Middle East Journal of Agriculture Research
Volume: 11 | Issue: 02| April – June| 2022

EISSN: 2706-7955 ISSN: 2077-4605
DOI: 10.36632/mejar/2022.11.2.31
Journal homepage: www.curresweb.com
Pages: 519-526

Suitability of Animal Manure for Melon Production and Soil Performance in an Utisol

B.O. Unagwu, C. Okpara and N. E. Ebido

Department of Soil Science, University of Nigeria, Nsukka, Nsukka 410001, Enugu State, Nigeria

Received: 04 April 2022 **Accepted:** 15 May 2022 **Published:** 30 May 2022

ABSTRACT

Low soil fertility is one major drawback to Egusi melon (*Colocynthis citrullus* L.) production, a popular and premium crop in southeastern Nigeria. To overcome this challenge, this study evaluated the effects of different animal manure types on egusi melon cultivation and on selected soil properties. The experiment was arranged in a completely randomized design with four treatments and three replications. The study treatments were: T1; Cow dung applied at 10 t ha^{-1} of dry mass (10 t DM ha^{-1}), T2; 10 t DM ha^{-1} Poultry manure, T3; 10 t DM ha^{-1} Pig manure, and T4; Control, unamended treatment. Results showed that treatments application had varied significant effects on soil pH, available phosphorus, total nitrogen, and soil organic carbon. Treatments application positively influenced egusi melon growth and yield. Except for number of plant leaves, data on vine length, and stem girth recorded for treatments T1, T2 and T3 did not differ significantly. Similar to the vegetative growth stage, the shoot fresh weight, root fresh weight, shoot dry weight, and root dry weight biomasses did not varied significantly across treatments T1, T2 and T3, except the fresh fruit weight. The animal manure types had similar strength in their effects on the measured soil and Egusi melon growth and yield properties. However, further studies are needed to evaluate the suitability of cow dung, poultry dung and pig manure application for melon production in a nutrient depleted coarse-textured ultisol.

Keywords: Suitability, Manure, Crop Productivity, Egusi Melon, Soil Nutrients,Ultisol

1. Introduction

One of the most essential food crop grown in Nigeria for its edible seeds is Egusi melon (*Colocynthis citrullus* L.) (Ogbonna and Obi, 2007). Egusi melon is a herbaceous plant that belongs to the Cucurbitaceae family similar to crops like: watermelon, cucumber, and pumpkin (Olaniyi and Tella, 2011). Egusi melon is a premium crop in southeastern Nigeria (Igboland). Egusi melon seeds are used for cooking continental dishes (Ogbonna and Obi, 2007). The seeds are nourishing and contain about 53.1% dietary oil, 33.8% protein, water, vitamins and a small amount of P, K, Ca, Zn and Fe and high amino acids content (Nwokolo and Sim, 1987; Setiawan *et al*., 2001; Ogbonna and Obi, 2007). There is a super-high demand for egusi melon in Nigeria, especially, in southeastern Nigeria. Unfortunately, egusi melon production (yields) are generally poor due to low soil nutrient content that is inherently associated with soils of southeastern Nigeria (Unagwu, 2014).

Soil nutrient depletion remains a major challenge that affects agricultural productivity in developing countries (Senjobi *et al*., 2010). One critical factor that contributes to the decline in soil nutrient is increased rate of farm cultivation with little or no soil fertility management practice (nutrient mining approach) by most rural and small scale farmers. It is worth mentioning that most of the foods consumed in Nigeria are produced by rural and small scale farmers. Thus, to meet up the consumers' food demands, these farmers continually cultivate their farmlands without appropriate soil care (soil nutrient management). Unfortunately, because the farmers' farmlands are degraded, their crop productivity continually dwindles, posing great difficulty in satisfying the high food demands. This challenge, nevertheless, could contribute to the inability of Nigeria and some other countries, to attain the FAO goal of achieving food security by 2020.

Corresponding Author: B. O. Unagwu, Department of Soil Science, University of Nigeria, Nsukka, Nsukka 410001, Enugu State, Nigeria.
E-mail: benedict.unagwu@unn.edu.ng; benedictunagwu@yahoo.com

There is need to boost soil productivity, enhance plant growth and yield to ensure food security and food sufficiency. This prospect is achievable through appropriate and adequate fertilizer or manure applications. Organic amendment application is fundamental to sustainable agriculture, because they not only provide huge quantities of macro- and micro-nutrients for good crop growth and high yield performance; they are also environmentally friendly (Amos *et al*., 2015). Although nutrients contained in organic amendments are slowly released, the positive effects of manure application have been reported (Sharma and Mittra, 1991; Ayuso *et al*., 1996; Abou El-Magd *et al*., 2005; Eifediy *et al*., 2017; Unagwu, 2019).

