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Comparative Effect of Poultry Manure and Cattle Dung on Soil Chemical Properties and Growth Components of *Solanum Macrocarpon*

*[1]Ayeni L. S., [2]Oyebamiji, K. J. and [1]Adeleye, A. A.

[1]Department of Agricultural Science, Adeyemi College of Education, Ondo, Nigeria.
[2]Department of Crop Science, Ayo Babalola University, Arakeji, Ikeji, Osun State, Nigeria.
**Corresponding Author's Email: leyesam@gmail.com*

Abstract

Pot and field experiments were conducted at the Teaching and Research Farm of Agricultural Science Department, and the screen-house of the Department of Biology, Adeyemi College of Education, Ondo, South western Nigeria in 2018 to compare the effect of cattle dung (CD) and poultry manure (PM) on soil chemical properties and growth components of *Solanum macrocarpon.* In pot experiment, CD and PM were individually applied as treatments at the rate of 0, 25, 37.5 and 50g/10 kg soil while CD and PM were applied at 0, 5, 7.5 and 10 t ha^{-1} in field experiment. In pot experiment, the treatments were laid out in CRD while RCBD was used in field experiment. All the treatments were replicated three times. Results obtained in pot and field experiments followed the same trend. Relative to control, except 5CD and 5PM, all the treatments significantly increased ($p < 0.05$) growth parameters of *Solanum macrocarpon.* Poultry manure applied at 7.5 and 10 t ha^{-1} had higher increase in growth parameters of *Solanum macrocarpon* than its corresponding 7.5 and 10 t ha^{-1} CD. In screen-house experiment, the increase in fresh leaf weight of *Solanum macrocarpon* were in the order of 10PM > 7.5PM > 10CD > 7.5CD > 5PM > 5CD > Control while the order of fresh leaf weight in field experiment were 7.5PM > 10PM > 10CD > 7.5CD > 5PM > 5CD > Control. Compared with control, except 5CD, all the treatments significantly increased ($p < 0.05$) soil parameters.

Keywords: Growth, chlorophyll, nutrients, organic manure, soil chemical properties

1. Introduction

Many researchers have advocated for the use of organic fertilizers for growing arable crops especially vegetable crops (Makinde,, Ayeni, & Ojeniyi, 2010, Schppers, 2000, Anosike,., Abonyi, & Ubaka, 2011) because organic manures have less adverse effects on soils and human health. The uses of animal wastes as fertilizers serve as environmental sanitation. Garden egg (*Solanum macrocarpon)* has a rich amount of phytochemicals which fight against cancer and due to its high vegetable fibre content which helps stimulate the flow of faeces down the colon (Okunlola & Adeona, 2016).

Therefore, it is important to investigate into the use of locally sourced organic materials, which are cheap, environmentally friendly and probably have long term effect for

improving and sustaining the productivity of soils and arable crops such as *Solanum macrocarpon.* Also, organic manures release their nutrient slowly during decomposition period. About one – half of the nutrients supplied by the poultry manure are recovered by the first crop following application and much of the remaining are held in the humus-like compounds subject to very slow decomposition (Adenawoola & Adejoro, 2005).

Many people prefer organic foods to synthetic foods because of their adverse effect on health. It is observed that organically produced vegetables are more nutritious with longer shelf life than synthetic foods. African leafy vegetables could make a positive contribution to world food security because they are often well adapted to adverse environmental conditions, and are generally resistant to pests and diseases (Chadha., Oluoch & Silue, D. 2007).

Despite the significance importance of *Solanum macrocarpon* , there are little research work on the effect of organic manures such as cattle dung and poultry manure on growth, nutritional quality of the plant in Ondo south western Nigeria. The objectives of this study were to compare the effect of poultry manure and cattle dung on soil chemical properties and growth parameters of African garden eggplant.

2. Materials and Methods

2.1. Site Description

Screen-house and field experiments were carried out at the Research Farm of the Department of Agricultural Science, Adeyemi College of Education, Ondo, Ondo State of Nigeria to compare the effects of poultry manure and cattle dung on soil chemical properties, nutritive value and growth components of African garden eggplant.

