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EFFECTS OF SOLE AND COMBINED APPLICATIONS OF ORGANIC MANURES AND UREA ON SOIL PROPERTIES AND YIELD OF FLUTED PUMPKIN (*Telfairia occidentalis*, Hook F.)

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ABSTRACT

Field experiment was conducted at the Teaching and Research Farm of the University of Calabar to compare the effects of sole and combined use of organic manure and urea on soil properties and yield of fluted pumpkin during 2009 and 2010 cropping seasons. There were seven treatments consisting of sole and the combinations of organic manures and urea with a rate of 100 kg N/ha, regarded as full dose (i.e. 100 % sole applied urea, pig manure, poultry manure, 50 % combination of urea with 50 % of either of the organic manures, 50 % urea with 25 % of each of the organic manures and control). They were arranged in a randomized complete block design with three replications. Results showed that the application of the amendments significantly ($P < 0.05$) increased soil chemical properties (soil pH, total N, organic carbon, available phosphorus, exchangeable Ca, Mg, K, ECEC and base saturation) with the combined application of 50 % urea with 25 % of each of the organic manures giving the highest value for most of the parameters determined. The 50 % urea with 25 % of each of the organic manures significantly reduced soil acidity from a very strongly acid level of 4.10 (initial value before experiment) to 5.16, increased total N from 0.9 g/kg to 1.08 g/kg, increased organic carbon from 11.6 g/kg to 15.8 g/kg, increased available phosphorus from 40.50 mg/kg to 70.20 mg/kg. The fresh yield of fluted pumpkin was significantly ($P < 0.05$) increased across all stages of growth as a result of the amendments applied when compared with the control. The highest yield of 6178 kg/ha at 9 weeks after planting (WAP) was obtained from the combination of 50 % urea with 25 % of each of the organic manures. The use of urea in combination with poultry and pig manures, where available, or with either of the organic manures is recommended for yield and soil fertility improvements in the study area.

Key words: Fluted pumpkin, fresh yield, organic manure, urea fertilizer, soil chemical properties,

INTRODUCTION

Under a system of continuous cropping, which has become a characteristic feature of Nigerian farmers, soil fertility and productivity can only be maintained through the use of soil amendments. The use of inorganic fertilizers has proven to be more convenient and impactful than the use of organic fertilizers, but the resulting soil physical degradation, increased soil acidity and soil nutrient

imbalance have drawn the attention of researchers back to the use of manure. While the use of inorganic fertilizer is limited by cost and scarcity, the use of organic manure is limited by the large quantities needed to meet crops nutritional needs due to its low nutrient content. Judicious application of inorganic fertilizer along with organic manure is one of the concepts gaining importance as it forms the integrated soil fertility management (ISFM). The combined use of organic and inorganic fertilizers reduced the bulk of organic fertilizer required for optimum crop production and also prevents rapid degradation of the soils as a result of continuous use of inorganic fertilizers.

Integrated use of organic and inorganic fertilizers has been advocated by several researchers (Lombin *et al*., 1991; Agboola and Obatolu, 1989; Adeniyan and Ojeniyi 2003, 2005; Iren *et al*., 2012). Inorganic fertilizer provides readily available nutrients for plant uptake and growth; while its organic counterpart besides nutrients supply to crop, also improves soil physico-chemical condition, thereby increasing soil organic matter content. Soil organic matter has a biological function in that it provides carbons, energy source for soil microbes, enhances plant growth, and seed germination (Kumbhar *et al*., 2007). There is however very few information on the response of fluted pumpkin to combined use of organic manures and urea in Southeastern zone of Nigeria. Therefore, this study was aimed at determining effect of sole and complementary application of organic manure and urea on soil properties and yield of fluted pumpkin.

