Scientia Africana, Vol. 11 (No.1), June 2012. pp 84-91
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STUDIES ON SOIL AMENDED WITH POULTRY MANURE AND ITS EFFECTS ON YIELD AND YIELD COMPONENTS OF PUMPKIN

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Received: 21-02-12
Accepted: 21-03-12

ABSTRACT

Studies on soil amended with poultry manure (PM) and its effects on some growth parameters of pumpkin, Cucurbita moschata (Duch. ex Lam.) Duch. ex Poir. were conducted at the University of Port Harcourt Botanical Garden. Six treatments viz; 0, 1, 2, 3, 4 and 5 tons of poultry manure per hectare (t PM/ha) were used in a randomized complete block design (RCBD) with four replicates. Treatments were applied in a single dose at two week-old seedlings of C. moschata using ring method. The effects of these treatments on leaf area (LA), stem diameter (SD) and number of leaves (NL) were monitored weekly while fresh weight and dry weight of C. moschata were determined 6 weeks after planting (WAP). Soil organic matter (OM), organic carbon (OC), ash content, pH and nutrient (N, P, K, Ca, Na and Mg) levels were also monitored for 0, 2 and 6 weeks. The study showed that poultry manure increased the LA, SD, NL and nutrient (N, P, K, Ca, Na and Mg) contents of the soil. The highest leaf area, number of leaves and fresh weights were obtained from PM treatments at 5 t/ha while 3 t/ha gave the highest dry weight and stem diameter. Two weeks after treatment, the concentrations of K, Ca, Na and ash content in the soil were highly increased by 2 t PM/ha whereas 5 t PM/ha gave the highest concentrations of N, Mg, OM and OC content. However, the control (0 t PM/ha) gave the highest P concentration. The study after six weeks showed that 4 t PM/ha gave the highest concentrations of P, Ca and Mg in the soil while 5 t PM/ha gave the highest concentrations of N and K. In most cases, the control recorded the lowest levels. At $P<0.05$, there were significant difference among treatments. The study recommends an application rate of 5 t PM/ha for the improvement of the soil nutrients.

Key words: *Poultry manure, amended soil, Cucurbita moschata*

INTRODUCTION

The use of inorganic fertilizer has not been helpful under intensive agriculture because it is often associated with reduced crop yield, soil acidity and nutrient imbalance (Kang and Juo, 1980; Obi and Ebo, 1995; Ojeniyi, 2000). Soil degradation which is brought about by loss of organic matter accompanying continuous cropping becomes aggravated when inorganic fertilizers are applied annually. This is because crop response to applied fertilizer depends on soil organic matter (Agboola and Omueti, 1982). In most Sub-Saharan African countries, fertilizer is not readily available and when available the cost is often limiting to small scale resource poor farmers (Smestad *et al.*, 2002). This leads to non-use or use of suboptimal quantities of fertilizer to avoid crop failure, thus posing a threat to food security. It is therefore imperative that other sustainable alternatives of soil fertility management are sought to ensure improved crop production and consequently

improved food security. The quantity of soil organic matter depends on the quantity of organic material added to the soil either by natural returns through roots, stubble, slough off roots nodules and root exudates or by artificial application in the form of organic manures.

Organic manures play a direct role in plant growth as a source of necessary macro and micronutrients need for plant growth. Thereby, they improve both the physical and chemical properties of soil (El Shakweer *et al*., 1998), thus enhancing soil water holding capacity and aeration (Abou el Magd *et al*., 2005). The release nutrients from organic materials rather slowly and steadily over a longer period and also improve soil fertility status by activating soil microbial biomass (Ayuso *et al*., 1996). Thus, ensure a longer residual effect (Sherma and Mittra, 1991), support better root development and this leads to higher crop yields of Broccoli (Abou el Magd *et al*., 2005). Organic nutrient management, based on biodegradable material is one such alternative. Among the most promising organically based soil nutrient management practices include use of animal manure, incorporation of crop residues and improved legume fallows (Place *et al*., 2003).