Ondo is located in the latitude 070^0, 05^0N, longitude 040^0, 55^0E and at elevation of 381.3m above the sea level (Harpstead, 1975). It belongs to the tropical rain forest zone. The soil is dominated by Alfisols (Harpstead, 1975) and belonged to the Egbeda soil series, which is derived from fine grained biotitegnesis (Smyth and Montgomery, 1962). Ondo has bimodal rainfall pattern. Evidence has shown that the land had been in use for planting various crops in the past. The land was fairly flat with gentle slope.

2.2. Sources of Materials

The Garden egg seeds were bought from NIHORT, Ibadan, Oyo State of Nigeria. Fresh poultry manure was collected from a local poultry farm in Ondo while cattle dung was collected from abattoir in Ondo.

Washed river sand was collected from the river near the Research Farm of the Department of Agricultural Science, Adeyemi College of Education, Ondo. The soil sample was bulked, air-dried for two weeks and sieved through a 2mm mesh.

2.3. Experimental Design and Lay Out

Poultry manure at 0, 25, 37.5 and 50g to represent 0, 5, 7.5 and 10 t ha^{-1} and cattle dung at 0, 25, 37.5 and 50g to represent 0, 5, 7.5 and 10 t ha^{-1} were individually applied to 10 kg soil in a perforated poly pot. The treatments were placed on raised platform in the screen- house. The treatments were replicated three times and arranged on completely randomized design.

The treatments were watered with equal volume of water every week. Hands were used to uproot the weeds in the screen-house.

2.4. Soil chemical properties determination

The initial and final soil analyses were carried out to determine the amount of plant nutrients present in the soil before the conduct of the experiment and then determined the residual effect of poultry manure and cattle dung after the harvest of *Solanum macrocarpon* in both screen-house and field experiments. Soil samples were randomly collected, bulked, air dried and sieved through 2mm mesh for initial analysis while soil samples were collected per pot or plot in final analysis. The pH of the two soils was determined in 1:2 soil – water ratio. Organic carbon was determined by Walkely and Black (1962) Method, total nitrogen was determined by Mickrockjedahl method (Jackson, 1962) and available phosphorus was extracted with Bray – 1 – method and determined colourimetrically (Bray and Kurtz,1945). Exchangeable potassium, Calcium and Magnesium were extracted with neutral ammonium acetate and determined by Atomic Absorption Spectrophotometer (AAS). The micronutrients were extracted with hydrochloric acid and determined by AAS (AOAC, 2000).

2.5. Organic Materials Analysis

The nutrient composition of powdered poultry manure and cocoa husk ash were also determined after ashing in the muffle furnace. Total N was determined by Kjedahl method. For other nutrients, ground samples were subjected to wet digestion using 25 – 5 – 5 ml of HNO_3 – H_2SO_4 – $HClO_4$ acids (A.O.A.C, 2000). The filtrate was used for nutrients determination as done in routine soil analysis. Total P was determined by colorimeter, K by flame photometer and Ca, Mg, Fe, Cu, Zn and Mn by AAS.

2.6. Field Experiment

The land was manually cleared, stumped, mapped out, pegged and made into twenty eight beds. The size of each plot was 4m x 4m with alley way of 1m apart.

2.7. Experimental Design and Procedure

The field experiment was laid out in randomized complete block design and replicated three times. Three levels of each of the poultry manure and cattle dung at 0, 5, 7.5 and 10 t ha $^{-1}$ were formulated as treatments. The fresh poultry manure and cattle dung was each cured for two weeks under shade before they were applied as treatments. Poultry manure, and cattle dung were incorporated into the soil with local hoe two weeks before the eggplants seedlings were transplanted into the plots. The seedlings of eggplants were transplanted at a spacing of 60cm x 60cm. Weeding was carried out at three weeks interval using hand hoe.

Leaf Area was determined by graphical method at 50% flowering by collecting three (5) leaves from each plot, transported inside a well labeled paper envelope into the laboratory. The leaves were placed on a graph paper of 2mm by 2mm dimension of traced out.

