Eurasian J Soil Sci 2019, 8 (4) 313 - 320

Eurasian Journal of Soil Science

Journal homepage : http://ejss.fesss.org

Neem leaf and poultry manures soil amendment on growth and yield of Telfairia occidentalis

Norah Godwin Ekanem *, Leonard Itsede Akpheokhai

Department of Crop Science, Faculty of Agriculture, University of Uyo, Nigeria

Abstract

Telfairia occidentalis is a widely used leafy and seed vegetable in West Africa and adequate soil fertility management is essential for its higher productivity. Field experiments were conducted on neem leaf and poultry manures soil amendment to assess the growth and yields of *Telfairia occidentalis* between 2013 and 2014 cropping seasons. The experiment was laid out in a randomised complete block design with four replications to include 5 t ha^{-1} of neem leaf manure (NLM), 5 t ha^{-1} of poultry manure (PM), 2.5 t ha^{-1} of neem leaf manure plus 2.5 t ha^{-1} of poultry manure (NLM+PM) and control. Data collected on vegetative and yield related components were subjected to analysis of variance at $p \leq 0.05$ significance level. The results showed that number of leaves, vine length, leaf area and number of branches increased significantly ($p \leq 0.05$) in plants treated with NLM, PM and NLM+PM from 2-5 months after planting (MAP) compared to control. At five MAP, NLM+PM significantly ($p \leq 0.05$) produced more leaves (52.5; 56.4), longer vines (473.0; 488.4cm), more branches (14.6; 16.3) compared to sole treatment and control. In addition, foliar yield (4.29; 4.94 t ha^{-1}), number of pods/plant (3.09; 4.11), length of pods (72.80; 81.60cm), number of seeds/pod (87.62; 89.51), seeds yield (61.60; 62.54 t ha^{-1}) and pod yield (49.85; 50.15 t ha^{-1}) produced were higher in plants treated with combined manures in the two cropping seasons. The applied combined manures (neem leaf and poultry) could be exploited for soil improvement and sustainable yield increase of *Telfairia occidentalis* production.

Keywords: Fluted pumpkin, organic source, growth characters, yield components.

Article Info

Received : 31.10.2018
Accepted : 07.07.2019

Introduction

Fluted pumpkin (*Telfairia occidentalis* Hook F.) belongs to the family of cucurbitaceae. It is an herbaceous perennial cucurbit which climbs by means of coiled tendrils and bears large fruits (pods) of various sizes (Akoroda, 1986, 1990). It is widely cultivated across West Africa for its nutritional values and palatability (Longe et al., 1983; Axtell, 1992). The succulent young shoots and leaves are used in preparing various vegetable soups depending on the ethnic group. The seeds also are premium part of the crop in local diets of south-eastern region of Nigeria (Orluchukwu and Ossom, 1988). Akoroda (1990) reported that the production of vegetables have been found to be viable and profitable to farmers not only as a garden crop but also as commercial crop. In vegetables cultivation, organic fertilizer contributes to increase in yield by up to 80% depending on the rate of application (Olasantan, 1994; Ogbonna, 2008). The use of organic manures on agricultural lands is advantageous in nutrient recycling, improving soil structure and promoting biological activities of the soil thereby improving overall soil health, enhanced growth and productivity of crops (Arisah et al., 2003). Sometimes, application of organic manure serves as an alternative practice to mineral fertilization and improving soil structure (Idem et al., 2012). In most tropical soil, organic manure has become the determinant for improving soil fertility (Ikpe and Powel, 2002; Uwa, 2013).

