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RESPONSE OF EXTRA-EARLY MAIZE VARIETY (Zea mays) TO DIFFERENT ORGANIC MANURES IN THE DRIER SUB-REGION OF NORTHERN NIGERIA

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ABSTRACT
This work was carried out to study effect of different organic manures on yield of maize in the study area. Field trials were carried out in 2008 and 2009 cropping seasons at the Teaching and Research Farm of the Department of Soil Science, University of Maiduguri, Maiduguri. The treatments consisted of three organic manures (cow dung, city refuse and poultry droppings) applied at four rates of each organic manure (0.0, 2.5, 5.0 and 10.0tons/ha). The experiment therefore contained twelve treatments laid out in a randomized complete block design (RCBD). Soil pH, electrical conductivity (EC), cation exchange capacity (CEC), effective cation exchange capacity (ECEC), percentage base saturation (PBS), soil organic carbon (SOC), total N, C:N ratio, available P (Bray-1) and exchangeable K were determined before the experiment. There was consistent increase in grain yield with addition of organic manures in 2008, 2009 and in the combined analysis. Poultry manure gave the highest grain yield in 2008 (1486 kg/ha), in 2009 (773.50 kg/ha) and in the combined analysis (1130.1 kg/ha), and the grain yield consistently increased as the application rate was increased. Cow dung also gave significant increase in grain yield and leaf area index of maize. For good crop performance of maize, poultry manure is preferred when applied at 5.0 to 10.0tons/ha.

INTRODUCTION
Maize is gaining prominence in the Sudan savanna of northern Nigeria especially with the introduction of the drought resistant, extra-early variety (SAMMAZ 28). In fact, it is replacing the traditional cereals, millet and sorghum . For mineral fertilizers a rate of 100-150 kg N, 40-50 P_2O_5 and 80-100 kg K_2O/ha has been recommended for maize in the savanna zone (Onyibe et al., 2006), while, FPDD (2002) recommended 120 kg N, 60 kg P_2O_5 and 60 kg K_2O/ha of mineral fertilizer for optimum yield of maize in the sub-sahelian zone. For farm yard manure, rate of 7.5-10.0 tons/ha has been recommended for cereals in general (Kwari and Bibinu, 2002).

Despite the beneficial effects of chemical fertilizers, resource- poor farmers are confronted with some problems concerning their use. Firstly, scarcity in supply and high cost prohibit their use by most small-holder farmers, hence they have often resorted to the use of farm yard manure (FYM) and household refuse to build up the soil nutrient status. Other problems associated with the use

of chemical fertilizers include physical degradation of soil, increase soil acidity and nutrient imbalance (Awanlemhen and Ojeniyi, 2012).

Adverse effects of chemical fertilizers can also be realized on the lacustrine soils of Lake Chad Basin bringing algal bloom, which can lead to excessive mortality rates of fish and other aquatic organisms. Organic manures could ameliorate these adverse effects of inorganic fertilizers aside from inproving the physical and biological aspects of soil and ensuring balanced plant nutrition and controlling soil acidity (Adeniyan and Ojeniyi, 2003, 2005).

Maize crop also significantly responds to organic manures. The use of poultry droppings, cow dung and household wastes increase the efficiency of mineral fertilizers by providing the secondary and micro-nutrients not present in the mineral fertilizers. Long-term studies in Northern Nigerian savanna showed that five tons (5 t/ha) of cow dung annually will maintain yield of maize under continuous cultivation especially in combination with chemical fertilizers (FPDD, 2002). Kwari and Bibinu (2002), recommended a rate of 7.5 to 10.0 t/ha of animal manure for cereals in general. This study was aimed at assessing effectiveness of three organic manures on yield components of a newly introduced extra-early variety of maize in the study area. Studies carried out on alfisols of south-west Nigeria had shown that combined application of organic and inorganic fertilizers were more effective and had residual effect of nutrients content and yield of maize than inorganic fertilizers alone.

MATERIALS AND METHODS

Description of the Study Area

Field trials were conducted during the rainy seasons of 2008 and 2009 at the Teaching and Research Farm of the Department of Soil Science, University of Maiduguri (11^{o}53'N; 13^{o}16'E), on the northern fringes of the Sudan savanna belt of Nigeria. This belt forms part of the semi-arid zone. It is characterized by a short rainy season of 100 – 150 days with a long dry season of at least 7 months, and a mean annual rainfall of about 500 mm (Yunusa and Ikwelle, 1990).

The major soil type found in the study area is Typic ustipsament as described by Rayar (1987) derived primarily from the recent Aeolian sand deposits of the Sahel savanna. Thus, the soils are characterized by sandy texture with low organic matter content, low CEC and inherent low fertility status.