Plant height was measured from the tip of the plant to the base of the plant by using measuring rule. Fresh leaves were plucked from the tagged eggplant and weighed with a

sensitive scale immediately after they were harvested. Data on number of leaves and branches were determined by visual counting. Dry on stem weight was determined by collecting fresh leaves from each pot and transported inside a well labeled paper envelope to the laboratory. The leaves were put inside the oven at low temperature (65^0C) and weighed after drying. Fresh root weight was determined by uprooting the roots and washed with water, air dried and removed from the stem before weighing with sensitive scales. The root was removed from the stem to determine the dry root weight. The roots were washed with water, air dried and packed inside a well labelled paper envelope and put inside a hot air oven pre-set to a reduced temperature of 65^0C until constant weight was recorded. Root dry matter = Root wet weight - Root dry weight.

Chlorophyll was extracted with ice-cold acetone until the samples became colourless. The crude extract (50 ml) was taken in a separating funnel; 100 ml of petroleum ether and 100 ml of aqueous sodium chloride (25%, w/v) were added, after mixing well, the upper layer was separated. The absorbance of the solution was read 663nm, 645nm and 450nm against the solvent blank respectively.

2.8. Data Analysis

Data collected was subjected to analysis of Variance (ANOVA) using Statistical Packages (SAS) where there is significant differences the means were separated using Duncan Multiple Range Test (DMRT).

3. Results and Discussion

3.1. Initial soil properties

The data in Table 1 shows the properties of the soil used for the conduct of the experiments before the treatments were applied. The soils were slightly acidic, low in OM, total N, available P and Ca. The soil was fairly adequate in Mg, Mn, Fe and Cu. Based on the established critical level of 3% organic matter, 0.15% total N, 8 -10 mg/kg available P. The soils were deficiency in OM, N, P, K and Mg but adequate in Ca and Mg (Ogunwale, (2002), Adebusuyi, (1985), Sobulo and Osiname (1987), Agboola and Corey, 1977). The deficient in OM, N, P, and K status and its acidic nature were expected to benefit from application of organic manures.

The nutrients composition of poultry manure and cattle dung used as treatments in the conduct of the experiments are shown in Table 2. Poultry manure and cattle dung had reasonable amount of N, P, K, Ca, Mg, Fe, Cu and Zn. This is in line with the assertion of Ayeni (2008) that animal manures comprised reasonable amount of plant nutrients that could be used to increase nutrient status of infertile soils. Poultry manure had higher amount of N, P, K, Ca, Mg and Cu than cattle dung while cattle dung had higher amount of Fe and Zn than poultry manure. This result shows that poultry manure might have added more N, P, K, Ca, Mg and Zn to the soil for eggplant uptake than cattle dung.

Table 1: Initial Soil Properties

Properties	Field	Screen-house
pH (H_20)	5.42	6.97
Org. Matter (%)	2.15	0.40
Total N (g/kg)	1.06	0.09
Avail P (mg kg^{-1})	7.41	0.37
Ca(Cmol kg^{-1})	0.21	3.62
Mg "	2.36	0.14
Na "	1.52	0.05
K "	0.63	0.35
Exch. Ac. "	0.62	1.00
CEC "	4.72	3.81
TEB	5.34	4.81
Base Sat. %	88.39	79.21
Mn (mg kg^{-1})	3.60	1.08
Fe "	9.60	1.72
Cu "	1.60	1.10
Sand (%)	76.00	88.00
Clay (%)	10.48	7.12
Silt (%)	13.52	4.88
Textural class	sandy loam	sandy clay

Table 2: Nutrients Composition of Poultry Manure and Cattle Dung (%)

Manure	OC	N	C/N	P	K	Ca	Mg	Fe^{2+}	Cu^{2+}	Zn2+
Poultry manure	20.4	2.41	8.46	3.9	3.2	2.6	0.69	0.03	0.11	1.40
Cattle dung	22.4	1.23	18.21	0.76	0.34	0.71	0.3	0.11	0.20	1.24