Conversely, chemical fertilizers release nutrients quickly to refill lost soil nutrients and increase crop yields. However, prolong and inapposite application of chemical fertilizers deteriorates soil functional capabilities, affects nutrient availability and its uptake by plants (Kerenhap *et al*., 2007), increase soil acidity, cause nutrient imbalance and soil degradation (Amos *et al*., 2015). Considering the demands for egusi melon in southeastern Nigeria, it is pertinent to increase egusi melon production (yields) to not only satisfy the current local demands but also to boost production for exports. This study assessed the growth and yield performance of egusi melon grown using different animal manure types and evaluated the contributary effects of animal manure application on the chemical properties of a coarse-textured utisol.

2. Materials and Methods

A glasshouse experiment was set up at the University of Nigeria Teaching and Research Farm, Nsukka, between December 2018 and September 2019. Topsoil (0-15 cm) was collected from a fallowed farm. The experiment, four treatments with three replications, were laid out in a completely randomized design. Animal manures (cattle dung, poultry dung, and pig manure) used in the study were obtained from Animal Research Farm of the University. A 44.4 g (equivalent to 10 t/ha of dry mass [10 t DM/ha]) air-dried manure type was thoroughly mixed with a 10 kg air-dried homogenized test soil and thereafter poured into 10 litre pot (25 cm x 22 cm x 16 cm). The treatments were incubated for two months afterwards, Zaki egusi melon seeds, a local variety obtained from Crop Science Department, University of Nigeria, Nsukka, were sown at the rate of three seeds per pot. After seedling emergence, the seedlings were thinned to one seedling per pot. Plant growth parameters were recorded weekly. The vine length, stem girth, leaf length, and leaf width were measured using a flexible meter tape. The number of leaves, number of branches and number of fruits were manually counted. At harvest, egusi melon fruits were weighed to obtain their fresh weight. The fruit girth was measured using flexible meter tape. At about 90 days after planting (DAS) when >50% of plants had stopped producing new flowering buds, egusi melon above-ground biomass (plant shoot) was harvested at about 5.0 cm above the soil surface to avoid soil contamination. Subsequently, the below-ground biomass (plant root) was harvested. Both biomasses (plant shoot and root) were weighed to obtain the fresh shoot and root weights, respectively. Afterwards, the biomasses were air-dried for one week and subsequently weighed to obtain their dry biomass weights.

2.1. Soil Analyses

About 100 g of soil sample was taken from each pot before and after manure application for soil chemical analysis. The manures were also analysed. The Walkley-Black method was used to determine the soil organic carbon (SOC) (Nelson and Sommers, 1996). Phosphorus was obtained by Bray II method (Bray and Kurtz, 1945) while total nitrogen was by the macro Kjeldahl method (Bremner, 1996). Soil pH was obtained using pH meter in a soil: liquid ratio of 1:2.5 suspensions of soil in 0.1 N KCl and distilled water.

2.2. Statistical analysis

Plant and soil data obtained were statistically analysed with GenStat Discovery Edition 4 software, by subjecting the data to analysis of variance (ANOVA). Treatment means were separated at a 5% probability level.

3. Results and Discussion

The test soil is a weathered brownish coarse-textured sandy loam (Table 1). Following Chude *et al*. (2011) soil fertility indices rating, the soil is strongly acidic (5.0-5.5), the SOC (10-14 g kg^{-1}) and available phosphorus (7-20 mg kg^{-1}) contents were moderate while the total N (0.6-1.0 g kg^{-1}) and exchangeable potassium (0.12-2.0 mg kg^{-1}) contents were very low (Table 1). The low soil nutrient and organic matter content associated with the soil test is characteristic of soils in the study area. This is due to bush burning, high temperatures that lead to high rate of organic matter decomposition (Eifediy, 2017), and poor farmers' attitude towards the use of soil amendments and inadequate nutrient application.