Field experiments were conducted in two successive cropping seasons, 2008 and 2009. The field was ploughed and harrowed to a fine tilth and marked out into plots of 4x4 m (16 m^2) during the first year. In the second year the plots were prepared by hand hoes so as not to disturb the plots.

Experimental Design and Treatments

The treatments were three sources of organic manures (cow dung, city refuse and poultry droppings) at four rates each (0, 2.5, 5.0 and 10.0 tons/ha). The experiment consisted of twelve treatments laid out in a Randomized Complete Block Design (RCBD) replicated three times giving a total of 36 plots.

The three sources of organic manures used were cow dung (CD), city refuse (CR) and poultry droppings (PD). Complete doses of organic manures (2.5 t/ha or 4.0 kg/ net plot, 5.0 t/ha or 8.0 kg/net plot) and 10.0 tons/ha or 16 kg/ net plot were applied at land preparation.

Before planting, the field was harrowed once, leveled and the plots were laid out. The plots measuring 4 x 4 m (16m^2) were marked out and treatments were applied. At planting, a certified seed was used and planted in holes about 3 cm deep on 11th July in 2008 and 2009, respectively. Seedlings were thinned to two plants per stand at about 2 weeks after

sowing (WAS). The inter row spacing was 60 cm and intra-row spacing was 30 cm. An extra-early variety of maize (SAMMAZ 28) was obtained from the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria. Weeds were controlled manually using a hand hoe at 3, 6, and 9 WAS.

The crop was harvested on 10th October and 12th October in 2008 and 2009, respectively. Two middle rows of each net plot were harvested and used as net weight after which the general harvest followed.

Data Collection

Soil samples were collected from surface (0-20 cm) using soil auger. Fifteen (15) samples were randomly collected across the farm, thoroughly mixed and a representative composite sample was taken before the experiment. The soil samples were then analyzed for all the necessary physico-chemical properties following discrete procedures.

The yield components measured include, number of leaves, plant height and leaf area index. Five randomly selected plants in each net plot were used for these purposes.

Ten grams of leaf and grain samples were taken from each net plot for determination of total nitrogen, available phosphorus and exchangeable potassium (NPK) contents.

Data were subjected to analysis of variance (ANOVA) using Statistix 8.0 statistical package. The differences between means were tested with Duncan's Multiple Range Test (DMRT) at 5% level of probability.

RESULTS AND DISCUSION

Physico-chemical properties of the soil of the experimental site

The physico-chemical characteristics of the soil of the experimental site are presented in Table 1. The soil was sandy loam in texture with sand, silt and clay contents of 762.0, 116.0 and 122.0 g/kg respectively. The sand proportion of soil of the study site was very high. This implies that basic cations such as Ca, K, Na and Mg would be leached more easily as texture determines the degree of retention or ease of leaching of basic cations. Bationo and Mokwunye (1991) reported that Entisols and Alfisols occupy most of the soils of Sudano-Sahelian zones of West Africa which are mainly composed of quartz sand, with low water and nutrient holding capacity The soil was slightly acidic (pH = 6.20) and low in EC (0.0173 dS/m). Both CEC (4.46 Cmol kg^{-1}) and ECEC (4.66 Cmol kg^{-1}) were very low in the soil. However, percentage base saturation (95.71 %) was high in the soil. Organic carbon (0.19 %) and total nitrogen (0.1%) were very low, C: N ratio (19.0) was wide. Low organic carbon is attributed to inadequate supply of organic litter, bush burning, long dry season and intensive mineralization during the rainy season (Dugje et al., 2008). Wapa and Kwari (2004) also observed that the soils of northern savanna of Nigeria are characteristically sandy, low in active clay content but high in kaolinite and variable in cation exchange capacity. Furthermore, the low N levels observed in the soil can be attributed to continuous cropping and increased land use intensity. Mafongaya et al. (2003) cautioned that soil fertility depletion would be a serious problem in areas where land use intensification was on the increase. Available phosphorus (Bray 1-P) (2.80 mg/kg) and exchangeable potassium (K = 0.24 mg/kg) were also low.