The effect of poultry manure (PM) and cattle dung (CD) on growth parameters of *Solanum macrocarpon* is shown in Table 3. Relative to control, except 5CD and 5PM, all the treatments significantly increased ($p < 0.05$) plant height, number of leaves, root length, fresh leaf weight, biomass weight and leaf area of *Solanum macrocarpon.* It was observed that poultry dung applied at 7.5 and 10 t ha^{-1} had higher increase in plant height, number of leaves, stem weight, fresh leaf weight, biomass and root length of *Solanum macrocarpon* than its corresponding cattle dung. The better performance of poultry manure on agronomic parameters of *Solanum macrocarpon* might be as a result of its higher nutrients especially N, P and K than cattle dung. John *et al*. (2004) reported that poultry manure contains essential nutrient elements associated with high photosynthetic activities and thus promotes roots and vegetative growth. Nitrogen is known to increase vegetative growth of plants, P increases root formation and growth while K helps in osmotic pull of water from the soil, starch translocation as well as guiding against logging of plants. The balance plant nutrition enjoyed

by the plants treated with 7.5 and 10 t ha $^{-1}$ PM as well as its lower C:N ratio than CD might led to the better performance of PM over CD at all rates. This observation is in line with the work of Dauda, Aliyu and Chiezy (2005) who observed that poultry manure has profound effect on the vegetative development of garden eggs and it ensures healthy and vigorous growth of the crop. Ibeawuchi,. Onweremadu and Oti (2006) also established that poultry manure increased agronomic parameters of *Talinum triangulare* . Ayeni (2010) observed that poultry manure mineralized earlier than cattle dung in an incubation experiment conducted to show the rate of mineralization of N form poultry manure and cattle dung in selected Nigeria soils. Moyin – Jesu *et al,* (2012) reported quick release of nutrient by manure with low C/N.

Table 3: Effect of poultry manure and cattle dung on growth and leaf chlorophyll content of *Solanum macrocarpon* in Screen-house

Treatment	plant height (cm)	No of leaves	Leaf area cm^2	Fresh leaf weight (g)	Dry leaf (g)	Biomass (g)	Root length (cm)	Fresh root weight (g)	Chlorophyll (%)
C	22.5b	6.67a	10.12c	6.27d	3.17c	6.69c	22.33c	2.87d	14.24b
5CD	23.67b	7.00a	12.00c	8.83d	5.22c	9.26c	28.00b	4.13c	14.70a
7.5CD	31.50a	10.00a	17.23b	14.00c	8.63c	14.54b	30.33b	8.00b	18.85a
10CD	39.83a	10.00a	19.45b	16.00c	8.99c	16.73b	37.00a	6.03c	18.97a
5PD	24.17b	7.67a	13.11c	10.63c	5.91c	11.28bc	27.33b	5.86c	15.63b
7.5PD	41.33a	11.33a	23.00a	20.53b	11.21b	21.76a	36.00ab	14.00a	20.70a
10PD	44.33a	11.00a	23.12a	27.57a	15.70a	22.77a	29.66b	11.10b	20.99a

Mean with the same letter are not significantly different at 5% using Duncan Multiple Range Test

It was observed in this experiment that agronomic parameters of *Solanum macrocarpon* increased as the rate of poultry manure and cattle dung increased. The increase in growth with increasing rates of poultry manure and cattle dung was in agreement with the findings of Dauda, Aliyu and Chiezy. (2005) in the experiment performed to determine the effect of poultry manure on growth and yield of watermelon (*Citrullus lanatus*). The lower performance in the Solanum treated with 5 t ha $^{-1}$ of both PM and CD might be as a result of their insufficient nutrients. Application of 5 t ha -^{1}of P*M* and CD might be too small to impact meaningful effect on the growth of *Solanum macrocarpon.* Many researchers (Ayeni,, Saliyu, Oyegbile, & Kawsar 2015, Ojeniyi, 2000) recommend 10 t ha $^{-1}$ of organic manures as adequate for optimum production of arable crops in south western Nigeria. This experiment shows that 7.5 t ha $^{-1}$ of organic manures could compete favourably with 10 t ha $^{-1}$ ha of organic manures in increasing growth parameters of *Solanum macrocapon.* This would depend on the type and age of the animal, type of feeds given to the animal as well as handling method of the organic manure used in the experiment (Ayeni *et al*., 2015).

Compared with control, except 5CD and 5PM, all the treatments significantly increased the chlorophyll content of the leaves of *Solanum macrocarpon (Table 3)*. John *et al*. (2004) reported that poultry manure contains essential nutrient elements associated with high photosynthetic activities and thus promotes roots and vegetative growth. Chlorophyll is one of the components of photosynthesis which helps in the formation of carbohydrate.

