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Comparative Effect of Chemical and Organic Amendments on *Telfairia Occidentals* in Coastal Plain Sands Derived Soil

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The present study was conducted during the 2016/2017 cropping season, to compare the effect of chemical fertilizer, organic manures and wood ash as amendments and their combinations on the soil chemical properties and performance of *Telfairia occidentalis*. The treatments were; (i) Control, (ii) 200 kg/ha NPK 20:10:10 fertilizer, (iii) 5 tonnes/hectre (t/ha) wood ash, (iv) 5 t/ha poultry manure, (v) 100 kg/ha NPK 20:10:10 + 2.5 t/ha wood ash, (vi) 100 kg/ha NPK 20:10:10 + 2.5 t/ha poultry manure, and (vii) 100 kg/ha NPK 20:10:10 + 1.25 t/ha wood ash + 1.25 t/ha poultry manure. The treatments were arranged in a randomized complete block design with three replications. The growth and yield parameters were measured at 6, 9, 12, 15 and 18 weeks after planting (WAP). Results of the chemical properties, lead to better performance on the test crop. The combined application of 100 kg/ha NPK 20:10:10 + 1.25 t/ha wood ash + 1.25 t/ha poultry manure give the highest value for most of the parameters studied. The fresh vegetable yield of fluted pumpkin was significantly (P<0.05) increased across all stages of growth as a result of the amendments relative to the control. The highest yield of 4.78 t/ha at 18 WAP was obtained from the combination of 100 kg/ha NPK 20:10:10 + 1.25 t/ha wood ash + 1.25 t/ha poultry manure. The use of 100 kg/ha NPK 20:10:10 + 1.25 t/ha wood ash + 1.25 t/ha poultry manure is recommended for soil fertility improvements and fluted pumpkin fresh vegetable yield in the study area.

Keywords: Coastal plain sands, fluted pumpkin, interaction, NPK fertilizer, organic manure, vegetable yield

INTRODUCTION

Vegetables like *Telfairia occidentalis* Hook f., popularly known as Fluted pumpkin, is an important vegetable crop belonging to the dicotyledonous family, Cucurbitaceae, and it is widely grown in the rain forest agroecology in Nigeria, where it is prized for its leaves and seeds used as food (Giami, 2004; Ayanwale and Abiola, 2007; Odiaka *et al*, 2008). Although a perennial by nature, it is often cultivated as an annual crop (Ogbonna, 2009). Low soil fertility is identified as a major factor militating against crop production in many tropical cropping systems where fertilizer used is low and agricultural residues are not returned to the soil for its rejuvenation (Eteng, 2015; 2017). Agro ecosystems differ from natural ecosystems in that large amount of biomass and nutrients are removed as crops. Nutrient outputs via crop harvests far exceed the other nutrient loss pathways combined. A long-standing principle of sound agriculture is to replace the nutrient lost via crop harvests by adding either inorganic or organic fertilizers (Eteng, 2017). Aside from adding nutrients, organic additions improve soil physical properties and help maintain soil organic matter content, all of which positively affect plant productivity (Nweke and Nsoanya, 2013). Now, because of the pressure on land and the impracticability of shifting cultivation, chemical fertilizers have been used to boost crop production in the face of reduced fallow periods, but over time, they become less and less effective, and eventually leave the land impoverished with some xenobiotic chemicals, and the soil also depleted of essential nutrients (Ekop and Eddy, 2007). Organic materials are a good source of plant nutrients and have a positive effect on improvement of the soil physical structure. A combined effect of animal and plant materials to agricultural fields are widely used method of increasing soil organic matter and fertility (Eteng, 2015; Ano and Agwu, 2005). Attention is now shifting to the use of organic manures as soil amendment for crop production (Ano *et al*., 2003; Eteng, 2015). The application of poultry droppings, animal manure, sewage sludge, and municipal waste, to agricultural lands solves the problem of biodegradable waste disposal and also improves agricultural productivity (Obasi *et al*., 2008; Odoemelam and Ajunwa, 2008). Ekop *et al* (2011) investigated the effects of poultry droppings in soil on the uptake of some heavy metals in fluted pumpkin, and reported that the concentrations of Fe, Zn, Cu, and Pb in the leaves of plants grown on amended soils were significantly higher than those from control plots, although the values remained below toxic levels. Continuous use of inorganic fertilizers affects soil structure negatively and may even lead to lower yields. Moreover, the use of inorganic fertilizer alone by poor farmers is limited by the high prices, frequently unavailable, and low benefit cost rations (Ano *et al*., 2003; Ano and Agwu, 2005), of the amendment. However, the use of organic fertilizers, such as, animal and plant manures, can serve as alternative to inorganic fertilizers in improving soil structure and fertility (Dauda *et al.,* 2008). These sources of nutrients (e.g. N, P, K etc) when added into the soil passed through the process of mineralization during decomposition (Akinmutimi and Godwin, 2017). Previous studies reported that, organic fertilizer increases soil organic matter content and also improves soil physico-chemical conditions. Soil organic matter performs a biological function as it provides carbon which is an energy source for soil microbes, enhances plant growth and seed germination (Kumbhar *et al.,* 2007). In Nigeria, continual cropping without simultaneous use of manure and organic/inorganic fertilizer has reduced soil fertility, leading to nutrient mining and low crop yields. Integrated use of organic matter and chemical fertilizers is beneficial in improving crop yield, organic carbon and available N, P and K in coastal plain sand soil (Akinmutimi, 2012; Akinmutimi and Godwin, 2017). Fluted pumpkin does well on well drained soils rich in nitrogen, phosphorus and potassium (Lucas and Ojeifo, 1985), and these essential nutrients can be supplied by organic or inorganic fertilizer sources (Moritsuka *et al.,* 2001). Also, like other leafy vegetables, fluted pumpkin performs optimally in non-acidic conditions (Mbonu and Arifalo, 2006). In Southeastern Nigeria where most soils are acidic, wood ash, a proven liming agent, which is known to contain phosphorus and potassium, and is also a good source of some plant micro nutrients (Akinmutimi, 2012), is often used to bring down soil acidity. Recommended wood ash rate of 2.5 t/ha improved the growth and yield of soybean (Soretire and Olayinka, 2013) while recommended fertilizer rate of 250 kg/ha of NPK 15:15:15 fertilizer was used to raise fluted pumpkin (Grubben *et al*., 2004). Poultry manure recommendation for most leafy vegetables to supply 110 kg N, 90 kg P_2O_5 and 90 kg K_2O is 10 t/ha (Grubben *et al*., 2004). This study aims at comparing the effect of interaction of chemical fertilizer, organic manure and wood ash as amendments and their combinations on the performance of *Telfairia occidentalis* in Umudike Southeastern Nigeria.