Table 1: Physicochemical properties of the test soil

Soil properties	Values
Clay [< 0.002 mm] (g kg^{-1})	170
Silt [0.02-0.002 mm] (g kg^{-1})	80
Fine sand [0.02-0.02 mm] (g kg^{-1})	250
Coarse sand [0.02-2.00 mm] (g kg^{-1})	500
Textural class	Sandy loam
pH_H_2O	4.90
pH_KCl	4.70
Soil organic carbon (g kg^{-1})	13.8
Total nitrogen (g kg^{-1})	0.4
Available P (mg kg^{-1})	8.0
Exchangeable K (mg kg^{-1})	0.13

The organic amendments (animal manures**)** varied in their chemical compositions. The pH ranged from 6.9 - 8.5 while the organic carbon content ranged from 167 – 350 g kg^{-1} (Table 2). Poultry manure had the highest organic carbon content while cow dung had the least organic carbon content. Overall, except for total nitrogen content, poultry manure came out top for all the properties analysed (Table 2). The observed differences in the nutrient compositions associated with the manures relative to the test soil, suggests that animal manure application will have significant effects on the soil nutrient status and consequently influence egusi melon growth and yield performance.

Table 2: Chemical composition of animal manure applied

Parameters	Poultry manure	Cow dung	Pig manure
pH_H_2O	8.50	7.30	6.90
pH_KCl	8.20	6.70	6.70
organic carbon (g kg^{-1})	352	167	320
Total nitrogen (g kg^{-1})	18.2	19.6	32.2
Available P (mg kg^{-1})	567	210	410

3.1. Effects of Animal Manure Application on Soil Chemical Properties

Animal manure application had significant effects on the soil chemical properties (Table 3). Soil pH ranged from 4.8 (treatment T4, control unamended treatment) to 5.9 (treatment T2, poultry manure applied at 10 t/ha). Treatments T1 (Cow dung applied at 10 t/ha); T2, and T3 (Pig manure applied at 10 t/ha) increased the soil pH by 4.2-23% relative to treatment T4. Across the manured treatments, treatment T2 had the highest ($p < 0.05$) effect on soil pH while treatment T1 had the least effect. Soil organic carbon (SOC) content varied significantly across treatment applications (Table 3). Treatments T1-T3 had 10-24% higher SOC relative to treatment T4. Treatments T1 and T2 did not differ significantly in their SOC content but were significantly higher compared with treatment T3. For soil N content, treatment T4 recorded low ($p < 0.05$) values relative to T1-T3 (Table 3). Statistically, treatments T1 and T3 not differ in their N content but were significantly lower when compared with treatment T2. Treatment T1 has the least ($p < 0.05$) available P as compared with Treatments T2-T3. Treatment effect on soil available P is as follows; T2 > T3 > T1 > T4. The higher available P recorded for treatments T2 is linked to the huge P composition contained in poultry manure relative to cow and pig manures (Table 2). The significantly ($p <0.05$) higher soil pH observed for treatment T2 is attributed to the high pH that is associated with poultry manure (Table 2) relative to other animal manures. The result obtained is similar to that of Eifediy *et al*. (2017), who reported 5.1-6.5% increase in soil pH following the application of 15 t/ha poultry manure and 15 t/ha cow dung. In a similar study, Unagwu *et al*. (2019) reported an increase in soil pH when poultry manure at 10 t/ha was applied. The authors reported that the soil pH increased with increase in poultry manure application rate. The trend in the effect of treatment application on the chemical properties is thus: T2 > T1 > T3 > T4. The high pH, SOC, and available P associated with treatment T2 is attributed to the huge chemical contents contained in poultry manure relative to pig and cow manures (Table 2). The observed results may suggest why poultry manure is in high demand by farmers relative to other animal manure types.