The pumpkin, *C. moschata,* is cultivated for both the leaves and fruits while the leaves are important vegetables, the pulp of the fruit is eaten when cooked (Okoli, 1984; Ndukwu and Okoli, 1992). The seeds are eaten whole, roasted or toasted and are ground into different stews. They have high oil and protein contents and their consumption in urban areas is also fairly common. It is rarely found growing in the wild; however, it occasionally grows as an escape on dumpsites in most parts of Southeastern Nigeria (Okoli, 1984). Okonwu and Mensah (2011) reported that soil treated with poultry manure increased the nutrient uptake of *C. moschata*. More information about this manure is needed to extend to farmers. The study, therefore, seeks to determine effects of rates of poultry manure application on soil nutrient content and yield and yield components of pumpkin, *C. moschata.*

MATERIALS AND METHODS

The mature fruits of pumpkin, *C. moschata* used for this study were harvested from a subsistent farm in Abiriba, Abia State. The seeds were removed from the fruits, air dried and stored at room temperature. Poultry manure was collected from the poultry farm of the University of Port Harcourt. The field experiment was laid out in a Randomized Complete Block Design at the University of Port Harcourt Botanical Garden. Soil samples were obtained from the upper soil surface layer (0 - 15 cm) using a 5 cm diameter soil auger. The soil samples and poultry manure were air dried for analysis to establish the initial soil chemical properties and poultry manure used for the experiment. About 5 gram of the air-dry soil was taken in a glass beaker and 10 ml of distilled water was added. The contents were mixed thoroughly with a glass rod and allowed to stand for 30 minutes. The soil pH was measured using EQUIP-TRONICS Digital pH meter model EQ-610. The soil samples and poultry manure were digested on a labcon digester at 300°C in a mixture of hydrogen peroxide, sulphuric acid, selenium and salicyclic acid (Okalebo *et al*., 2002). The digests were analysed for total N, P, K, Na, Ca, and Mg. The total N content in the digests were determined by Kjeldahl method, 10 ml of the digest solution was taken in the distillation flask, 20 ml of 40 % NaOH was added and the NH_3 evolved was collected in a flask containing 4 % H_3BO_3. Finally, the distillate was titrated against 0.1 N H_2SO_4. Total phosphorous was determined using the ascorbic acid blue colour procedure and the absorbance measured at 880 nm wavelength UV-spectrophotometer. The Ca, K and Mg contents in 1/20 dilution (sample /distilled water) soil and poultry manure digests were measured by reading their absorbance on a

Scientia Africana, Vol. 11 (No.1), June 2012. pp 84-91
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UNICAM 969 Atomic Absorption Spectrophotometer at 766.5, 422.7 and 285.2 nm, respectively. The sodium content in 1/20 diluted sample were determined by reading their absorbance at 248.3 nm (Okalebo *et al.*, 2002). For total organic carbon, two gram of soil was taken in a 500 ml Erlenmeyer flask, 10 ml of 1 N K_2CrO_7 was added and the flask was swirled to mix the contents. Twenty ml of conc. H_2SO_4 was added to the soil suspension; flask was swirled again for 1 minute and allowed to stand for 30 minutes. After this, 200 ml of water, 10 ml of H_3PO_4 and 1 ml of diphenylamine indicator were added and the contents were titrated against 0.5 N $FeSO_4$.7H2O until the colour changed from blue to red. The organic matter was obtained by multiplying total organic carbon values by a conversion factor of 1.27 (AOAC, 1990). The planting was done during the rainy season in the month of May. Poultry manure (PM) was used as treatment. The treatments were 0, 1, 2, 3, 4 and 5 t PM/ha. The experiment was laid out in a Randomized Complete Block Design (RCBD). The treatments were applied once to two week-old seedlings of *C. moschata* using ring method. Each treatment was replicated four times. The plants were staked to avoid creeping on the ground. The soil chemical properties (N, P, K, Ca, Na and Mg) were assessed 2 and 6 weeks after planting following the method described above.