MATERIALS AND METHODS

Experimental site

The field experiment was conducted at the National Root Crops Research Institute Farm, Umudike, Abia State, Nigeria. The co-ordinates of the field plot lies between Latitude 05°29.059¹ -05°29.082¹N and Longitude 07°32. 197¹-07°32. 205¹E on an elevation of 100 m above sea level. The land had been under cultivation for some time. Umudike is located within the tropical rainforest zone with a mean annual rainfall range of 1512 – 2200 mm, which is distributed over nine to ten months in bimodal rainfall pattern. The monthly minimum air temperature ranges from 20°C to 24°C while the monthly maximum air temperature ranges from 28°C to 35°C. The relative humidity varies from 51% to 87%. The average number of sunshine hours varies from 3 to 7 and appears always lowest in the months of July and August (NRCRI, Umudike Meteorological Station, 2014). The soil of the study area has been classified as Typic Paleudult according to USDA classification. The site was manually cleared, tilled and flat beds made. There were a total of 21 plots; the experimental layout was 10 ×27m (270m^2) with each plot measuring 2 × 3m (6m^2) with 1m spacing between plots and 2m spacing between replicates or blocks. The weather data during the period of the experiment is shown in (Table 1). The monthly maximum air temperature ranged from 29.2°C-35.8°C while the minimum air temperature ranged from 21.9°C- 24.7°C. The total rainfall amount was 2206.8 mm while the average sunshine hours ranged from 3.35-7.36. The relative humidity ranged from 50.8-89.3% at 900 h to 30.8-81.2% at 1500 h.

Experimental design

The experiment was laid out in a randomized complete

Table 1. Weather data in the study area (2016)

Month	Rainfall Amt (mm)	Days	Temperature (°C) Max	Min	Relative humidity (%) 900	1500	Sunshine (H)
January	0	0	22.5	34.1	50.8	30.8	6.95
February	0	0	24.1	35.8	62.0	35.9	4.68
March	266.6	10	24.8	33.3	79.8	65.9	4.42
April	129.3	8	24.7	33.1	78.9	69.7	5.11
May	277.8	16	24.6	31.8	81.9	71.0	5.44
June	324.9	16	21.9	30.1	89.0	71.7	4.67
July	265.1	15	23.6	29.3	88.5	80.9	3.85
August	308.0	22	23.5	29.2	89.3	81.2	3.35
September	312.6	15	23.4	30.1	85.8	76.5	6.23
October	273.4	7	23.5	31.4	80.0	69.0	5.81
November	45.0	2	23.9	32.3	83.1	64.0	7.36
December	4.1	1	23.6	32.6	70.9	51.3	7.36
Total	2206.8	112	284.1	383.1	940.0	767.9	65.23
Mean	183.9	9.3	23.7	31.9	78.3	64.0	5.43

Source: NRCRI, (2016)

block design (RCBD) with three replications. There were seven (7) treatments as follows:

T_1 – Control (no soil amendment)
T_2 – 200 kg/ha N P K 20:10:10
T_3 – 5 t/ha Wood ash
T_4 – 5 t/ha Poultry manure
T_5 – 100 kg/ha N P K 20:10:10 + 2.5 t/ha Wood ash
T_6 – 100 kg/ha N P K 20:10:10 + 2.5 t/ha Poultry manure
T_7 – 100 kg/ha N P K 20:10:10 + 1.25 t/ha Wood ash + 1.25 t/ha Poultry manure

The fluted pumpkin seeds used in the study were obtained from a local market in Ndoro, Ikwuano Local Government Area of Abia State. The poultry manure was from National Root Crops Research Institute, Umudike Poultry Farm, the wood ash was collected from Michael Okpara University of Agriculture, Umudike kitchen while the NPK 20:10:10 fertilizer was purchased from an open market in Umuahia town.

Planting and duration of experiment

The wood ash and poultry manure were incorporated to specified plots one week before planting in line with the method of (Iren *et al.,* 2011). One seed of fluted pumpkin was planted per stand at a spacing of 1 × 1 m (1 m^2) giving a plant population of 10,000 plants ha^{-1}. The NPK 20:10:10 fertilizer was applied to specified plots 4 weeks after planting (4 WAP). The farm was kept weed-free throughout the period of the experiment. The fluted pumpkin crop lasted four months in the field, from 15^{th} August to 19^{th} December, 2016.