Table 3: Effects of animal manure on the soil chemical properties 8 weeks after application

Treatments	**pH H_2O**	**pH KCl**	**Soil organic carbon ($g\ kg^{-1}$)**	**Total Nitrogen (%)**	**Available P ($mg\ kg^{-1}$)**
T1	5.5	4.4	26.2	0.17	9.30
T2	5.9	4.9	26.0	0.19	26.6
T3	5.0	4.4	23.2	0.16	14.9
T4	4.8	4.0	21.0	0.06	8.40
LSD (0.05)	**0.07**	**0.05**	**0.90**	**0.02**	**3.46**

T1; Cow dung 10 t/ha, T2; Poultry manure 10 t/ha, T3; Pig manure 10 t/ha, T4; Control, no amendment, OM; organic manure, LSD; Least significant difference at 5% probability

3.2. Effects of Animal Manure on Stem Girth and Number of Plant Leaves

Throughout the growth period, treatments application had varied effects on Egusi stem girth. The stem girth ranged from 1.4 cm (at 21 days after planting, DAS) to 1.97 cm (at 84 DAS). The stem girths for treatments T1 and T3 from 21-84 DAS were non-significantly wider than treatment T4. Beyond 21 DAS, treatment T2 maintained a significantly wider stem girth compared with treatments T1, T3 and T4. The number of plant leaves is presented in Table 4.

Table 4: Effects of animal manure application on stem girth, vine length and number of leaves

Treatments	**21 DAS**	**42 DAS**	**63 DAS**	**84 DAS**
		Treatment effects on stem girth (cm)		
T1	1.53	1.63	1.67	1.73
T2	1.43	1.70	1.83	1.97
T3	1.40	1.53	1.67	1.67
T4	1.40	1.43	1.57	1.53
LSD (0.05)	**0.17**	**0.22**	**0.20**	**0.22**
		Treatment effects on the number of plant leaves		
T1	9.7	40.0	35.0	21.3
T2	9.7	24.0	23.3	25.3
T3	10.3	41.7	30.7	26.3
T4	5.0	16.7	22.7	18.7
LSD (0.05)	**1.6**	**4.80**	**3.90**	**3.30**
		Treatment effects on vine length (cm)		
T1	*	151	179	192
T2	*	147	173	182
T3	*	151	163	174
T4	*	103	136	134
LSD (0.05)	**-**	**3.66**	**4.17**	**6.81**

T1; Cow dung 10 t/ha, T2; Poultry manure 10 t/ha, T3; Pig manure 10 t/ha, T4; Control, no amendment, DAS; Days after sowing, *; data not collected, LSD; Least significant difference at 5% probability, Treatment application had a positive ($p < 0.05$) effect on the number of plant leaves produced, which varied significantly across the amended treatments. Except at 21 DAS and 84 DAS, Treatment T3, as compared with treatments T1 and T2, had significantly ($p < 0.05$) lower number of plant leaves. Throughout the growth period, the number of plant leaves associated with treatments T1 and T2 were not statistically ($p < 0.05$) different. The significantly wider stem girth and greater number of plant leaves produced following treatment application indicate a positive influence of animal manure addition on egusi melon growth. This present result corroborates the findings of Eifediyi *et al*. (2017) who reported that plants in plots treated with 15 t/ha poultry manure produced greater (47.3) number of water-melon leaves relative to cow dung manure applied at the same rate. Dauda *et al*. (2009) observed reported significantly higher amount of plant leaves when 9.9 t/ha poultry manure was applied compared with the control treatment.

3.3. Effects of Animal Manure on Vine Length

Egusi melon vine length was highly ($p < 0.05$) influenced by animal manure addition when compared with treatment T4 (Table 4). Statistically, treatments T1-T3 did not differ in their vine length. The present result is consistent with the results of Adekiya *et al*. (2016), who reported increases in melon plant growth parameters, following animal manure application. A study by Ogbonna and Obi (2007) found that poultry manure applied at 10 t/ha increased the crop vine length 30 DAS. Eifediyi *et al*. (2017) reported that plants grown in plots that received 15 t/ha poultry manure and 15 t/ha cow dung produced statistically the same number of vine leaves both of which were significantly higher relative to the control treatment. Dauda *et al*. (2009) reported significantly longer vine length following the application of 9.9 t/ha poultry manure relative to the unamended control. The increases in stem girth, vine length and the number of leaves recorded for the manured treatments as relative to the unamended control is due to huge amounts of available nutrients in the animal manure applied. More importantly, unlike the control treatment, the soil pH (Table 3) associated with the manure amended pots is within the recommended range 5.0 – 7.0 for vegetable cultivation in acid soils (Masabni and Dainello, 2009), this also contributed to the observed increases in crop performance since soil pH affects a range of nutrient availability in the soil that is essentially needed for crop production. Soil pH also influences nutrient bioavailability, which affects crop growth and development since low nutrient solubility could limit (immobilize) plant nutrients. This is because, bioavailability of nutrient is the quantity of soluble nutrient that is mobilized by root exudates (Neumann and Römheld 2012; Goulding, 2016).