MATERIALS AND METHODS

Experimental Site

Field experiment was conducted at the Teaching and Research Farm of the University of Calabar (5^o 32' and 4^o 27' N and 7^o 15' and 9^o 28' E) for two years. The entire Calabar environment is in the tropical rainforest belt of Nigeria with an annual rainfall ranging from 2000 – 2500 mm, mean temperature range of 23- 33 ^{0}C and mean relative humidity of 60 to 90 %. The soil of the experimental site falls within the coastal plain sands underlain by kaolinite and is generally referred to as the "Acid Sands". The soil is loamy sand in texture and classified as an Ultisol (Soil Survey Staff, 1999). The experimental site was manually cleared, tilled and flat beds measuring 3 m x 1.5 m made. An alley of 1.2 m was left between blocks and 0.6 m between plots.

Experimental Design and Treatments

The experiment was laid out in a randomized complete block design with three replications. The full dose of N used was 100 kg /ha for fluted pumpkin. The rate of organic manure used was based on N equivalent and applied on dry weight. There were 7 treatments as follows:

Control (no fertilizer)
100 kg N/ha of urea
100 kg N/ha of poultry manure
100 kg N/ha of pig manure
50 kg N/ha of urea + 50 kg N/ha of poultry manure
50 kg N/ha of urea + 50 kg N/ha of pig manure
50 kg N/ha of urea + 25 kg N/ha pig manure + 25 kg N/ha of poultry manure

The organic manures used were collected from the University of Calabar Animal Farm while the fluted pumpkin seeds and urea were purchased from the open market in Calabar Municipality.

FIELD STUDIES

Planting and Collection of Yield Data

The organic manures were evenly distributed and incorporated to specified plots one week before planting (WBP) as recommended by Iren *et al*., (2011a). Fluted pumpkin seeds were separated from the pulp and dried before planting. Two seeds of fluted pumpkin were planted per stand at a spacing of 75cm x 75cm ($0.5625m^2$) giving a plant population of 35,

556 plants/ ha. Urea was applied to specified plots 2 weeks after planting (WAP). Weeding was done manually at 4 WAP. Weight of freshly harvested vine was taken at 5, 7 and 9 WAP.

Collection and Preparation of Soil Samples

Before the experiment, 12 auger point samples taken at 0-15 cm depth were randomly collected, bulked and sub- sampled for analysis. At the end of the experiment, 8 soil auger point samples were taken per plot at the same depth, bulked and sub-sampled for analysis. The composite soil samples were air-dried, sieved through a 2 mm sieve and stored for onward analysis in the laboratory.

Laboratory Studies

The animal manures used in the study were analyzed using standard procedures (Juo, 1979). Particle size distribution of soil was determined by the hydrometer method using sodium hexameta-phosphate as the dispersing agent. Soil pH was determined potentiometrically in distilled water at 1:25 soil to water ratio. Total nitrogen was determined using the modified macro-kjeldahl method of Bremner (1996) while organic carbon was by the dichromate wet oxidation method. Available P was extracted by the Bray 1 extraction method, and the content of P was determined colorimetrically using a Technico AA11 auto analyser. Exchangeable bases (K, Na, Ca, and Mg) were extracted with neutral ammonium acetate (NH_4OAc). Calcium and magnesium were determined using 0.01N Ethylene di-aminetetra-acetic acid (EDTA) (versenate) titration method, while sodium and potassium were determined by flame photometry. Exchangeable acidity was determined by the 1NKCl extraction procedure as described by Mclean (1965). Effective cation exchange capacity (ECEC) was calculated as the sum of exchangeable cations and exchangeable acidity. The percent base saturation was calculated as the sum of exchangeable cations divided by the ECEC and multiplied by 100.

Data Analysis

Data collected were analyzed according to the procedures outlined by Gomez and Gomez (1984) for randomized complete block design. Means that were statistically significant were separated using Fisher's least significant difference (FLSD) at 5 % level of probability.

RESULTS AND DISCUSSION

Properties of the manure and soil used for the experiment

The chemical composition of the pig and poultry manures is as provided in Table 1. From the analysis of the organic manures used for the study, pig manure had higher levels of total N, K and Mg than poultry manure while total P and Ca were higher in poultry manure. A lower C: N ratio of 9.92 obtained from pig manure shows faster rate of mineralization when compared with a C: N ratio of 11.37 obtained from poultry manure.