Preparation of soil samples, data collection

Before the start of experiment, soil samples were randomly collected at the depth of 0 – 20 cm, bulked together to form a composite sample from which samples were drawn, air-dried, sieved through a 2 mm sieve and kept for the determination of soil physical and chemical properties. This was repeated at the end of the experiment. For each of the 21 plots in the experiment, three plants were sampled and tagged for plant data collection. Measurements were carried out on the tagged plants five times, namely, at 6, 9, 12, 15 and 18 weeks after planting (WAP). The measurements were in respect of four parameters, namely, (i) vine length, (ii) number of leaves per plant, (iii) leaf area (cm^2), and (iv) fresh vegetable yield. Vine length was obtained as the length (cm) of the longest branch, from the base to the tip of a given plant, using a measuring tape at 6, 9, 12, 15 and 18 WAP. Number of leaves was obtained as the number of fully expanded leaves per plant at 6, 9, 12, 15 and 18 WAP. Leaf area (cm^2) was obtained by tracing leaves on a graph sheet, and computing the area as the sum of full and half squares covered by the tracing. The values were obtained at 6, 9, 12, 15 and 18 WAP. For any given plot, fresh vegetable yield was obtained as the total yield (in kg) of fresh vegetables obtained from the plot at the end of the harvests. The weighing was done by the use of a sensitive weighing balance. The total yield was the sum of the yields obtained at 6, 9, 12, 15 and 18 WAP.

Laboratory studies

Soil particle size distribution was done using the

Bouyoucos hydrometer method described by Shadrick and Wang, (1993). Soil pH was determined using a ratio of 1: 2.5 in soil water medium and read with a digital pH – meter (Ibitoye, 2006). Soil total nitrogen was determined by the micro–kjeldahl method (Bremner, 1996). Organic carbon content was determined by Walkley and Black dichromate oxidation method as modified by Nelson and Sommers, (1996). The available phosphorus was extracted by the Bray – 2 extractant methods (Bray and Kurtz, 1945). The exchangeable bases (Ca^{2+}, K^+, Mg^{2+} and Na^+) were extracted with 1 normal (IN) NH_4OAc, using a soil: solution volume ratio of 1:10. The K and Na in the extract were read using a flame photometer, while Ca and Mg were determined by EDTA titration method (IITA, 1989). Exchangeable acidity (H^+ and Al^{3+}) were determined from IN KCl extract and titrated with IN HCl (Hendershot and Lalande, 1993). Effective cation exchange capacity was calculated as the sum of exchangeable bases (Ca^{2+}, Mg^{2+}, K^+, Na^+) and exchangeable acidity (H^+ and Al^{3+}). The percentage base saturation was determined as the total exchangeable bases (TEB) divided by effective cation exchange capacity (ECEC) and multiplied by 100. The wood ash and poultry manure were equally analyzed using wet digestion method.

Data analysis

The data collected were subjected to analysis of variance (ANOVA) for a randomized complete block design (RCBD) and statistically significant means were separated using Fisher's least significant difference (LSD) at 5% level of significance.

RESULTS AND DISCUSSION

Properties of the soil before experiment

The physical and chemical properties of the surface soil (0-20 cm) obtained from the experimental site are presented in (Table 2). The soil of the experimental site was texturally classified as sandy clay loam. The soil was strongly acidic with a pH of 4.2, against the normal range of 5.5 – 6.5 given by Enwezor *et al*. (1990) for soils of Southeastern Nigeria. The soil was low in organic carbon content with the value of 1.32%, which is lower than the critical level of 1.74% given by Ezeaku, (2011) for crop production in tropical and sub tropical soils. The total nitrogen content in the soil (0.084%) was also lower than the critical value of 0.15%. The observation is in agreement with that of Ezeaku, (2011). Available phosphorus value (32.2 mg/kg) obtained in this study exceeded the critical limit of 8-12 mg/kg given by Ezeaku, (2011) and was therefore rated as high. Exchangeable potassium value of 0.083 cmol/kg was very low when compared to the critical level of 0.16 to 0.20 cmol/kg given by Ezeaku, (2011). Enwezor *et al.* (1990) showed that values of effective cation exchange capacity (ECEC) below 6-8 cmol/kg is low, 6-11 cmol/kg (medium) and > 12 cmol/kg is considered high. Therefore, the ECEC (4.82 cmol/kg) of the study area was low. The exchangeable calcium (2.00 cmol/kg) and sodium (0.03 cmol/kg) were also relatively low when compared with the levels recommended by Enwezor *et al.* (1990) for Southeastern Nigeria. The low exchangeable bases and higher exchangeable acidity explains why the soil showed strong acidity of pH 4.2 (Chude *et al*., 2005). This reveals that the soil is highly degraded, which could be due to the climate and parent material of the study area (Akamigbo, 1999) in addition to the manner the land has been used over time. The site was potentially low in fertility and would therefore depend on soil amendments for sustainable agricultural yield.

Properties of the amendments used for the experiment

The chemical composition of the poultry manure and wood ash used in the experiment are presented in (Table 3). From the analysis of the organic amendments used for the study, poultry manure had higher levels of total nitrogen and phosphorus than the wood ash while total potassium, calcium and magnesium were higher in wood ash. A lower C: N ratio of 5.01 obtained from poultry manure showed faster rate of mineralization when compared with a C: N ratio of 6.29 obtained from wood ash. This is similar to results obtained by Iren *et al. (*2014). The poultry manure and the wood ash had high contents of potassium (5.32% and 6.92%), magnesium (0.44% and 0.49%) and sodium (1.72% and 0.44%) respectively. These are capable of improving the buffering potentials of the soil. Their high nitrogen content, (1.89% and 1.05%), organic carbon (9.46% and 6.60%) and organic matter (16.30% and 11.37%) showed the level of nutrient reserve in poultry manure and wood ash which will be released during mineralization. It equally indicated high moisture retentive capacity, soil aggregation and accommodation of different soil organisms which are agents of soil fertility (Nwosu, *et al*., 2013).

Properties of the soil after the experiment

Effects of sole and combined application of NPK (20:10:10), wood ash and poultry manure on soil chemical properties are presented in (Table 4). The results obtained from the study showed that the application of the amendments significantly improved the soil chemical properties (total nitrogen, soil pH, organic

Table 2. Physical and chemical properties of soil of the experimental site before commencement of experiment.