3.4. Effects of animal manure on fruit number produced

Treatments application had significant ($p < 0.05$) effects on the number of fruits produced and on other plant yield parameters measured. Across the amended treatments, treatment T1 had the highest ($p < 0.05$) quantity of egusi melon fruit produced, followed by treatments T3 and T2, which had the least egusi melon fruit produced. Treatments T1, T2 and T3 did not differ statistically (Table 5).

Table 5: Effects of animal manure application on the average number of fruits produced

Treatment	14 DAF	28 DAF	42 DAF	56 DAF
T1	1.67	1.33	1.67	1.68
T2	0.67	1.00	0.67	0.67
T3	1.33	1.33	1.00	1.36
T4	0.33	0.33	0.33	0.33
LSD $_{(0.05)}$	**1.09**	**1.08**	**0.75**	**0.76**

T1; Cow dung 10 t/ha, T2; Poultry manure 10 t/ha, T3; Pig manure 10 t/ha, T4; Control, no amendment, DAF; Days after flowering, LSD; Least significant difference at 5% probability

The higher number of egusi melon associated with the amended treatments relative to the control treatment is attributed to the animal manures applied, which provided extra nutrients for plant uptake. Several studies also reported similar results. For instance, Dauda *et al.* (2009) in their study on the effect of different poultry manure rates on watermelon found that higher rates of poultry manure (9.9 t/ha) produced a greater number of fruits relative to lower application rates (3.3 t/ha), while the control treatment produced the least number of fruits. Study has shown that poultry manure has a fast mineralization rate, which makes nutrients available (Eifediyi et al., 2017). The high crop growth performance observed for poultry manure treatment may be due to high decomposition rate (Eifediyi et al., 2017) and higher nutrient status associated with the poultry manure (Table 2). In a field study at Nsukka southeast Nigeria, Ogbonna and Obi (2007) reported increases in the number of egusi melon produced following application of 10 t/ha poultry manure relative to the unamended control treatment.

3.5. Effects of animal manure on plant yield parameters

Treatments T1-T3 had higher ($p < 0.05$) fresh fruit weight (FFW), fruit girth (FG), root dry weight (RDW), root fresh weight (RFW), shoot dry weight (SDW), shoot fresh weight (SFW) relative to treatment T4 (Table 6). It was expected that treatment T1, which had greater number of melon fruit yields (Table 5) would have higher ($p < 0.05$) FFW relative to treatments T2 and T3. On the contrary, treatment T2 had the highest ($p < 0.05$) FFW as compared treatments T2 and T3 (Table 6). Treatment T2 was 12% and 22.2% higher than treatments T1 and T3, respectively; while treatment T1 was higher treatment T3 by 11.6%. Ideally, if a plant produces more fruits than another plant, there are tendencies of producing smaller sized fruits in the former than the later plant. This may account for the lower FFW recorded for treatment T1. Treatment T2 had higher ($p < 0.05$) SFW relative to treatment T1 but was statistically at par with treatment T3. Across treatments T1-T3, no significant difference was observed for FG, RFW, RDW and SDW (Table 6).

Table 6: Effect of animal manure application on fruit and plant yield parameter

Treatments	FFW (g pot^{-1})	FG (cm)	RFW (g pot^{-1})	RDW (g pot^{-1})	SFW (g pot^{-1})	SDW (g pot^{-1})
T1	71.5	16.4	2.4	0.6	16.8	6.5
T2	81.2	18.2	2.2	0.5	23.4	7.5
T3	63.2	16.1	2.0	0.5	20.8	6.7
T4	15.0	5.10	0.8	0.3	9.50	3.0
LSD $_{(0.05)}$	**5.10**	**2.60**	**0.80**	**0.14**	**4.70**	**1.2**

FFW; Fresh fruit weight, FG; Fruit girth, RDW; Root dry weight, RFW; Root fresh weight, SDW; Shoot dry weight, SFW; Shoot fresh weight, T1; Cow dung 10 t/ha, T2; Poultry manure 10 t/ha, T3; Pig manure 10 t/ha, T4; Control, no amendment, LSD; Least significant difference at 5% probability