The effect of poultry manure and cattle dung on growth parameters of African eggplant *(Solanum macrocarpon)* in field experiment is shown in Table 4. The growth pattern followed the same trend as observed in screen-house experiment. Relative to control, all the treatments (except 5CD and 5PM) significantly increased ($p < 0.05$) plant height, number of branches, fresh leaf weight and chlorophyll content of *Solanum macrocarpon.* Application of 7.5 and 10 t ha^{-1} poultry manure significantly increased ($p < 0.05$) the number of leaves and biomass of *Solanum macrocarpon.*

Table 4: Effect of Poultry Manure and Cattle Dung on Growth and Leaf Chlorophyll Content of *Solanum Macrocarpon* in Field Experiment

Treatment	plant height (cm)	No of leaves	No of branches	Leaf area cm^2	Fresh leaf weight (g)	Dry leaf (g)	Biomass (g)	Root length (cm)	Chlorophyll (%)
C	60.31b	70.13b	6.70b	223.60d	61.21c	30.99d	350.01d	42.52a	34b
5CD	60.00b	72.32b	6.30ab	336.12c	71.83c	41.70c	400.45c	40.41a	40b
7.5CD	65.82a	71.31b	7.30a	458.21b	95.04b	50.58b	497.47d	36.00a	62a
10CD	65.00a	76.43b	5.71b	453.01c	92.01b	49.96b	462.61c	40.12a	64a
5PD	58.00b	64.30c	7.05a	336.33c	77.32c	42.28c	460.13c	40.30a	43b
7.5PD	69.01a	89.17a	8.32a	669.41a	109.41a	60.18a	660.19b	38.23a	65a
10PD	68.60a	94.17a	8.00a	692.10a	106.80a	60.47a	680.00a	41.00a	65a

Mean with the same letter are not significantly different at 5% using Duncan Multiple Range Test

The Effect of poultry manure and cattle dung on soil chemical properties of *Solanum macrocarpon.*in Screen-house Experiment is shown in Table 5. Compared with control, except 5CD, all the treatments significantly increased ($p < 0.05$) the soil pH, available Ca, Mg, available K, Na, ECEC, BS and total N. Cattle dung applied at 5 t ha $^{-1}$ significantly increased ,exchange acidity. The reduction of exchange acidity by poultry manure and cattle dung applied at 7.5 and 10 t ha $^{-1}$ showed their liming effect. It was observed that 7.5 and 10PM recorded higher pH, Mg, K, OM and available P than their corresponding 7.5 and 10 t ha $^{-1}$ CD. This shows the superiority of poultry manure over cattle dung in increasing soil nutrients. Cattle dung and poultry manure applied at all rates had no significance difference on Mn, Fe, Cu and Zn compared to the control experiment. The rates at which cattle dung

and poultry manure released the micronutrients under study were not consistent. This finding is in line with the work of Ayeni *et al*., (2015) which showed that animal manures are not consistent in their release of nutrients for plant use.

Table 5: Effect of Poultry Manure and Cattle Dung on Soil Chemical Properties after the Harvest of *Solanum Macrocarpon i*n Screen-House Experiment

		Exchangeable bases						Base	Total		Av. P		Micro-nutrients		
treatment	pH	Ca	Mg	K	Na	Al+H	ECEC	Sat	N	OM	P	Mn	Fe	Cu	Zn
		cmol/kg	cmol/kg	cmol/kg	cmol/kg	cmol/kg	cmol/kg	%	%	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Control	5.02c	1.11c	0.12c	0.04b	0.02b	0.15a	1.36b	89a	0.03b	0.42b	4.52b	10.11a	2.40a	0.40a	1.03a
5CD	5.12c	1.12c	0.15c	0.08b	0.08b	0.14a	1.49b	91a	0.07ab	0.47b	4.78b	10.12a	2.62a	0.40a	1.00a
7.5CD	5.43b	1.98ab	0.46b	0.23ab	0.09ab	0.10b	3.88a	95a	0.09a	0.78b	4.78b	11.32a	2.76a	0.44a	1.05a
10CD	5.43b	2.99a	0.47b	0.23ab	0.09ab	0.10b	3.78a	97a	0.09a	0.78b	6.45ab	11.32a	2.66a	0.43a	1.02a
5PM	5.66b	1.98ab	0.45b	0.43a	0.12a	0.10b	3.08a	97a	0.09a	0.52b	4.34b	9.87a	2.45a	0.39a	1.02a
7.5PM	6.17a	2.12a	0.78a	0.67a	0.13a	0.08b	3.78a	97a	0.09a	0.97ab	7.21a	9.05a	2.22a	0.41a	0.91a
10PM	6.51a	2.12a	0.78a	0.95a	0.13a	0.08b	4.08a	98a	1.11a	1.04a	7.00a	9.76a	2.01a	0.41a	1.00a