Soil properties	Values
Sand (g/kg)	612
Silt (g/kg)	88
Clay (g/kg)	300
Textural class	Sandy clay loam
pH (H_2O)	4.2
pH (KCl)	3.1
Organic matter (%)	2.37
Organic carbon (%)	1.32
Total nitrogen (%)	0.084
C : N ratio	15.70
Available phosphorus (mg/kg)	32.20
Exchangeable potassium (cmol/kg)	0.08
Exchangeable calcium (cmol/kg)	2.00
Exchangeable magnesium (cmol/kg)	0.40
Exchangeable sodium (cmol/kg)	0.03
Exchangeable acidity (EA) (cmol/kg)	2.32
Effective cation exchange capacity (ECEC) (cmol/kg)	4.82
Total exchangeable bases (TEB) (cmol/kg)	2.50
Base saturation (BS) (%)	51.87

Table 3. Chemical composition of amendments used for the study.

Parameter	Amendments	
	Poultry manure (PM)	Wood ash (WA)
Organic matter (%)	16.30	11.37
Organic carbon (%)	9.46	6.60
Total nitrogen (%)	1.89	1.05
C:N ratio	5.01	6.29
Total P (%)	21.70	7.40
Total K (%)	5.32	6.92
Ca (%)	0.80	0.90
Mg (%)	0.44	0.49
Sodium (%)	1.72	0.44

carbon, organic matter, available phosphorus, exchangeable calcium, magnesium and potassium, effective cation exchange capacity (ECEC), base saturation (BS) and total exchangeable bases (TEB)). With the combined application of 100 kg/ha NPK (20:10:10) + 1.25 t/ha wood ash + 1.25 t/ha poultry manure giving the highest for most of the parameters measured. 100 kg/ha NPK (20:10:10) + 1.25 t/ha wood ash + 1.25 t/ha poultry manure significantly reduced soil acidity from a very strongly acidic level of 4.2 (Table 2) to 5.0 (Table 4). It increased total nitrogen from 0.084 - 0.168%, increased organic carbon from 1.32-1.76%, organic matter from 2.37 - 3.23% and also increased available phosphorus from 32.20 - 64.10 mg/kg. It increased exchangeable magnesium from 0.4-1.6 cmol/kg and base saturation from 51.8-72.3%. However, it was observed that the combination of NPK (20:10:10) with either poultry manure or wood ash increased most of the soil parameter measured. The soils that received 200 kg/ha NPK (20:10:10), 5 t/ha wood ash, 5 t/ha poultry manure, 100 kg/ha NPK (20:10:10) + 2.5 t/ha wood ash and 100 kg/ha NPK (20:10:10) + 2.5 t/ha poultry manure gave significantly higher total nitrogen, organic carbon, base saturation (BS) and total exchangeable bases (TEB). While the soils in combination with 100 kg/ha NPK (20:10:10) + 2.5 t/ha wood ash and 100 kg/ha NPK (20:10:10) + 2.5 t/ha poultry manure gave significantly higher pH, effective cation exchange capacity (ECEC) and exchangeable calcium and magnesium than that of 200 kg/ha NPK (20:10:10) fertilizer (Table 4). This could be due to enhanced release and mineralization of nutrients from the inorganic and organic amendments as a result of the synergistic effects of the NPK (inorganic fertilizer) on organic matter. This result is in agreement with those reported by Adeniyan and Ojeniyi, (2005); Iren et al. (2011) and Olatunji et al. (2012). Organic matter shows a greater capacity to release and retain nutrients in forms that can be easily taken up by plants over a

Table 4. Effects of incorporating chemical and organic amendments on soil chemical properties

Treatment	pH H_2O	pH KCl	Total N (%)	Org. C (%)	Org. M (%)	Av. P (mg/kg)	Ca (cmol/kg)	Mg (cmol/kg)	Na (cmol/kg)	K (cmol/kg)	EA (cmol/kg)	ECEC (cmol/kg)	TEB (cmol/kg)	BS (%)
Control	4.07	2.97	0.070	1.28	2.43	29.50	1.73	0.40	0.18	0.06	2.61	4.99	2.37	47.58
200 kg/ha NPK (20:10:10)	4.40	3.40	0.126	1.54	2.73	35.70	2.13	0.80	0.16	0.24	2.03	5.35	3.33	62.21
5 t/ha Wood ash (WA)	4.85	3.50	0.112	1.52	2.67	41.70	2.53	1.20	0.10	0.10	1.83	5.76	3.93	67.84
5 t/ha Poultry manure (PM)	4.70	3.43	0.131	1.65	2.79	45.3	2.67	1.20	0.15	0.10	1.84	5.96	4.12	69.10
100 kg/ha NPK + 2.5 t/ha WA	4.60	3.50	0.126	1.60	3.07	47.20	3.07	0.93	0.10	0.18	1.65	5.92	4.28	72.24
100 kg/ha NPK + 2.5 t/ha PM	4.50	3.47	0.140	1.71	3.07	46.20	2.87	1.33	0.06	0.24	1.83	6.33	4.50	71.20
100 kg/ha NPK + 1.25 t/ha WA + 1.25 t/ha PM	5.00	3.50	0.168	1.76	3.23	64.1	2.60	1.60	0.08	0.14	1.70	6.11	4.42	72.30
LSD (0.05)	0.40	0.16	0.023	0.22	0.27	13.4	0.46	0.44	NS	0.06	NS	0.65	0.48	4.63

longer period of time. Nutrients released from NPK 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 nutrient buffering capacity and the release of nutrients.