Measurement of plant material: The leaf area, stem diameter and number of leaves were measured weekly, while fresh weight and dry weight of *C. moschata* were measured 6 weeks after planting. The leaf area was determined by graph method and stem diameter was determined by measuring the stem close to the ground with vernier caliper while the number of leaf was obtained by direct counting of the leaves. The fresh weights *C. moschata* were obtained using Metler balance (Model PN 163) which were measured immediately after harvest to avoid water loss while the dry weight were obtained by drying the samples in a plant dryer (Baird and Tatlock, Greenfield England) at 80 ^oC for a period of 48 hours to obtain a constant weight; after which the weights were taken using Metler balance (Model PN 163).

Statistical analysis: Statistical analyses of data obtained for plant parameters and soil samples were by Analysis of Variance (ANOVA) using 5 % level of significance. The statistical package used was SPSS 17.3. Means were compared using Duncan's Multiple Range Tests (DMRT).

RESULTS

Effect of poultry manure on some growth indices of *C. moschata:*

The addition of poultry manure to the soil increased the leaf area, stem diameter, number of leaves, fresh weight and dry weight of *C. moschata* and 31 days after treatment (DAT), all poultry manure treatments showed significantly ($P<0.05$) broader leaf area, stem diameter, number of leaves (Table 1), fresh weight and dry weight of *C. moschata* (Table 2) than the control respectively. However, among treatments, 5 t PM/ha showed the highest leaf area, number of leaves and fresh weight of *C. moschata* while 3 t PM/ha gave the highest stem diameter and dry weight values respectively. The result obtained from 3 t PM/ha was not significantly different among PM treatments but significant when compared to control (0 t PM/ha) at $P<0.05$. Stem diameter value was not significant among PM treatments but significant when compared with the control.

Effect of poultry manure on the soil nutrient content:

The initial chemical compositions of the soil used in this study were as presented in Table 3. Table 4 presents results on soil nutrient composition 2 weeks after planting (WAP).

The results showed that the poultry manure treatments increased the OM, OC and nutrient content of the soil while the control showed reduction in OM, OC and all nutrients assessed except available P. Among treatments, 5 t PM/ha had the highest value for N, Mg, OM, OC while 2 t PM/ha gave the highest value for K, Ca and Na content of the soil. The pH values varied from control (5.78) to 3 t PM/ha (7.21) while the percentage ash content ranges from 89.2-92.7 % for 5 and 1 t PM/ha respectively. The ash content was not significant among treatments.

However, the results obtained 6 WAP was not consistent with the trend of results obtained 2 WAP. Treatments showed varied improvement of macro and micro-nutrients of the soil. The available P, Ca, Mg, OM and OC were quite high at 4 t PM/ha while 5 t PM/ha gave the highest value for N and K. The control showed the least for all nutrients assessed in the soil 6 weeks after planting (Table 5).

Table 1: Effect of poultry manure treatments on NL, LA and SD of *C. moschata*

Treatment (t PM/ha)	10 DAT			17 DAT			24 DAT			31 DAT		
	NL	LA (cm^2)	SD (cm)	NL	LA (cm^2)	SD (cm)	NL	LA (cm^2)	SD (cm)	NL	LA (cm^2)	SD (cm)
0	6	29.75	0.395	7	35.50	0.468	8	43.25	0.610	8	47.00	0.513
1	7	96.00	0.633	9	163.50	0.910	9	170.00	1.003	10	170.75	0.990
2	4	43.75	0.495	7	125.50	0.790	14	186.50	1.038	18	200.75	1.045
3	7	79.75	0.630	13	186.25	0.950	24	226.75	1.198	28	223.75	1.188
4	5	37.00	0.458	11	75.50	0.588	21	147.50	0.843	30	199.75	1.130
5	4	35.50	0.448	7	80.75	0.648	23	191.75	0.913	31	230.50	1.070
SE	0.466	2.137	0.129	0.655	3.094	0.178	1.106	3.249	0.182	1.309	3.364	0.201
SD	1.301	27.388	0.100	2.578	57.453	0.190	7.342	63.320	0.199	10.288	67.897	0.243
LSD (0.05)	0.971	4.457	0.269	1.367	6.455	0.371	2.307	6.777	0.380	2.732	7.017	0.420

