at medium. There is no significant different observed from the total N in soil. Jayasundra (2007) reported that Nitrification which is a process of conversion of ammonium in to nitrogen for plant uptake which will consequentially lead to loss from the soil. There was a significant different observed among the treatment with in available phosphorus in soil AVP with poultry manure content high number of available phosphorus .

While plot with no manure or urea application in the soil provide lowest phosphorus . this occurred according to Boetang et al., (2006), soil higher in organic matter generally exhibit low level of phosphorus fixation because large humic molecules can adhere to surface of clay and metal hydrous oxide particle ,masking the phosphorus fixation site and preventing them from the interacting with phosphorus ions in the solution. Significant difference was recorded on total phosphorus in plant among the treatment with the highest number total phosphorus recorded in poultry manure. While sheep produce lowest.

Table 10: Effect of N Sources and Variety on TN in Soil, TN in Plant Tissue, Available P in Soil and Total P in Plant Tissue.

Treatments	TN Soil (%)	TN Plant (%)	Av. P Soil (mg/kg)	TP Plant (mg/kg)
N Sources				
Control	0.22	0.2	3.8b	27.1b
Cow manure	0.15	0.4	8.8b	22.8b
Sheep manure	0.17	0.5	12.5b	23.9b
Poultry manure	0.11	0.5	74.2a	59.9a
Urea	0.12	0.3	3.7b	25.2b
SED	0.0768	0.142	6.27	8.84
Varieties				
2009EVDT	0.18	0.4	20.9	29.4
2009TZEEW	0.12	0.4	20.3	34.0
SED	0.0480	0.089	3.97	5.59
In teractions				
NxV	NS	NS	NS	NS

Means in a column followed by the same letter(s) are not significantly different at 5% level of probability using SNK Test.

CONCLUSION

This study showed that poultry manure is valuable fertilizer whose application needs to been encourage for both sustainable soil fertility maintenance and optimum plant growth. An application of poultry manure a is comparable to inorganic fertilizer and significantly better than control, CM, SHM and urea fertilizer.

Results of this study demonstrate that the total N uptake was greater in PM than in CM, SHM, UF and control. N availability of SHM and PM was similar, but higher than that of CM, UF fertilizer and control. Furthermore, results of this experiment indicated that the application of PM alone could be the most efficient fertilizers for improvement of maize production and N uptake due to a great potential for N mineralization and availability when compared to CM, SHM, UF and control . In summary, these results suggest that the application of PM improves maize growth and production, with subsequent enhanced N uptake in arid soils with low SOM, soil moisture and N availability. Therefore, soil and manure N uptake should be taken into account when applying UF or manure fertilizers in maize cropping systems as to successfully apply these N resources and lower the consequences for the environment.

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