Effects of incorporating chemical and organic amendments on the number of leaves per plant in fluted pumpkin

Figure 1 shows the effects of incorporating NPK 20:10:10, wood ash and poultry manure on the number of leaves per plant in fluted pumpkin at 6, 9, 12, 15 and 18 weeks after planting (WAP). 100 kg/ha NPK 20:10:10 + 1.25 t/ha wood ash + 1.25 t/ha poultry manure (T7) gave the highest number of leaves per plant except, at 12 WAP, followed by 100 kg/ha NPK 20:10:10 + 2.5 t/ha poultry manure (T6) which gave the next higher number of leaves per plant, except at 6 WAP and gave the highest number of leaves per plant at 12 WAP. The control ($T_{1,}$ no amendment), gave the least values for this parameter in all the harvests. The seven treatments differed significantly from each other (P<0.05). 100 kg/ha NPK 20:10:10 + 1.25 t/ha wood ash + 1.25 t/ha poultry manure (T_7) gave higher number of leaves than the solely treated (T_2, T_3 and T_4) as well as the control (T_1) plots. This could be due to enhanced release and mineralization of nutrients from inorganic and organic manures due to synergistic effects of the inorganic fertilizer (NPK) on organic manure. These results are similar to those obtained in the studies reported by Adeniyan and Ojeniyi, (2005), Iren et al. (2011), and Olatunji et al. (2012).

Effects of incorporating chemical and organic amendments on the vine length of fluted pumpkin

The effects of incorporating NPK 20:10:10 fertilizer, wood ash and poultry manure on vine length in fluted pumpkin at 6, 9, 12, 15 and18 weeks after planting (WAP) are shown in the form of a graph in (Figure 2). As shown in (Figure 2), the treatments differed significantly (P<0.05) among themselves in respect of this character. Incorporating 100 kg/ha NPK 20:10:10 + 1.25 t/ha wood ash + 1.25 t/ha poultry manure (T7) gave the highest vine length values except at 6WAP, followed by the plots treated with 5 t/ha poultry manure (T_4), which gave a higher vine length at 9 WAP and 18 WAP, then the plots treated with 100 kg/ha NPK 20:10:10 + 2.5 t/ha poultry manure (T_6), which gave higher vine length at 9 WAP and 18 WAP. The control gave the least vine length values in all the harvests. 100 kg/ha NPK 20:10:10 + 1.25 t/ha wood ash + 1.25 t/ha poultry manure (T_7) and solely treated poultry manure (T_4) gave higher vine length than the sole treatment of wood ash (T_3), NPK 20:10:10 (T_2) and the control (T_1) plots. Plots with any quantity of poultry manure gave higher vine length than those without it. This is in agreement with the finding of Ketkar, (1993) who worked on different types of organic manure and reported that poultry manure proved to be a better source of nitrogen than others.

Effects of incorporating chemical and organic amendments on the leaf area of fluted pumpkin

The effects of incorporating NPK 20:10:10 fertilizer, wood ash and poultry manure on leaf area in fluted pumpkin at 6, 9, 12, 15 and 18 weeks after planting (WAP) are shown in the form of a graph in (Figure 3). As shown in (Figure 3), the treatments differed significantly (P<0.05) among themselves in respect of this character. The plots treated with 5 t/ha poultry manure (T4)