Mean with the same letter are not significantly different at 5% using Duncan Multiple Range Test

The effect of poultry manure and cattle dung on soil chemical properties after the harvest of *Solanum macrocarpon* in the field is shown in Table 6. The results in field experiment corroborate with the result obtained in the screen- house experiment. Compare with control, except 5 CD and 5PM, poultry and cattle dung at 7.5 and 10 t ha $^{-1}$ significantly increased ($p < 0.05$) soil pH, exchangeable Ca, Mg and K as well as Na. This is in agreement with the findings of Aboutayeb *et al*, (2014) who reported that chicken manure significantly increased post planting soil P and other essential nutrients above control. Adeleye., Ayeni and Ojeniyi, (2010) also observed that poultry manure increased magnesium content of soil planted with yam. Cattle dung and Poultry manure were able to reduce soil acidity buttressing their liming ability.

4. Conclusion

A screen-house and field experiments were conducted to compare the effect of cattle dung and poultry manure on soil chemical properties and growth components of *Solanum macrocarpon.* The screen-house experiment was followed by the field experiment. In screen-house and field experiments, agronomic parameters of *Solanum macrocarpon* such as pant height, number of leaves, number of branches, leaf area, dry matter and wet leaves were studied. The residual effect of cattle dung and poultry manure on soil chemical properties after the harvest of *Solanum marcrocarpon* were also studied in both screen house and field experiments. Poultry manure applied at 7.5 t ha $^{-1}$compared favourably with its corresponding 10 t ha^{-1}and it is the most suitable level for growing *Solamun macrocarpon* and where poultry manure is not available cattle dung can be used.

Table 6: Effect of Poultry Manure and Cattle Dung on Soil Chemical Properties of *Solanum Macrocarpon i*n Field Experiment

		Exchangeable bases						Base	Total		Av. P	Micro-nutrients			
treatment	pH	Ca	Mg	K	Na	Al+H	ECEC	Sat	N	OM	P	Mn	Fe	Cu	Zn
		cmol/kg	cmol/kg	cmol/kg	cmol/kg	cmol/kg	cmol/kg	%	%	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Control	5.35b	0.19c	1.02c	0.07g	1.37b	0.71a	3.36c	79.00a	0.06d	1.11d	7.22c	18.35a	5.50b	0.84a	3.08d
5CD	5.44b	2.87b	1.05c	0.80f	1.39b	0.51a	6.62b	92.00a	0.12c	2.32c	7.99c	19.99a	6.95a	0.91a	5.68b
7.5CD	6.67a	4.67a	2.12b	1.32d	1.65ab	0.12b	9.88a	99.00a	0.15b	3.12b	7.83c	20.34a	6.67a	0.92a	5.11c
10CD	6.90a	4.98a	2.43b	1.75c	1.67a	0.12b	10.95a	99.00a	0.15b	3.11b	7.98c	23.00a	6.19a	0.88a	5.12a
5PM	5.56b	3.17b	1.05c	0.17e	1.31b	0.40ab	6.11b	79.00a	0.14b	2.37c	9.35b	21.7a	5.95b	0.71a	3.68b
7.5PM	6.88a	4.95a	2.33b	1.99b	1.76a	0.11c	11.14a	99.00a	0.16b	3.93a	10.45b	16.89	5.89b	0.99a	3.69b
10PM	6.92a	4.97a	2.56a	2.23a	1.96a	0.11c	11.83a	99.00a	0.19a	3.97a	15.21a	17.98a	5.98b	0.94a	3.69b

Mean with the same letter are not significantly different at 5% using Duncan Multiple Range Test

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