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Growth and Yield Response of Cowpea (*Vigna unguiculata*) to Poultry and Cattle Manure as Amendments on Sandy Loam Soil Plot

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Abstract: The effect of cattle and poultry manures on growth and yield of TV×3236 cowpea (*Vigna unguiculata*) variety was investigated. The effect of added manures on the fertility and salinity levels of the receiving soil was also evaluated on 10×20 m sandy loam plot containing eight 10×2 m ridges. After the establishment of the cowpea crops, plant parameters like height, stem girth and leaf area index were measured while the yield parameters like average length of one pod, number of pod/stand, weight of 20 grains and total weight of bean grain per 20 m^2 were also measured. It was observed from the results that a combination of poultry and cattle manures gave better leaf area of 1.445 cm over either of cattle and poultry manure which were 1.191 and 1.215 cm, respectively. Other growth parameters were affected by the application of these manures if compared with crop on the control plot. The plot treated with poultry waste alone has the highest yield of 854 kg ha^{-1}. The applied manures have significant effect on soil chemical and organic parameters. Soil organic matter for instance increased from 438 mg L^{-1} for control plot to 865 mg L^{-1} on poultry and cattle manure plot while the electrical conductivity increased from 66.7-90 dS m^{-1}. It can be concluded from this research that while the effect of organic manure on the fertility level of soil is high, its usage should also be regulated to avoid salt build up that can render the receiving soil too saline.

Key words: Amendment, growth, manures, sandy loam soil and yield, plot, poultry

INTRODUCTION

Animal manures and compost have been used since, earliest civilizations for improving soil property. In years gone by these fertilizers were the only sources of nutrient for crops production. Though, they contain relatively low concentrations of nutrients and handing them is labour intensive, there has been largely increase in their use over inorganic fertilizers as nutrient source on many farms (Kannan *et al*., 2005). Their beneficial effects on soil physical properties and the ease with which they decompose inside soil are major advantage they have over inorganic fertilizers.

Their effects on soil is manifold, it can increase the nutrient availability; alter chemical properties of the solid such as salinity, sodicity and pH (Alabadan *et al*., 2009). They can also improve organic matter as well as physical property of the soil such as bulk density, aggregate stability, aggregation, crust strength and water infiltration (Zeidan, 2007). Allowing manure to flow into surface water can give rise to pollution, time has therefore come when one must worry about the impact of organic manure on the soil and crop production and also its effect on the environment and human's health. Considerations such as appropriate rate, timing and method of application and expected crop response are important when using manure as a source of plant nutrient. Crop may suffer from deficiency and injury as a result of under application and over application, respectively both leading to reduced yield (Saleh *et al*., 2003).

Cowpea (*Vigna unguiculata)* is a legume grown in savannah region, the tropics and sub-tropics. It is largely grown in West and Central African countries. It value lies with high protein content, its ability to tolerate drought and the fact that it fixes atmospheric nitrogen if allowed to grow on a poor soil (Akinyele *et al*., 1986). The ability of cowpea plant to tolerate drought and poor soil makes it an important crop in the savannah region where these constraints restrict other crops. Its grain is nutritious and is a cheap source of protein for both rural and urban consumers. Its grain contains about 25% protein and 64% carbohydrate, it is also a genuine African crop for hay and forage production (Chinma *et al*., 2008).

The 1st step in good management of any product is to understand the nature of the material. A practical approach to poultry manure handling is to characterize the

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waste material before it can be appropriately used as soil amendment because variation is introduced by differences in species of animal used, housing systems and age even within a specific operation, the characteristics of the manure will be influenced greatly by the ration, the type of bedding and the handling system (Zeidan, 2007). Cattle manure is a combination of faeces, bedding material, wasted feed and water. It has high organic matter content. The organic fraction of manure plays an important role in increasing soil organic matter and tilth, improving soil structure and soil infiltration capacity (Reyhan and Amiraslani, 2006). Many of the nutrients in the manure, however are tied up in the organic fraction and must go through a decomposition process to be converted to the inorganic forms available for plant uptake (Kannan and Saravanan, 2006). Getting the maximum value out of cattle manure requires applying the manure at proper rates and frequency. Over application can lead to transport of nutrients into the groundwater through leaching or overland flow and can also lead to losses of ammonia and nitrous oxide into the atmosphere (Gerard *et al*., 1982).

Several studies have been conducted to know the negative impact of organic fertilizer on soil; Reyhan and Amiraslani (2006) stated that the applications of cattle feedlot manure at the rate of 90 mg/ha/year increased the electrical conductivity of a soil in southern Alberta by about 6 dS m^{-1} and the sodium adsorption ratio by about 3 mol dm^{-1}. Kannan and Saravanan (2006) reported that repeated annual applications of manure which has high salt content caused a build-up of soluble salts in the soils to the extent of lowering crop productivity. Also, Assefa reported that four annual applications of solid dairy manure at an average rate of 158 Mg ha^{-1} reduced the yield of Sudan grass due to salinity. In a study that was conducted in the Peace river region of Alberta, single manure application to soils at rates as high as 176 kL ha^{-1} of hog or 185 Mg ha^{-1} of cattle manure did not pose any significant problem of salinity. In the same study in Central Africa, however four annual applications of cattle manure at the rate of 15 Mg ha^{-1} increased the salinity (EC) of the soil from 0.3 dS m^{-1} to 1.6 dS m^{-1} and increased the sodicity (Sodium Adsorption Ratio, SAR) from 0.7-1.7 (Saleh *et al*., 2003).