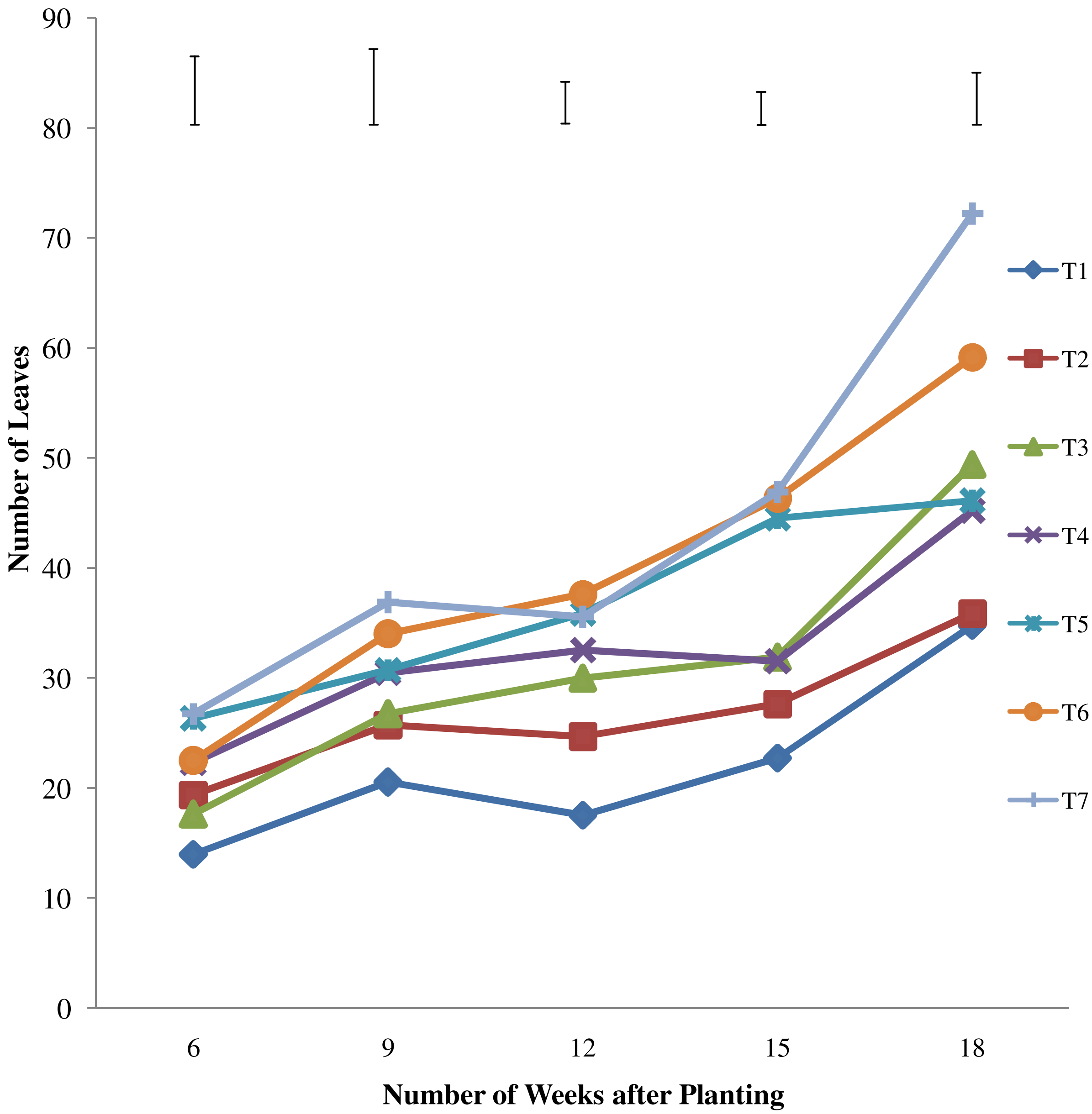

Figure 1. Effects of incorporating chemical and organic amendment on the number of leaves per planted fluted pumpkin. Vertical bars represents LSD at 0.05. T_1 – Control (No amendment), T_2 – 200 kg/ha N P K 20:10:10, T_3 – 5 t/ha Wood ash,T_4 – 5 t/ha Poultry manure, T_5 –100 kg/ha N P K 20:10:10+2.5 t/ha Wood ash, T_6 – 100 kg/ha N P K 20:10:10+2.5 t/ha Poultry manure ,T_7 –100 kg/ha N P K 20:10:10+1.25 t/ha Wood ash+1.25 t/ha Poultry manure.

gave the highest leaf area at 18 WAP followed by the plots treated with 100 kg/ha NPK 20:10:10 fertilizer + 1.25 t/ha wood ash and 1.25 t/ha poultry manure (T_7), which gave the highest leaf area at 9, 12, and 15 WAP. Next were the plots treated with 100 kg/ha NPK + 2.5 t/ha poultry manure (T_6) gave the second higher leaf area at 9 and 12 WAP. The control plants had the least leaf areas in all the harvests. The treatments in this order (T_7, T_6, T_5 and T_4) gave higher leaf area than the solely treated NPK 20:10:10 fertilizer (T_2), wood ash (T_3), and the control (T_1) plots at 12 WAP. At 15 WAP, there was a reduction in leaf area for most of the treatments, perhaps as a result of very dry conditions occasioned by cessation of rains in the month of November (Table 1). At 18 WAP, even though there were hardly any rains in December, the leaf area was higher than what it was at 15 WAP.

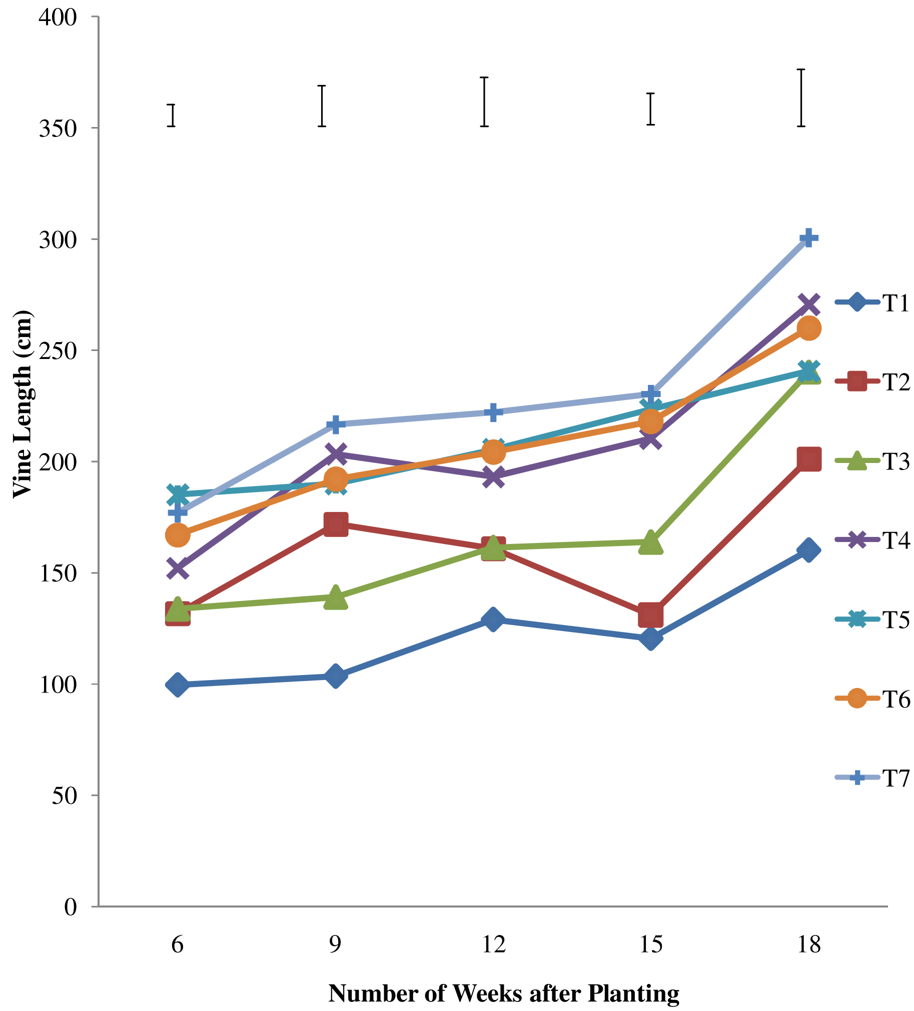

Figure 2. Effects of incorporating chemical and organic amendments on the vine length of fluted pumpkin. Vertical bars represents LSD at 0.05. T_1 – Control (No amendment), T_2 – 200 kg/ha N P K 20:10:10, T_3 – 5 t/ha Wood ash, T_4 – 5 t/ha Poultry manure, T_5 – 100 kg/ha N P K 20:10:10 + 2.5 t/ha Wood ash, T_6 – 100 kg/ha N P K 20:10:10+2.5 t/ha Poultry manure,T_7 – 100 kg/ha N P K 20:10:10 +1.25 t/ha Wood ash+1.25 t/ha Poultry manure.