According to Agyarko et al. (2006), soil nutritional status increased with addition of poultry manure and increasing levels of neem leaves in vegetable production across West Africa (Lombin et al., 1991). Neem

* Corresponding author.
Department of Crop Science, Faculty of Agriculture, University of Uyo, Nigeria
Tel.: +234 (0) 7030146317
E-mail address: norahgodwin75@yahoo.com

e-ISSN: 2147-4249
DOI: 10.18393/ejss.589439

leaves could be used for the preparation of vermin-compost having both fertilizer and pesticidal potential (Vethanayagam and Rajendran, 2010; Oyekunle and Abosede, 2012). Neem extract has been known to increase fruit weight and diameter of tomatoes (Moyin-Jesu et al., 2012). The phyto-chemicals such as liminoids in neem has demonstrated a dual purpose potential for bio-fertilizer source when ploughed into the soil; improves soil fertility and protects plant roots from nematodes and whiteflies in tomatoes production (Moyin-Jesu et al., 2012). Neem leaf manure (NLM) is gaining popularity due to being environmental friendly and could as well increase nitrogen and phosphorus content of the soil (Lokanadhan et al., 2012; Oyekunle and Abosede, 2012). Globally, growing awareness on health and environmental issues associated with the intensive use of inorganic inputs has led to interest in alternate forms of agriculture (FAO, 1999). Therefore, organic cropping system could be a way of ensuring a healthy agro-ecosystem, including concerns on biodiversity, biological cycles and soil biological activity. Awareness of crop quality and soil health has accelerated the attention of people towards organic farming (Sharma et al., 2008). Balanced use of nutrients through organic sources like farm yard manure, poultry manure (PM), vermicompost, green manuring, neem cake and biofertilizers, are prerequisites for sustaining soil fertility and producing maximal crop yields with optimal input levels (Dahiphale et al., 2003). Organic carbon build-up is increased when organic matter is applied to soil as organic manures leave behind residues in sufficient quantity for the next crop in the sequence (Singh et al., 1996; Baruah et al., 1999). In view of these, field experiments were conducted to evaluate the sole organic manure or combined organic manures soil amendment on growth and yield of fluted pumpkin.

Material and Methods

Description of pilot study area

The trial was carried out at the University of Uyo Teaching and Research Farm, Akwa Ibom State (Lat. $5^0$20´N and $5^0$30´ N, Long. $7^0$27´ E and 5´ 62 E at 68.0 m above sea level, average annual rainfall 2500 mm, relative humidity 79.8%, monthly mean temperature range: 26.88-32^{0}C (UCCDA, 1998), soil type: Ultisol, during the 2013 and 2014 cropping seasons (Agbede, 2015). The site had been under continuous cropping to various arable crops.

Soil sampling and analyses

Twenty-five core soil samples were collected randomly with a soil auger at the depth of 0-15 cm and 15-30 cm. The soil samples were thoroughly mixed, bulked, air dried, crushed with mortar and pestle and sieved using a 2 mm mesh sieve for physicochemical analyses in various methods described by Bouyoucos (1962), McLean (1965), Jackson (1967), Syers et al. (2012), AOAC (2016) and de Souza et al. (2016).

Collection and analysis of experimental materials

Neem leaves were obtained from Pharmacy Research Farm, University of Uyo. Poultry manure was obtained from Okpon Farm, Uyo. The pumpkin seeds were obtained from University of Uyo Teaching and Research Farm, Use Offot. Neem leaves and poultry manure samples were analysed for some physicochemical properties such as organic matter, nitrogen, potassium, calcium, magnesium, sodium in addition to percentages of sand, silt and clay.

Fresh neem leaves collected were chopped into bits using a knife, air-dried for five days and milled into powder with a mortar and pestle in the Pathology Laboratory, Department of Crop Science, University of Uyo. Similarly, poultry manure was air-dried for five days in the Screenhouse, Department of Crop Science, University of Uyo. Milled neem powder and poultry manure were thoroughly mixed in a 1:1 ratio to obtain 5tha^{-1} organic manure.