The properties of the soil used for the study are presented in Table 2. The soil was strongly acidic with pH value of 4.10. This indicates the deficiency of calcium and magnesium in the soil. The soil was low in organic carbon content with the value of 11.6 g/kg lower than the critical level of 20 g/kg given by Aduayi *et al.*, (2002) for soils of the humid tropical region. The total N content in the soil was also low (0.9 g/kg) as against the critical value of 1.5 g/kg given by Aduayi *et al.*, (2002). The low nitrogen could be attributed to high rate of mineralization and subsequent high rate of leaching that accompany the heavy rains associated with the forest zone of South eastern Nigeria. The low amount of total N also reflects the amount of organic carbon in the soil. Available P value (40.50 mg/kg) obtained in this study exceeded the moderate level range of 15 – 25 mg/kg and was therefore rated as high. The values for exchangeable bases (Ca, Mg, K, and Na) and ECEC were low. The low ECEC and nutrient reserves of the study area have been attributed to the fact that soils of South eastern Nigeria are strongly

weathered, have little or no content of weather able rock in their sand and silt fractions and have predominantly kaolinite in their clay fraction (FPDD, 1990). The soil is inherently low in fertility and would therefore depend on soil amendments for sustainable agricultural productivity.

Table 1: Chemical Composition of organic manures used for the study

Parameter	Organic manures	
	Poultry manure	Pig manure
Organic carbon (%)	30.48	28.97
Total N (%)	2.68	2.92
C:N ratio	11.37	9.92
Total P (%)	1.32	1.13
Total K (%)	2.50	2.83
Ca (%)	4.35	3.56
Mg (%)	2.03	2.81

Table 2: The analysis of the soil before experiment

Soil properties	**Values**
Sand (g/kg)	843
Silt (g/kg)	87
Clay (g/kg)	70
Texture	Loamy sand
pH (H_2O)	4.10
Organic carbon (g/kg)	11.60
Total nitrogen (g/kg)	0.90
Available P (mg/kg)	40.50
Exch. K (cmol/kg)	0.05
Exch. Ca (cmol/kg)	2.20
Exch. Mg (cmol/kg)	0.80
Exch. Na(cmol/kg)	0.04
Exch. Acidity (cmol/kg)	2.28
ECEC (cmol/kg)	4.37
TEB	3.09
BS (%)	57.54

Properties of the soil after the experiment

Effects of sole and combined application of organic manures and urea on soil chemical properties are presented in Table 3. The results obtained from the study showed that the application of the amendments significantly improved soil chemical properties (soil pH, total N, organic carbon, available P, ECEC, exch. Ca, Mg, K, and base saturation) with the combined application of 50 % urea + 25 % pig manure + 25 % poultry manure giving the highest value for most of the parameters determined. The 50 % urea combination with 25 % of each of the organic manures significantly reduced soil acidity from a very strongly acid level of 4.10 (initial value before experiment) to 5.16, increased total N from 0.9 g/kg to 1.08 g/kg, increased organic carbon from 11.6 g/kg to 15.8 g/kg and also increased available phosphorus from 40.50 mg/kg to 70.20 mg/kg.

Generally, it was observed that addition of urea to either pig or poultry manure increased most of the soil parameters determined. The soils that received organic manure alone and in combinations with urea gave significantly higher total N and organic carbon contents than that of urea fertilizer alone (Table 3). This could be due to enhanced release and mineralization of nutrients from native and added organic manure due to synergistic effects of the urea (inorganic fertilizer) on organic matter (Olatunji *et al*.; Adenijan and Ojeniyi, 2005; Iren *et al*., 2011b). Organic matter shows a greater capacity to release and retain nutrients in forms that can be easily taken up by plants over a longer period of time. Conversely, nutrients released from urea fertilizer alone were of short period of time because of leaching loses. Hoffman *et al*. (2001) also pointed out that if inorganic fertilizer, especially nitrogen carrier, is combined with manure, the manure reduces soil acidification and improves the nutrients buffering capacity and the release of nutrients.