NL represent Number of leaves, LA – Leaf area, SD – Stem diameter, DAT - days after treatment, SE - Standard error, SD - Standard deviation, LSD - least significant different ($p<0.05$)

Table 2: Effect of PM treatments on dry weight and fresh weight of *C. moschata*

Treatment (t PM/ha)	Dry weight (g)	Fresh weight (g)
0	1.635	12.210
1	8.263	48.533
2	10.163	66.718
3	36.305	139.133
4	38.610	136.600
5	28.298	155.618
SE	1.624	3.124
SD	15.818	58.558
LSD (0.05)	3.460	6.657

SE represents standard error, SD - standard deviation, LSD - least significant different ($p<0.05$)

Scientia Africana, Vol. 11 (No.1), June 2012. pp 84-91
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Table 3: Soil chemical properties and poultry manure used for the experiment

Chemical properties	Soil	Poultry manure
Na (mg/kg)	206 .00	2095.28
K (mg/kg)	219.20	26,666.00
Ca (mg/kg)	13.20	7539.55
Mg (mg/kg)	95.75	843.15
PO_4^{2-} (mg/kg)	4.95	52.80
N (%)	0.22	0.21
OC (%)	4.77	47.56
OM (%)	8.20	81.82
Ash content (%)	91.80	18.20
pH ($_{1:2}$ soil to water)	5.94	

Table 4: Effect of poultry manure on soil chemical properties 2 weeks after planting (WAP)

Treatment (t PM/ha)	N (%)	P (mg/kg)	K (mg/kg)	Ca (mg/kg)	Mg (mg/kg)	Na (mg/kg)	OM (%)	OC (%)	Ash (%)	pH
0	0.126	28.875	311.20	1.75	84.25	149.10	8.10	4.71	91.9	5.78
1	0.259	12.375	563.05	266.75	205.10	242.40	7.30	4.24	92.7	6.49
2	0.280	8.25	1486.85	1903.80	426.50	558.60	7.80	4.53	92.2	6.51
3	0.350	15.675	1091.60	703.75	338.35	292.40	8.50	4.94	91.5	7.21
4	0.336	11.963	1104.20	618.35	371.60	358.55	10.20	5.93	89.8	5.72
5	0.364	8.25	1218.50	999.00	453.55	303.80	10.80	6.28	89.2	6.56
SE	0.121	1.133	0.121	271.178	57.932	4.788	0.571	0.333	0.57	0.227
SD	0.088	7.703	0.088	664.248	141.903	137.572	1.399	0.815	1.40	0.556
LSD (0.05)	0.259	2.415	0.259	577.881	123.452	9.989	1.217	0.709	1.22	0.484

SE represents standard error, SD - standard deviation, LSD - least significant different ($p<0.05$)

Table 5: Effect of poultry manure on soil chemical properties 4 weeks after application (6 WAP)

Treatment (t PM/ha)	N (%)	P (mg/kg)	K (mg/kg)	Ca (mg/kg)	Mg (mg/kg)	Na (mg/kg)	OM (%)	OC (%)	Ash (%)	pH
0	0.147	4.125	181.95	17.15	84.25	158.05	16.20	9.42	83.8	7.10
1	0.210	4.950	238.60	104.60	113.60	221.95	7.00	4.07	93.0	6.52
2	0.224	12.375	353.80	550.50	262.50	247.20	5.80	3.37	94.2	5.33
3	0.224	11.963	412.30	688.70	277.00	249.00	6.90	4.01	93.1	5.68
4	0.259	16.500	317.50	949.35	423.25	189.40	12.30	7.15	87.7	7.09
5	0.665	1.240	467.70	519.30	296.40	157.25	10.10	5.87	89.9	6.44
SE	0.177	0.994	0.177	144.348	51.259	2.638	1.628	0.947	1.63	0.296
SD	0.188	5.924	0.188	353.579	125.558	41.769	3.988	2.319	3.99	0.726
LSD (0.05)	0.377	2.117	0.377	307.606	109.232	5.504	3.469	2.018	3.47	0.632