This may have been because by this time, the roots had become more established, and had penetrated deeper into the soil where it could tap residual moisture for growth. The plots that contained poultry manure gave higher leaf area at 18 WAP. This might be due to the faster rate of mineralization as a result of lower C: N ratio of (5.01) in poultry manure as against (6.29) of wood ash (Table 3). Bitzer and Sims, (1988) found that approximately 69% of organic nitrogen in poultry litter incorporated into a sandy loam was mineralized in 140 days. This could be the reason why the leaf area of those plots having some quantity of poultry manure in them increased with time. The plots were T_4, T_7 and T_6; they gave higher leaf area at 18 WAP. This was almost 140 days following the incorporation of poultry manure into the soil.

Effects of incorporating chemical and organic amendments on the fresh vegetable yield of fluted pumpkin

The effects of sole and combined use of NPK 20:10:10, wood ash and poultry manure on the fresh vegetable yield of fluted pumpkin at 6, 9, 12, 15 and 18 weeks after planting (WAP) are as shown in (Table 5). Application of NPK 20:10:10 fertilizer, wood ash and poultry manure in a single or in a combined form, improved the fresh

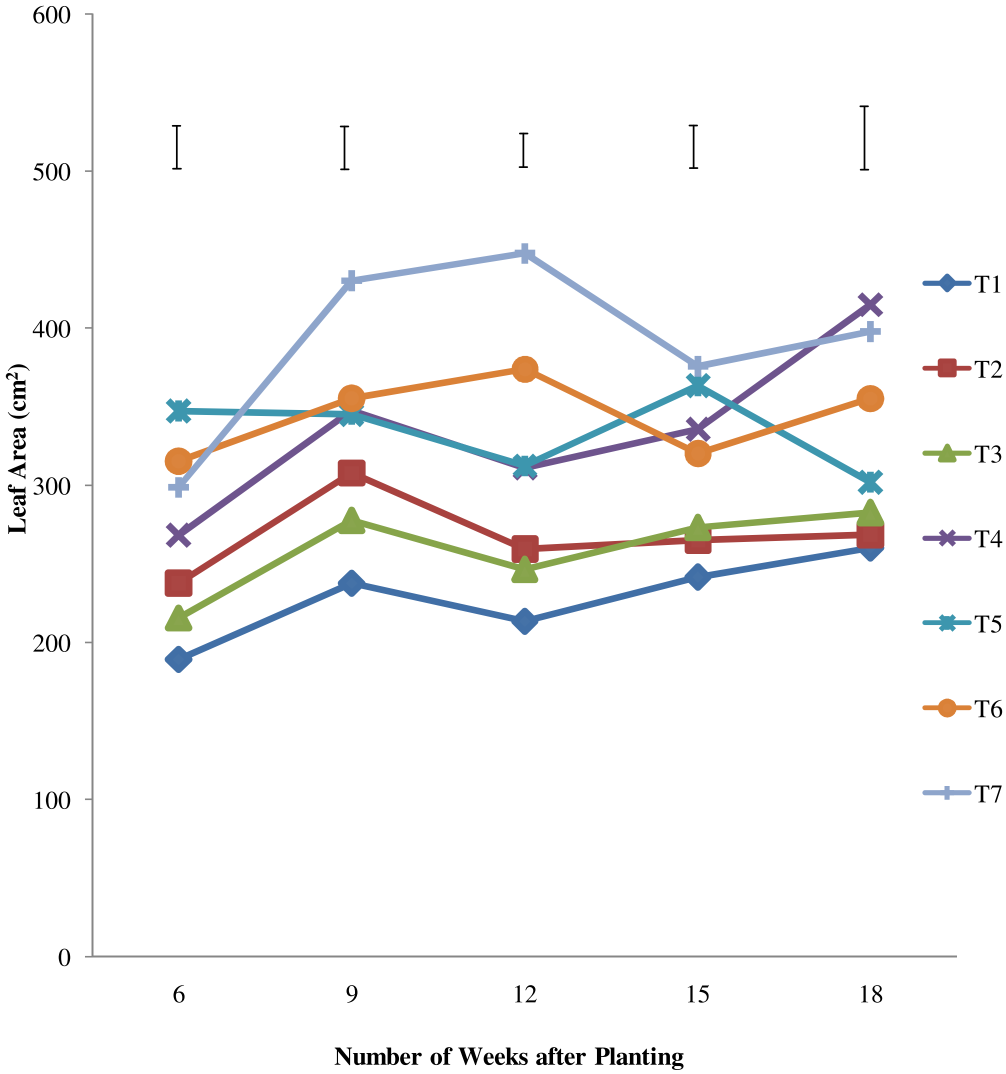

Figure 3. Effects of incorporating chemical and organic amendments on the leaf area of fluted pumpkin. Vertical bars represents LSD at 0.05.T_1 – Control (No amendment), T_2 – 200 kg/ha N P K 20:10:10, T_3 – 5 t/ha Wood ash, T_4 – 5 t/ha Poultry manure, T_5 – 100 kg/ha NPK 20:10:10 + 2.5 t/ha Wood ash, T_6 – 100 kg/ha NPK 20:10:10 + 2.5 t/ha Poultry manure,T_7 – 100 kg/ha NPK 20:10:10 + 1.25 t/ha Wood ash + 1.25 t/ha Poultry manure.