Field experiment and design

The land was manually cleared with a cutlass, ploughed, harrowed and beds were constructed according to Udoh et al. (2005). The beds were divided into four blocks and each block subdivided into four plots of 3 m x 2 m (6 m^2) each making a total of 16 plots separated by 1m furrow. Four treatments which include neem leaf powder applied at 5 t ha^{-1} (3 kg/plot), poultry manure applied at 5 t ha^{-1} (3 kg/plot), combined application (2.5 t ha^{-1} neem leaf manure plus 2.5 t ha^{-1} poultry manure) and control (no manure) were randomly incorporated into each plot before sowing. The experiment was laid out in a randomised complete block design (RCBD) and treatments replicated four times. One week later, two seeds of sun-dried fluted pumpkin were planted in a hole of 3 cm depth at 1 m x 1 m spacing giving a population of 12 plants per plot. Weeding was carried out regularly at 2, 5 and 12 weeks after planting. The experiment was repeated without any modification in order to validate the data. The plants were sprayed against insect pests using

Delthrin (content 100 g/ L cypermethrin E.C) at a rate of 50 ml to 20 ml of water using Knap-sack sprayer to control leaf defoliating insect. Four plants were randomly tagged per plot for data collection at 4, 8, 12, 16 and 20 weeks after planting (WAP).

Data collection

Data were collected on number of leaves/plant, vine length (cm) and leaf area (cm^2) by using the equation:

$$LA= 0.9467 + 0.2475\ LW + 0.9724\ LWN$$ (Akoroda, 1993);

where, LA = Leaf area, L = Length of the central leaflet, N= Number of leaflets in a leaf, W= Maximum width of the central leaflet and branches/plant.

At harvest, the length and diameter of pods (cm) were determined with a measuring tape, while the number of pods (fruits), number of ridges/pod, number of seeds/pod and seed yield (t ha^{-1}) were counted and recorded.

Statistical analysis

The trials were subjected to Analysis of Variance using Generalized Linear Models (GLM) of statistical analysis system 9.1 (SAS, 2002). Means were compared with Least Significant Difference (LSD) at 5% level of probability (Gomez and Gomez, 1984).

Results

The initial physicochemical properties that constituted soil fertility status were low before planting of *Telfairia occidentalis* during the two cropping seasons. The soil has low pH (5.50-5.80) values, which means that it is acidic. The organic matter (0.06 - 2.21%) and total nitrogen (0.05 – 0.06%) are low in soil fertility status compared with the recommended standard for organic matter and total nitrogen (Table 1) for crop production in Nigeria. Besides the low values obtained in exchangeable bases for magnesium (Mg) and sodium (Na), the soil texture was sandy loam (Table 1). The percentage composition of nutrients such as nitrogen (N), phosphorus (P), potassium (K), calcium (Ca) and magnesium (Mg) present in the various types of organic manures showed that nutrients in the mixture of milled neem leaves and poultry manure were significantly ($p \leq 0.05$) higher than those in the sole manure (neem leaves or poultry) used (Table 2). The lowest percentages of nutrients were present in milled neem leaves except sodium (Na) (1.56 and 1.61%) which was significantly ($p \leq 0.05$) higher than values in poultry manure and mixture of milled neem leaves and poultry manure applied (Table 2).

Table 1. Pre-planting physicochemical properties of experimental site

Parameters	2013		2014		Method of analysis
	Soil depths		Soil depths		
	0-15cm	15-30cm	0-15cm	15-30cm	
pH	5.50	5.70	5.66	5.80	pH meter
EC (dS/m)	0.08	0.05	0.06	0.06	Conductivity meter
Organic matter (%)	2.08	0.06	2.21	0.07	Dichromate oxidation
Total nitrogen (%)	0.05	0.05	0.06	0.05	Kjeldahl procedure
Available P (mg/kg)	20.16	6.05	22.09	7.14	Bray-P_1 method
Exchangeable K (cmol/kg)	0.08	0.08	0.12	0.06	Flame photometer
Exchangeable Ca (cmol/kg)	2.80	3.00	2.64	2.96	Flame photometer
Exchangeable Mg (cmol/kg)	1.10	1.14	1.30	1.41	AAS
Exchangeable Na (cmol/kg)	0.06	0.05	0.05	0.06	Flame photometer
CEC (cmol/kg)	6.62	6.85	6.55	6.68	Summation method
Base saturation (%)	65.65	67.59	53.60	58.47	Calculation
Sand (%)	90.60	86.60	88.50	80.70	Hydrometer method
Silt (%)	3.40	7.40	3.20	5.57	Hydrometer method
Clay (%)	6.00	6.00	6.21	6.54	Hydrometer method
Soil textural class	Sandy loam	Sandy loam	Sandy loam	Sandy loam	