DISCUSSION

The addition of poultry manure to the soil increased the leaf area, stem diameter, number of leaves, fresh weight and dry weight of *C. moschata* and 31 days after treatment (DAT), all poultry manure treatments showed significantly ($P<0.05$) broader leaf area, stem diameter, number of leaves (Table 1), fresh weight and dry weight of *C. moschata* (Table 2) than the control respectively. This finding is in conformity with the results obtained by Aliyu (2000) and Dauda *et al.* (2005b) who reported increase in growth with increased PM rates. Aliyu (2000) reported that the use of farm yard manure (FYM) plus PM at 5 t PM/ha resulted in higher fruit yield of egg plant. The application of N a major component of poultry manure has been reported to improve the yield of egg plant (Dauda *et al*., 2005b).

The initial chemical compositions of the soil used in this study showed variation from the earlier work of Ayeni (2010). The organic matter, total nitrogen, exchangeable Ca, Mg, and K were quite high except pH and available phosphorus contents of the soil when compared with the work of Ayeni (2010).

The results obtained 2 WAP showed that the poultry manure treatments increased the OM, OC and nutrient content of the soil while the control showed reduction in OM, OC and all nutrients assessed except available P.Among treatments, 5 t PM/ha had the highest value for N, Mg, OM, OC while 2 t PM/ha gave the highest value for K, Ca and Na content of the soil. The pH values varied from control (5.78) to 3 t PM/ha (7.21) while the percentage ash content ranges from 89.2-92.7 % for 5 and 1 t PM/ha respectively. The ash content was not significant among treatments. This result tallies with that of Aliyu (2002, 2003) who reported significant response in yield of pepper to different types of manure rate applications. The yield increases with an increase in PM rates suggest that PM supplied nutrients which enhance vigorous growth which are important indices that culminate in increase in fruit yield. Abou El-Magd *et al* (2006) also reported that application of organic manures plays a direct role in plant growth as a source of all necessary macro and micronutrients in available forms during mineralization, thereby improving both the physical and the biological properties of the soil.

However, the results obtained 6 WAP was not consistent with the trend of results obtained 2 WAP. Boateng *et al* (2006) reported that poultry manure application rate of 4 t/ha was the most effective on the growth and yield of maize. This is because as the yields (biomass and grain) increased linearly up to this level of application, higher applications to 6 and 8 t pm/ha continued to increase maize yields at a reduced rate, a probable case of diminishing returns. The organic matter component of PM decomposed and nutrients were released to soil. Hence the finding that PM increased soil N, P, K, Ca, and Mg significantly. The increases in soil fertility is consistent with findings of previous studies that amendment of soil using poultry manure improved soil OM, N, P, K, Ca and Mg (Kingery *et al.*, 1993; Adeniyan and Ojeniyi, 2005; Akanni, 2005; Adenawoola and Adejoro, 2005). The increased availability of nutrients in soil due to application of the manure expectedly led to increased uptake of N, P, K, Ca, and Mg. The finding that PM significantly increased growth and grain yield of sorghum is attributable to improved soil physical and chemical properties.

CONCLUSION:

The availability of nutrients influenced plant growth and could determine community structure. It is possible to generalize about the response of plants to limited amounts of most nutrients. This study has, however, shown that although the soil nutrient contents were reduced in the soil due its uptake by *C. moschata*, they

Scientia Africana, Vol. 11 (No.1), June 2012. pp 84-91
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were increased with fertilization. The use of poultry manures at 5 t PM/ha is therefore recommended for growing of *C. moschata* and improvement of soil nutrient level.

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