The results show that animal manures had relatively readily available nutrients for plant uptake resulting in the increases recorded in the plant morphological growth (Tswanya et al., 2017). Increase in FG, RFW and SFW associated with treatments T1-T3 is linked to animal manure's ability to boost plant growth, increase plant's meristematic and physiological activities (Dauda *et al.,* 2009) owing to improved soil properties and supply of plant nutrient. These effects resulted in the synthesis of more photo-assimilates (Dauda *et al.,* 2009) that contributed in the production of higher crop yields and FFW (Tables 5 and 6). In a similar study on okra production, Aniefiok *et al.* (2013) observed that organic manure especially poultry manure increased okra growth. Senjobi *et al*. (2010) found significant increases in the fresh and dry leaf yield and seed yield of scent leaf (*Ocimum gratissimum*) with manure application. Relative to the control treatment, Ogbonna and Obi (2007) reported increases in the fruit (egusi melon) yield when 10 t/ha poultry manure was applied. According to Dauda *et al*. (2009), significant increases in watermelon growth and yield performance over the control treatment were ascribed to the presence of vital plant nutrients contained in poultry manure, which promoted roots development and vegetative growth.

4. Conclusion

Treatments application had varied degrees of effects on the soil chemical properties and plant growth and yield parameters. From these results, it appears that the three animal manure types are relatively suitable for growing melon. Comparatively, treatments T2 (Poultry manure applied 10 t DM/ha), T1 (Cow dung, 10 t DM/ha) and T3 (Pig manure, 10 t DM/ha) were at almost par for most of the plant and soil parameters measured. Typically, treatment T2 stands tall for its effects on soil pH and available P relative to treatments T1 and T3. Further, treatment T2 outperformed treatments T1 and T3 with respect to FFW. Following the results obtained, further experimental (field) studies are needed to evaluate the suitability of cow dung, poultry dung and pig manure application for melon production in a nutrient depleted coarse-textured ultisol.

References

Abou, El-Magd M.M., A.M.Hoda and Z.F. Fawzy, 2005. Relationship, Growth, and Yield of Broccoli with Increasing N, P or K Ratio in a mixture of NPK fertilizers. Annal Agricultural Science Mosh. Journal, 43: 791-805.

Adekiya, A.O., S.O. Ojeniyi and O.E. Owonifari, 2016. Effect of cow dung on soil physical properties, growth and yield of maize (*Zea mays*) in a tropical Alfisol. Scientia Agricola, 15: 374-379.

Amos, H., N. Voncir, A.S. Fagam and A. Garba, 2015. Effect of Cattle Manure on the Growth and Yield Performance of Vegetable Maize (*Zea mays* saccharata) Varieties under Irrigation. Journal of Agriculture and Veterinary Science, 2: 19-32.

Aniefiok, E.K., A.U. Idorenyin and O.S. John, 2013. Effect of poultry manure and plant Spacing on the growth and yield of waterleaf (*Talinum fructicosum* (L.). Journal of Agronomy, 12: 146-152.

Ayuso, M.A., J.A. Pascal-Garcia and T. Hernandez, 1996. Evaluation of Urban Wastes for Agricultural Use. Soil Science and Plant Nutrition journal, 142: 105-111.

Bray, R.H. and N.T. Kurtz, 1945. Determination of total organic and available form of phosphorus in soil. Soil Science, 59: 39- 45.

Chude, V.O., S.O. Olayiwola, A.O. Osho and C.K. Daudu, 2011. Fertilizer Use and Management Practices for Crops in Nigeria (4 ed.). Fertilizer Procurement and Distribution Division (FPDD), Federal Ministry of Agriculture and Rural Development, Abuja. https:// businessdocbox. com/Agriculture/69535682-Edited-by-cv-o-chude-s-o-olayiwola-a-o-osho-c-k-daudu.html. Accessed 12 June 2020.

Dauda, S.N., F.A. Ajayi and E. Ndor, 2009. Growth and yield of watermelon (*Citrullus lanatus*) as affected by poultry manure application. Electronic Journal of Environment, Agriculture and Food Chemistry, 8: 305-311.

El-Shakweer, M.H.A., E.A. El-Sayad and M.S.A. Ewees, 1998. Soil and Plant Analysis as a Guide for Interpretation of the Improvement Efficiency of Organic Conditioners Added to Different Soils in Egypt. Communication in Soil Science and Plant Analysis, 29: 2067-2088.