At one month after planting (MAP), there was no significant difference ($p \geq 0.05$) in the number of leaves produced in plants treated with different manure and the control (Table 3). At three MAP, manure-treated *Telfairia occidentalis* significantly produced ($p \leq 0.05$) more leaves than the control. Plants treated with equal combination of milled neem leaf manure and poultry manure (NLM+PM) at 5 t ha^{-1} produced more leaves (37.2) followed by sole manure - poultry (33.1), neem leaf (30.8) (Table 3). At five MAP, similar trends in leaf production were observed in manure treated plants (Table 3). The vine lengths of manure-treated plants were not significantly different (p≥0.05) at one MAP (Table 4). At five MAP, there were significant differences (p≤0.05) between the manure-treated plants and control. The longest vines were produced by the combination of NLM+PM at 5 t ha^{-1} (488.4 cm), followed by poultry manure at 5 t ha^{-1} (420.1 cm) and neem leaf manure (388.8 cm) at five MAP (Table 4).

From 1-2 MAP, there were no significant differences (p≥0.05) in the number of branches produced by manure-treated plants and the control (Table 5). However, equal combination of NLM+PM produced more branches (7.44 branches), followed by poultry manure (6.24 branches) and the least number of branches was produced by control (1.99) at three MAP (Table 5). At five MAP, number of branches produced in plants treated with NLM+PM increased significantly (p≤0.05) than poultry manure, neem leaf and the control (Table 5). The leaf area (cm^2) and foliar yield (t ha^{-1}) of manure-treated *Telfairia occidentalis* plants at five MAP were significantly (p≤0.05) better than the control (Tables 6 and 7). The leaf area of plants treated with poultry manure (64.48 cm^2) increased significantly (p≤0.05) than plants treated with combined sources (NLM+PM) (59.26 cm^2) and sole manure (neem leaf - 46.56 cm^2) (Table 6). Furthermore, manure-treated plants significantly (p≤0.05) produced more foliar yield than the control. The highest yield was obtained from equal proportion of NLM+PM (4.99 t ha^{-1}), followed by poultry manure (3.78 t ha^{-1}), neem leaf (3.33 t ha^{-1}) while the least foliar yield was obtained from control (1.92 t ha^{-1}) at three MAP (Table 7). In addition, manure-treated *Telfairia occidentalis* plants significantly (p≤0.05) produced more yield components (number of seeds/pod, length of pod (cm), pod diameter (cm), number of pods/plant, pod and seed yield (t ha^{-1}) at five MAP than the control (Table 8). The yield components of manure-treated and the control plants followed an increasing significant (p≤0.05) performance order: control < NLM < PM < NLM+PM (Table 8).

Discussion

Fluted pumpkin treated with organic manures at 5 t ha^{-1} revealed an increase in growth characters and yield-related components. This could be due to rapid availability and utilization of nitrogen for various internal processes in the plant in these treatments. Among the manure-treatments, equal combinations of neem leaf and poultry manures showed superiority in foliar yield and yield components and followed by sole application of poultry manure. Evidently, vegetative growth of manure-treated plants performed overwhelmingly better than control due to high availability of organic matter and nutrients in the soil for plant utilisation. Vimala et al. (2006) and Srinivasan et al. (2014) reported that the application of poultry manure and neem cake at 37.9 t ha^{-1} enhanced the rapid availability and utilisation of macro and micro nutrients in the soil significantly and consequently improve the uptake of nutrients such as nitrogen for various internal processes in cabbage. In addition, the lower significant values obtained in the control (no manure) could be attributed to low nutrients availability observed in the experimental plot. This observation agrees with the findings of Moyin-Jesu and Atoyosoye (2002) and Ogbonna (2008) that soil with low nutrients responded better to organic or inorganic fertilizer applications. Furthermore, poultry manure treated plants produced more leaves, increased vine length, more branches, increased foliar and seeds yield/ha better than the neem leaf manure treated fluted pumpkin. This is in contrast to the reports of Oyekunle and Abosede (2012) that neem manure could be preferred to poultry manure on its application to fluted pumpkin. The performance of poultry manure as shown on fluted pumpkin in this study could also be attributed to higher essential mineral components released for plant growth and development. Awodun (2007) demonstrated that poultry manure applied at 6 t ha^{-1} increased foliar growth and essential elements (N, P, K, Ca and Mg content) of fluted pumpkin in a field trial. The application of the combined poultry and neem leaf manures was superior in all growth and yield parameters evaluated compared with other treatments. In other words, their higher performance could also be attributed to high nutrients availability (N, P, K, Ca, Mg) compared to sole application of neem leaf and poultry manure. This corroborates the report of Moyin-Jesu et al. (2012) on superior performance of maize and watermelon treated with modified neem leaf extract in a field trial.