Some chemical properties of the organic manures used

Some chemical properties of the different types of organic manures used are presented in Table 2. Cow dung (CD), city refuse (CR) and poultry droppings (PD) were neutral in pH (7.3, 7.3 and 6.85), and high EC, 10.42, 18.98 and 8.06 dSm/m soil. Nevertheless, the pH was highest in municipal wastes (7.34) and lowest in poultry droppings (6.85). Organic carbon content was highest in cow dung (14.63

%) followed by poultry droppings (11.31 %) and lowest in city refuse (6.83 %). Nitrogen content was highest is poultry droppings (0.45 %) and lowest in city refuse (0.34 %). However, P and K contents were highest in cow dung (2.9 g/kg and 19.7 g/kg) and lowest in poultry droppings (0.45 g/kg and 5.7 /kg). Carbon/nitrogen ratio was highest in cow dung (37.52) and lowest in city refuse (20.08).

Effects of Manures on Maize Performance

The three sources of organic manure had significant effect on maize grain yield. Poultry dropping gave the highest grain yield in both 2008 and 2009 and in the combined analysis. Lowest yield was obtained with city refuse treatment. High yield in the soils treated with poultry droppings might be attributed to the fact that poultry manure contained higher content of N than the other manures. According to Awotundun (2005) maize requires heavy fertilizer N application for optimum yield. The FPDD (2002) and Kwari and Bibinu (2002), recommended 5.0 t/ha of cow dung annually for maize under continuous cultivation. Irrespective of manure type or their application rates, grain yields were generally higher in 2008 than in 2009 cropping season.

Organic manure had significant effect on plant height only in 2009.

Organic manure had significant effects on LAI in both years and in the combined analysis. Soils treated with poultry droppings had highest LAI in 2008, 2009 and in the combined analysis respectively. Soils treated with city refuse recorded the least LAI in 2009 and in the combined analysis. The different rates of organic manure applied to the soil also had significant effect on the LAI. There were significant progressive increases in LAI with increase in the rate of organic manures from 0.0 tons /ha to 5.0 tons/ha in 2008, 2009 and in the combined analysis. Soils treated with 5.0tons/ha of poultry dropping in particular had the highest LAI in 2008 (422.83), 2009 (358.75).

Effects of Manures on NPK contents of Grains and Leaves

Organic manures had no significant effect on N content of maize leaves in 2008, 2009 and in the combined analysis. Manure rates had significant effect on N content in 2008, 2009 and in the combined analysis. However, the trend was not regular.

Organic manure types had significant effect on K content of leaf in 2008, 2009 and in the combined analysis. Both cow dung and poultry droppings significantly increased the K content of leaves in 2008, 2009 and the combined.

The types of organic manure and their rates had significant effect on N, P and K contents of grain in 2008. There was significant increase in N content of grain with application of cow dung, municipal wastes and poultry dropping. However, poultry droppings treatment had the highest N content (11.72 g/kg) in the grains compared to cow dung (5.68 g/kg) and city refuse (6.05 g/kg) applied at 5.0 tons/ha. The organic manures also significantly increased P and K contents of grains in 2008 with higher rates giving higher contents.

CONCLUSION AND RECOMMENDATIONS

Grain yield and yield parameters as well as N.P.K content of grains and leaves of maize were significantly increased with the application of different organic manures. Poultry droppings gave the highest grain yield. The following recommendations were proposed;

1. For improving maize yield, poultry droppings applied at the rate of 5.0 to 10.0tons/ha were more suitable.
2. City refuse should not be applied because of its significantly low nitrogen content. However, it can be applied on acid soils for the amelioration of soil pH.

Table 1: Physico-chemical characteristics of the soil of the experimental site

Soil characteristics	Value
pH (1:2.5 H_2O)	6.20
EC (dS/m)	0.01
Exch. Acidity ($H^+ + Al^{3+}$ Cmol/kg)	0.20
ECEC (Cmol/kg)	4.66
Percentage Base Saturation (PBS %)	95.71
Organic carbon (%)	0.19
Total Nitrogen (%)	0.1
C : N Ratio	19.0
Available Phosphorus (Bray-1 P mg/kg)	2.80
Exchangeable Potassium (Cmol/kg)	0.24
Texture	Sandy loam

Table 2: Some Chemical Characteristics of the Different Organic Manures used

Sample	pH (1:2.5 H_2O)	Org. C (%)	N (%)	C : N Ratio	P (g/kg)	K (g/kg)
Cow dung	7.31	14.63	0.39	37.52	2.9	19.7
City refuse	7.34	6.83	0.34	20.08	0.5	6.0
Poultry droppings	6.85	11.31	0.45	26.13	0.5	5.7

Table 3: Effects of Different Organic Manures Sources on Maize Grain Yield (kg/ha) in 2008 and 2009 Cropping Seasons