vegetable yield of fluted pumpkin throughout the period of growth when compared with the control (Table 5). At 6 WAP, all the amendments except 5 t/ha wood ash significantly ($P<0.05$) increased the vegetable yield of fluted pumpkin with the highest yield of (1.66 t/ha) obtained from the combination of 100 kg/ha NPK 20:10:10 + 2.5 t/ha wood ash (T_5), closely followed by (T7) 100 kg/ha NPK 20:10:10 + 1.25 t/ha wood ash + 1.25 t/ha poultry manure (1.53 t/ha) and the lowest yield of (0.67 t/ha) from the control plot (T_1). At 9 WAP, all the amendments except 5 t/ha wood ash significantly ($P<0.05$) increased the yield of fluted pumpkin, with the highest fresh yield of (3.15 t/ha) being obtained from the combination of 100 kg/ha NPK 20:10:10 fertilizer + 1.25 t/ha wood ash + 1.25 t/ha poultry manure (T_7) followed by (T6) 100 kg/ha NPK 20:10:10 + 2.5 t/ha poultry manure (2.40 t/ha), and were significantly higher than the rest of the treatments, including the control. At 12 WAP, the highest yield was obtained from 100 kg/ha NPK 20:10:10 + 1.25 t/ha wood ash + 1.25 t/ha poultry manure (2.92 t/ha), closely followed by 100 kg/ha NPK 20:10:10 fertilizer + 2.5 t/ha poultry manure (2.87 t/ha) and were significantly higher than the yield obtained from all the amendments and control except the amendment from

Table 5. Effects of incorporating chemical and organic fertilizers on the fresh vegetable yield (t/ha) of fluted pumpkin.

Treatment	6WAP t/ha	9WAP t/ha	12WAP t/ha	15WAP t/ha	18WAP t/ha	Mean t/ha
Control	0.67	1.26	1.17	1.29	1.96	1.27
200 kg/ha NPK 20:10:10	0.86	1.84	1.59	1.34	2.04	1.54
5 t/ha Wood ash (WA)	0.79	1.51	1.90	1.94	2.67	1.76
5 t/ha Poultry Manure (PM)	1.16	2.08	2.06	2.57	3.39	2.25
100 kg/ha NPK+2.5 t/ha WA	1.66	2.14	2.30	2.80	3.17	2.41
100 kg/ha NPK + 2.5 t/ha PM	1.21	2.40	2.87	2.99	3.69	2.63
100 kg/ha NPK + 2.5 t/ha WA + 1.25 t/ha PM	1.53	3.15	2.92	3.35	4.78	3.15
Mean	1.12	2.05	2.12	2.33	3.10	
LSD (0.05)	0.16	0.40	0.30	0.26	0.39	

WAP = Weeks after planting

100 kg/ha NPK 20:10:10 + 2.5 t/ha poultry manure. As the growth stages progressed to 15 WAP and 18 WAP, the highest yields of (3.35 t/ha and 4.78 t/ha) were obtained from T7, - (100 kg/ha NPK 20:10:10 fertilizer + 1.25 t/ha wood ash + 1.25 t/ha poultry manure) followed by T_6, - (the combination of 100 kg/ha NPK 20:10:10 fertilizer + 2.5 t/ha poultry manure) - 2.99 t/ha and 3.69 t/ha, while the lowest yield of 1.29 t/ha and 1.96 t/ha were from the control plots (T1). The yield obtained from T2, - (200 t/ha NPK 20:10:10 fertilizer at 15 WAP and 18 WAP) were not significantly higher than the control. This result was expected because although NPK fertilizer, releases its nutrients faster, nutrients so released are prone to loses through volatilization and leaching. The results obtained from this study agree with the findings of Ayeni et al. (2008), Bello and Adekunle, (2013) and Iren et al. (2014), all of whom reported that the combined use of inorganic fertilizer and organic manure supported the supply of adequate quantities of plant nutrients required to sustain maximum crop production. Across the weeks, 6 WAP (1.12t/ha) gave the lowest, while 18 WAP (3.10 t/ha) had the highest fresh vegetable yield. Fresh vegetable yield increased from 6 WAP to 18 WAP. Across the treatments, the control plots (1.27 t/ha) recorded the lowest yields while the treatments with 100 kg/ha NPK 20:10:10 fertilizer + 1.25 t/ha wood ash + 1.25 t/ha poultry manure (3.15 t/ha) had the highest yield. The differences were in this order: (T7) 100 kg/ha NPK 20:10:10 fertilizer + 1.25 t/ha wood ash + 1.25 t/ha poultry manure > (T6) 100 kg/ha NPK 20:10:10 + 2.5 t/ha poultry manure > (T5) 100 kg/ha NPK 20:10:10 fertilizer + 2.5 t/ha wood ash > (T4) 5 t/ha poultry manure > (T3) 5 t/ha wood ash > (T2) 200 t/ha NPK 20:10:10 fertilizer > (T1) control.

Conclusion

The study clearly shows that addition of amendments (wood ash and poultry manure) - solely or in combination with NPK 20:10:10 fertilizer, improved the chemical properties of the soil as well as the performance of the fresh vegetable yield of fluted pumpkin relative to the control. Results obtained also showed that the combined application of NPK 20:10:10, wood ash and poultry manure could neutralize the acidifying effect of nitrogen in the inorganic fertilizer which improved the soil fertility and helped in the availability of plant nutrients. Wood ash and poultry manure have also been shown to be effective sources of nutrients for fluted pumpkin if combined with NPK fertilizer thus: 100 kg/ha NPK 20:10:10 + 1.25 t/ha wood ash + 1.25 t/ha poultry manure.

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