The organic-based soil amendment with neem leaf and poultry manures demonstrated higher effectiveness in the improvement of the experimental site. This finding agrees with Agbede (2015) which revealed that soil amendment could be utilized to enhance higher crop production. This also supports the reports of Schipper (2000) and Awodun (2007) that application of organic manures significantly influenced the growth and yield of fluted pumpkin.

Table 2. Mineral elements composition analysis of nutrient sources

Organic manure sources	2013 N, %	P, %	K, %	Ca, %	Mg, %	Na, %	2014 N, %	P, %	K, %	Ca, %	Mg, %	Na, %
Neem leaf	2.13	1.15	0.97	0.75	0.67	1.56	2.10	1.10	0.87	0.55	0.62	1.61
Poultry dropping	3.55	1.82	2.86	3.01	0.88	0.48	3.40	1.53	2.35	3.27	0.99	0.58
Neem leaf+ poultry	3.94	2.96	3.01	4.42	2.96	0.69	4.01	3.16	4.02	4.33	3.28	0.56
LSD (p<0.05)	0.41	0.96	0.33	1.15	0.45	0.55	0.40	0.84	0.31	1.11	0.40	0.63

Table 3. Influence of organic manure on the number of leaves per plant of *Telfairia occidentalis* in the field

Treatment	2013 Months after planting (MAP)					2014 Months after planting (MAP)				
	1	2	3	4	5	1	2	3	4	5
Neem leaf manure (5 t ha-1)	13.60	21.40	29.40	39.70	44.40	14.40	22.50	30.80	39.90	48.40
Poultry manure (5 t ha-1)	14.40	23.21	32.80	41.20	50.10	15.60	23.56	33.10	40.70	51.50
Neem leaf + poultry manure (2.5+2.5 t ha-1)	16.20	25.40	36.50	49.70	52.50	17.10	26.61	37.20	50.80	56.4
Control (0 t ha-1)	12.00	16.20	21.00	30.30	35.00	13.10	15.90	20.70	30.10	35.20
LSD (p<0.05)	ns	0.58	1.66	0.27	1.54	ns	0.59	1.66	0.38	1.46

NLM = Neem leaf manure; PM = poultry manure; ns = not significant

Table 4. Influence of organic manure on the vine length (cm) of *Telfairia occidentalis* in the field

Treatment	2013 Months after planting (MAP)					2014 Months after planting (MAP)				
	1	2	3	4	5	1	2	3	4	5
Neem leaf manure (5 t ha-1)	201.40	269.50	294.30	321.30	387.40	203.10	269.80	301.20	324.60	388.80
Poultry manure (5 t ha-1)	227.20	299.70	316.60	350.20	418.20	237.20	299.90	319.50	354.10	420.10
Neem leaf + poultry manure (2.5+2.5 t ha-1)	246.60	306.10	337.00	412.00	473.00	250.70	318.20	351.20	419.70	488.40
Control (0 t ha-1)	189.00	211.00	232.40	264.20	305.30	185.10	219.10	236.60	288.30	307.40
LSD (p<0.05)	ns	0.74	1.26	1.32	2.02	ns	0.78	1.32	1.57	2.12