An application of manure at 40 g kg^{-1} of soil increased the pH from 4.8-6 and from 5.5-6.3 for fresh or composted animal manure applications. Ramadan and Adam (2007) then suggested that the increase in pH of an acid soil following manure addition was only partially due to buffering from bicarbonates since they did not detect carbonate in either the manure or soils examined in their study. They proposed that compounds other than carbonates and bicarbonates such as organic acids with carboxyl and phenolic hydroxyl groups have important roles in buffering soil acidity and increasing the pH of acid soils amended with manure. Their conclusion was that the effects of manure on soil pH would depend on the manure source and soil characteristics. Manure has been recognized throughout recorded history as an excellent soil amendment that can be used as organic fertilizer however, they are also known to have negative effects on soil if not handled appropriately and therefore study needs to be conducted to ascertain the extent of positive and negative effect of this cheap but important resource. The objectives of this study are therefore to evaluate the effect of poultry and cattle manure on cowpea production and to evaluate the salinity effect of the two organic manures on the soil under cultivation.

MATERIALS AND METHODS

The experiment was conducted on a 10×20 m plot along London street in Chanchaga local government area of Niger state. The site lies on latitude 09°30′ and longitude 06°32′ (Chukwu *et al*., 2008) with the average annual rainfall of 1287.4 mm. Soil samples were taken from the selected site and taken to laboratory for physical properties and textural class determination. Eight 10×2 m ridges were then made on the plot. The study is aimed at investigating the effect of cattle and poultry manures either used alone or combined together on its soil amendment effect and the yield of cowpea using the same application ratio. Therefore, cattle manure was obtained from local cattle farm at Gbeganu village in the same local government.

The poultry manure was collected from the rearing section of a local poultry farm where the birds were under 16 weeks old and kept under deep litre system on floors with sawdust. The manures were weighed and 10 kg each of poultry and cattle manure were applied to the cultivated ridge one to four, respectively. Ridge five and six were treated with a mixture of poultry and cattle manure mixed at equal proportions while the last ridge seven and eight were left untreated to serve as control. The applied manure was allowed to mix well with the soil by light irrigation with portable sprinkler system once daily for 3 days. TV×3236 cowpea variety was then planted at the rate of three seeds per stand at 45 cm intra-row spacing. The treatments with manure were done at 2 weeks interval three times after the establishment of the crops.

Plant parameters measurement: The plant parameters measured were the Heights (H), Stem Girth (SG) and Leaf Area Index (LAI). Plant height was measured using a meter rule while the leaf area (cm^2) calculated as the

product of the total length and breadth at the broadest point of the longest leaf on the plant. Stem girth (cm) was measured with vernier caliper. This was done four times at 2 weeks interval during the growing period of the crop.

Calculations:

$$\text{Leaf Area (LA)} = \text{Laminal length} \times \text{maximum width} \times 0.75$$

$$\text{Leaf Area Index (LAI)} = \text{LA} \times n$$

where, n is number of ridges. Physicochemical parameters of the soil samples were also analyzed before and after the application of the manure. After fruiting, some harvested pod were also taken randomly and assessed for parameters needed to calculate the yield like number of pod per stand and number of grain per pod to ascertain whether the applied manure has any effect on the yield of the cowpea variety.

RESULTS AND DISCUSSION

The results of all the parameters measured are showed in Table 1. Both manures have significant effects on both the soil properties and growth parameters of the cowpea variety used. From Table 1, the average bulk density of the soil is calculated to be 1.50 g cm^{-3}. From the textural class determination using sieve analysis method, it was observed that the soil is sandy loam with 55% sand, 26% clay and 19% silt. From Table 2, there was a remarkable increase in all the growth parameters for all the treatments over the control.

All the growth parameters were affected by manure application. Also, poultry manure alone led to remarkable difference in height, leaf and stem diameter while combination of poultry and cattle manures (p+c) gave better leaf area compared to the use of either of the manures alone. The improvement in crop parameters is associated with increase nitrogen, phosphorus and potassium levels in the soil as affirmed by Reyhan and Amiraslani (2006).

Table 3 shows that the plot treated with poultry waste has the highest yield followed by that of a mixture of poultry and cattle manure. One will expect the plot treated with cattle manure to yield more than the control plot but converse is the case. This is in line with the findings of Reyhan and Amiraslani (2006) that the efficiency of cowpea is high but may be inhibited by the application of cattle manure. It may also be traced to the salinity effect which if too high in cattle manure may affect the yield considerably. Table 4 shows that application of organic manures has a significantly effect on soil chemical characteristics. Porosity increased from 0.47 for control plot to 0.88 for plot treated with a combination of poultry and cattle manure. This might be partly due to Obi and Ebo's findings that application of organic manure enhances the promotion of biological activity which in turn increases the organic matter content of soil. The pH value increased for all the three treatment with combination poultry and cattle manure having highest of 8.2 as against 6.4 on the control plot. This may be due to the increase in availability of P and K in the soil. This may also be in line with the findings of Dewi that plots treated with poultry manure do have increase in the carbonate content due to availability of calcium containing materials in poultry feeds.