Table 3: Effects of sole and combined use of organic manures and urea on soil chemical properties

Treatment	Soil pH	Total N (g/kg)	Organic C (g/kg)	Av. P (mg/kg)	Ex. bases (cmol/kg) Ca	Mg	Na	K	E.A. (cmol/kg)	ECEC (cmol/kg)	BS (%)
Control	4.17	0.83	10.5	50.2	1.20	1.07	0.04	0.07	2.11	4.49	53.01
100 % urea (100 kg/ha)	4.48	0.93	11.6	56.1	1.47	1.53	0.04	0.07	2.50	5.61	55.44
100% poultry manure (100kg N/ha)	4.96	1.07	13.6	64.7	2.07	2.67	0.04	0.08	2.11	6.97	69.73
100 % pig manure (100kg N/ha)	4.94	1.05	12.6	58.4	2.23	2.67	0.05	0.10	2.16	7.21	70.04
50 % urea + 50 % poultry manure	4.80	1.03	12.5	53.8	2.20	2.80	0.06	0.09	2.14	7.29	70.64
50 % urea + 50 % pig manure	4.84	1.05	12.2	57.7	2.73	2.86	0.06	0.09	2.42	8.16	70.34
50 % urea + 25 % poultry manure + 25 % pig manure	5.16	1.08	15.8	70.2	2.60	2.93	0.05	0.10	2.08	7.76	73.20
LSD (0.05)	0.31	0.04	0.29	4.3	0.72	0.68	NS	0.03	NS	0.32	2.72

Effects of Sole and Combined use of organic manures and urea on fresh yield of fluted pumpkin

Application of urea fertilizer and organic manure in a single or in a combined form improved fresh yield of fluted pumpkin across all stages of growth when compared with the control (Table 4). At 5 WAP, all the amendments whether applied alone or in combination significantly ($P < 0.05$) increased the yield of fluted pumpkin with the highest fresh yield of 2267 kg/ha obtained from the combination of 50 % urea + 25% of each of the organic manures, closely followed by sole applied urea (2069 kg/ha) and lowest yield (1422 kg/ha) from the control plot.

At 7 WAP, the highest yield was obtained from sole applied urea (3933 kg/ha), closely followed by 50 % urea + 25 % of each of the organic manures (3822 kg/ha), and were significantly higher than the yield obtained from sole applied organic manure sources and control but not significantly higher than the yield obtained from combined use of urea with any of the organic manures. As the growth stage prolonged to 9 WAP, the highest yield of 6178 kg/ha was obtained from the 50 % urea + 25 % of each of the organic manures, followed by the combination of 50 % urea with 50 % pig manure (5511 kg/ha) while the lowest yield of 2300 kg/ha was from the control. The yield obtained from sole applied urea at 9 WAP was not significantly higher than control. This result is expected as urea fertilizer, though it releases its nutrient faster, is prone to losses through ammonia volatilization and leaching. The results obtained from this study agreed with the findings of other researchers (Ayeni, 2008; Iren *et al*., 2012b, Bello and Adekunle, 2013) that combined use of inorganic fertilizer and organic manure will support the supply of adequate quantities of plant nutrient required to sustain maximum crop production while minimizing environmental impact from nutrient use.

CONCLUSION

The results obtained from this study have shown that the addition of organic manure such as pig and poultry manures solely or in combination with urea fertilizer improved the chemical properties of the soil as well as fluted pumpkin yield relative to control. The combined application of urea and organic manure could neutralize the possible acidifying effect of nitrogen in the inorganic fertilizer while ensuring balanced plant nutrition and improved soil fertility. The use of urea in combination with both sources of organic manure, where available, or with either of the organic manures is recommended for yield and soil fertility improvement in the study area.

Table 4: Effects of sole and combined use of organic manures and urea on fresh yield of fluted pumpkin

Treatment	5WAP	7WAP	9WAP
Control	1422	2322	2300
100 % urea (100 kg/ha)	2067	3933	3244
100 % poultry manure (100kg N/ha)	1867	3119	4089
100 % pig manure (100kg N/ha)	1811	3222	4218
50 % urea + 50 % poultry manure	1800	3489	5489
50 % urea + 50 % pig manure	1842	3533	5511
50 % urea + 25 % poultry manure + 25 % pig manure	2267	3822	6178
LSD (0.05)	562.4	604.44	1000.8

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