Treatment	2008	2009	Combined
Control	858.3^{c}	491.67^{c}	875.0^{b}
CD at 2.5 t/ha	1428.8^{b}	638.33^{bc}	1033.6^{ab}
CD at 5.0 t/ha	1385.2^{b}	731.42^{ab}	1058.3^{ab}
CD at 10.0t/ha	1433^{a}	799^{a}	1116^{a}
CR at 2.5 t/ha	1498.8^{b}	661.67^{a-c}	1080.3^{ab}
CR at 5.0 t/ha	1499.2^{b}	581.42^{bc}	1040.3^{ab}
CR at 10.0t/ha	1412^{c}	453^{c}	932.5^{b}
PD at 2.5 t/ha	1434.8^{ab}	500.92^{bc}	967.9^{b}
PD at 5.0 t/ha	1863.8^{ab}	848.33^{a}	1356.0^{a}
PD at 10.0t/ha	1980^{a}	980^{a}	1480^{a}

Means in a column followed by similar letters are not significantly different at 5% level of probability by DMRT test.

* = significant at 5% level of the F-test

** = significant at 1% level of the F-test

Table 4: Effects of Different Organic Manures Sources on Plant Height (cm) in 2008 and 2009 Cropping Seasons

Treatment	2008	2009	Combined
Control	153.00	148.42^{ab}	150.71
CD at 2.5 t/ha	154.00	137.67^{b}	145.83
CD at 5.0 t/ha	153.17	149.25^{ab}	151.21
CD at 10.0t/ha	152.16	145.80^{ab}	148.98
CR at 2.5 t/ha	157.08	155.67^{ab}	156.42
CR at 5.0 t/ha	160.08	157.33^{a}	158.71
CR at 10.0t/ha	161.11	154.98^{ab}	156.23
PD at 2.5 t/ha	188.17	147.17^{ab}	167.67
PD at 5.0 t/ha	155.50	152.67^{ab}	154.08
PD at 10.0t/ha	156.22	149.09^{ab}	154.88
SE±	23.794^{ns}	9.705*	12.459^{ns}

Means in a column followed by similar letters are not significantly different at 5% level of probability by DMRT test.

* = significant at 5% level of the F-test

** = significant at 1% level of the F-test

NS = Not significant

Table 5: Effects of Different Organic Manures Sources on Leaf Area Index in 2008 and 2009 Cropping Seasons

Treatment	2008	2009	Combined
Control	218.43^{c}	198.10^{c}	208.26^{c}
CD at 2.5 t/ha	371.81^{b}	351.24^{a}	261.51^{ab}
CD at 5.0 t/ha	425.24^{a}	261.86^{b}	343.55^{b}
CD at 10.0t/ha	432.12^{a}	298.11^{b}	388.21^{a}
CR at 2.5 t/ha	468.81^{a}	318.05^{a}	393.43^{a}
CR at 5.0 t/ha	243.89^{c}	209.48^{c}	216.99^{c}
CR at 10.0t/ha	434.22^{a}	311.65^{a}	334.76^{a}
PD at 2.5 t/ha	218.43^{c}	198.10^{c}	208.26^{c}
PD at 5.0 t/ha	371.81^{b}	351.24^{a}	261.51^{ab}
PD at 10.0t/ha	341.71^{b}	355.03^{a}	277.43^{a}
SE±	25.24*	21.86**	23.55**

Means in a column followed by similar letters are not significantly different at 5% level of probability by DMRT test.

* = significant at 5% level of the F-test

** = significant at 1% level of the F-test

Table 6: Effects of Different Organic Manure Sources on Nutrient Contents of Maize Grains (NPK) in 2008 g/kg

Treatment	N- grain	P- grain	K- grain
Control	7.85[ab]	1.81[bc]	6.84[b]
CD at 2.5 t/ha	4.77[b]	2.56[ab]	7.87[b]
CD at 5.0 t/ha	5.68[b]	0.22[a-c]	8.52[b]
CD at 10.0t/ha	5.09b	5.44[a]	9.66a
CR at 2.5 t/ha	5.24[b]	1.77[c]	7.19[b]
CR at 5.0 t/ha	6.05[b]	2.66[ab]	9.71[ab]
CR at 10.0t/ha	6.99[a]	4.33[a]	9.88[a]
PD at 2.5 t/ha	4.09[b]	2.26[a]	9.16[b]
PD at 5.0 t/ha	11.72[a]	0.23[a-c]	12.51[a]
PD at 10.0t/ha	11,99[a]	3.55[a]	13.32[a]
SE±	2.070*	0.375*	1.612*

Means in a column followed by similar letters are not significantly different at 5% level of probability by DMRT test.

* = significant at 5% level of the F-test

** = significant at 1% level of the F-test

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