Table1: Bulk density determination

Samples	Weight of clod in air (g)	Weight of waxed clod (g)	Volume of clod (cm^3)	Volume of waxed clod (cm^3)	Bulk density (g cm^{-3})
1	2.44	2.95	2.5	0.638	1.310
2	3.14	3.96	3.0	1.025	1.590
3	6.59	7.68	5.5	1.363	1.593
4	5.51	6.58	5.0	1.338	1.505

Table 2: Average plant parameters 6 weeks of manure application

Treatments	Height (H cm)	Leaf Area (LA cm)	Stem girth (SP cm)
Poultry and cattle manure	26.5[a]	1.352	0.096
	29.5[b]	1.445	0.095
	28.5[c]	1.201	0.079
Poultry manure	31.4[a]	1.191	0.076
	30.5[b]	0.880	0.122
	32.5[c]	1.219	0.095
Cattle manure	30.4[a]	1.130	0.108
	29.5[b]	1.215	0.098
	31.2[c]	0.850	0.105
Control	26.5[a]	0.940	0.045
	28.5[b]	0.690	0.052
	27.9[c]	0.960	0.072

[a-c]Letters inside the parentheses indicate 2, 4 and 6 weeks after planting, respectively

Table 3: Average yield from the plot

Yield	Cattle	Poultry	Cattle and poultry	Control
Number of pod per stand	14.00	22.00	17.00	15.00
Average length of one pod (m)	0.10	0.17	0.15	0.09
Average no. of grain per pod	8.00	14.00	10.00	8.00
Weight of 20 grains (g)	5.00	6.00	5.00	5.00
Average no. of pod per 10×2 m ridge	155.00	244.00	189.00	167.00
Total weight of bean grain (g) per 20 m^2	62.00	170.80	94.50	66.80
Yield (kg ha^{-1})	310.00	854.00	472.50	334.00

Health impacts: The 1st health impact associated with the used of animal manure is bad odour from the manure especially poultry manure. Others include the danger of zoonosis and tendency of contacting skin diseases if the

Table 4: Average physicochemical parameters of the soil

	Samples				
Parameters	Control	Cattle	Poultry	Poultry and cattle	Average value before any treatment
Conductivity	68.000	86.000	90.000	73.000	66.700
pH	6.600	7.900	7.700	8.200	6.400
Total alkalinity (mg L^{-1})	255.000	480.000	223.000	354.000	254.000
Total hardness (mg L^{-1})	407.000	434.000	695.000	445.000	405.000
Ca^{2+} (mg L^{-1})	56.000	79.000	101.000	88.000	55.000
Mg^{2+} (mg L^{-1})	332.000	329.000	431.000	202.000	331.000
Sulphate So_4^{2+} (mg L^{-1})	126.000	563.000	765.000	820.000	125.700
Nitrate NO_3^- (mg L^{-1})	255.000	382.000	497.000	356.000	270.000
Fe^{2+} (mg L^{-1})	0.260	0.470	0.790	0.880	0.260
K^{1+} (mg L)	0.332	0.302	0.224	0.232	0.330
Pb^{2+} (mg L^{-1})	0.221	0.204	0.204	0.210	0.253
PO_4 (mg L)	354.000	766.000	1029.000	958.000	362.000
SAR (mg L^{-1})	0.112	0.221	0.241	0.241	0.112
Soil organic matter (mg L^{-1})	438.000	733.000	653.000	865.000	436.000
Porosity	0.470	0.790	0.810	0.880	0.570
Soil redox potential (Eh mv^{-1})	433.000	435.000	538.000	502.000	427.000

person applying is not properly protected. Protection of skin and other part of the body for the person applying the manure is recommended and can be achieved by using hand gloves and other protective wears like nose guard to reduce the health impact while working on the farm.

CONCLUSION

The result of this study has buttressed earlier findings that organic manure in general can provide the necessary nutrients needed by plants for growth. The study also showed that both poultry and cattle manure can provide the fertilizer requirements of cowpea either when applied alone or combined together. Meanwhile, the physical parameters of cowpea on the plot treated with poultry and cattle manure did not give progressive increment in parameters with respect to increasing application rate as some findings have shown, this might be due to accumulation of some chemicals present in the manure that may eventually render the soil saline and thereby reduces crop productivity.

RECOMMENDATIONS

For future improvement on this research, it is recommended that mechanical device should be used in the application of both manure and seed in further studies. Government should also encourage the use of organic fertilizers for their farming activities and a proper method of analyzing the amount of animal manure needed for a particular plot to avoid under or over application problems on fields.

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