Eifediy, E.K., S.U. Remison, H.E. Ahamefule, K.O. Azeez and P.O. Fesobi, 2017. Performance of watermelon (*Citrullus lanatus* L.) in response to organic and NPK fertilizers. Acta Universitatis Sapient Agriculture and Environment, 9: 5-17.

Goulding, K.W.T., 2016. Soil acidification and the importance of liming agricultural soils with particular reference to the United Kingdom. Soil Use and Management 32: 390–399.

Kerenhap, W., V.Thiagarajan and V. Kumar, 2007. Biochemical and bioassay studies on the influence of different organic manures on the growth of mulberry variety and Silkworm, Bombyx mori L. Caspian. Journal of Environmental Science, 5: 51-56.

Masabni, J.G. and F.J. Dainello, 2009. Vegetable growers handbook. 4th Ed. Texas A&M University, Texas.

Nelson, D.W. and L.E. Sommers, 1996. Total carbon, organic carbon, and organic matter. In Methods of Soil Analysis: Part 3 Chemical Methods Eds., Sparks, D.L., A.L., Page, P.A., Helmke, R.H., Loeppert, P.N., Soltanpour, M.A., Tabatabai, C.T. Johnston, and M.E. Sumner American Society of Agronomy Monograph No. 9, Madison WI, pp: 961-1010.

Neumann, G. and V. Romheld, 2012. Rhizosphere Chemistry in Relation to Plant Nutrition. In: Mineral Nutrition of Higher Plants ed. Marschnar, A. 3rd Ed. Elservier, New York

Nwokolo, E. and J.S. Sim, 1987. Nutritional Assessment of Defaulted Pumpkin (*Telfaria occidentalis* Hook) by chick assay. Journal of Science Food Agriculture, 38: 237-246.

Ogbonna, P.E. and I.U. Obi, 2007. Effect of time of planting and poultry manure application on growth and yield of egusi melon (*Colocynthis Citrullus* L.) in a derived savannah agro-ecology. Agro-Science, Journal of Agriculture Food Environment and Extension, 6: 33-38.

Olaniyi, J.O. and B.A. Tella, 2011. Effects of Nitrogen and Potassium Fertilizers on the Growth, Seed Yield and Nutritional Values of Egusi Melon (*Citrullus lanatus* (thumb) manf.) in Ogbomoso Southwest Nigeria. International Research Journal of Plant Science, 2(11): 328-331.

Senjobi, B.A. 2007. Comparative Assessment of the Effect of Land Use and Land Type on Soil Degradation and Agricultural Productivity in Ogun State, Nigeria. Unpublished Ph.D. Thesis. Department of Agronomy, University of Ibadan, Nigeria.

Senjobi. B.A., Peluola, C.O., Senjobi, C.T., Lawal, I.O., Ande, O.T. and B.T. Salami, 2010. Performance of *Corchorus olitorius* as Influenced by Soil type and Organic Manure Amendments in Yewa North Local Government Area, Ogun State. African Journal of Biotechnology, 9: 5309-5312.

Setiawan, B., A. Sulaeman, D.W. Giraud and J.A. Driskell, 2001. Carotenoid content of selected Indonesian fruits. Journal of Food Composition and Analysis, 14: 169–17.7

Sharma, A.R. and B.N. Mittra, 1991. Effect of Different Rates of Application of Organic and Inorganic Manure. Journal of Agricultural Science (Cambridge), 117: 313-318.

Tswanya, M.N., K.M. Isah, M. Ahmed, P.Z. Yisa, and S.N. Lile, 2017. Effect of Poultry Droppings on Growth and Fruit Yield of Okra (*Abelmoschus esculentus*). International Journal of Environment Agriculture and Biotechnology, 2: 110-116.

Unagwu, B.O., 2014. Maize performance in a sandy loam ultisol amended with NPK 15:15:15 and poultry manure. African Journal of Agriculture Research, 9: 1020-1024.

Unagwu, B.O., 2019. Organic amendment applied to a degraded soil: short term effect on soil quality indicators. African Journal of Agriculture Research, 14:218-225.

Unagwu, B.O., R.W. Simmons and R.J. Rickson, 2019. Organic amendment and inorganic fertiliser addition: effect on soil nutrient, growth and yield of maize. Middle East Journal of Agriculture Research 8:445-456.