NLM = Neem leaf manure; PM = poultry manure; ns = not significant

Table 5. Influence of organic manure on the number of branches in *Telfairia occidentalis* in the field

Treatment	2013 Months after planting (MAP)					2014 Months after planting (MAP)				
	1	2	3	4	5	1	2	3	4	5
Neem leaf manure (5 t ha-1)	0.18	1.74	5.30	6.65	10.40	0.17	1.81	6.30	6.71	11.60
Poultry manure (5 t ha-1)	0.22	2.25	5.74	9.42	11.20	0.24	2.27	6.24	9.48	10.90
Neem leaf + poultry manure (2.5+2.5 t ha-1)	0.27	2.98	6.45	13.20	14.60	0.37	2.62	7.44	14.60	16.30
Control (0 t ha-1)	0.11	1.20	1.97	3.24	5.10	0.14	1.41	1.99	4.14	6.11
LSD (p<0.05)	ns	ns	1.30	2.01	2.32	ns	ns	1.38	2.25	2.41

NLM = Neem leaf manure; PM = poultry manure; ns = not significant

Table 6. Influence of organic manure on leaf area (cm)^2 on *Telfairia occidentalis* in the field

Treatment	2013					2014				
	Months after planting (MAP)					Months after planting (MAP)				
	1	2	3	4	5	1	2	3	4	5
Neem leaf manure (5 t ha^{-1})	15.82	28.05	36.22	40.23	46.52	15.96	28.55	36.41	40.13	46.56
Poultry manure (5 t ha^{-1})	16.30	39.41	52.36	59.72	64.04	16.37	39.90	52.31	58.88	64.48
Neem leaf + poultry manure (2.5+2.5 t ha^{-1})	16.64	32.26	40.08	48.07	58.66	17.15	36.55	41.18	49.06	59.26
Control (0 t ha^{-1})	14.86	19.12	21.35	26.08	30.22	15.11	19.26	21.38	25.62	30.19
LSD($p<0.05$)	ns	ns	1.46	ns	2.05	ns	ns	1.55	ns	2.08

NLM = Neem leaf manure; PM = poultry manure; ns = not significant

Table 7. Influence of organic manure on foliar yield (t/ha) on *Telfairia occidentalis* in the field

Treatment	2013					2014				
	Months after planting (MAP)					Months after planting (MAP)				
	1	2	3	4	5	1	2	3	4	5
Neem leaf manure (5tha^{-1})	2.12	2.83	3.32	2.54	2.14	2.18	2.88	3.33	2.66	2.06
Poultry manure (5tha^{-1})	2.55	3.64	3.75	3.12	2.55	2.62	3.66	3.78	3.22	2.64
Neem leaf + poultry manure (2.5+2.5tha^{-1})	2.84	3.91	4.29	3.72	3.28	2.99	4.14	4.94	3.71	3.41
Control (0 tha^{-1})	0.90	1.00	1.60	1.20	0.81	0.88	1.07	1.62	1.40	0.62
LSD($p<0.05$)	0.54	1.02	0.83	0.06	1.03	0.53	1.04	0.92	0.08	1.05

NLM = Neem leaf manure; PM = poultry manure; ns = not significant

Table 8. Influence of organic manure on yield and yield component of *Telfairia occidentalis*

	2013						
	Yield components						
Treatment	No. of seed per pod	No. of ridges per pod	Length of pod (cm)	Pod dia-meter (cm)	No. of pods/ plant	Seed yield (tha^{-1})	Pod yield (tha^{-1})
Neem leaf manure (5 t ha^{-1})	58.24	10.00	54.51	43.21	2.40	39.26	30.00
Poultry manure (5 t ha^{-1})	66.50	10.00	67.63	54.02	2.50	46.73	38.37
NLM+PM (combined) (2.5 + 2.5 t ha^{-1})	87.62	10.00	72.80	65.20	3.09	61.60	49.85
Control (no manure)	35.81	9.30	40.12	33.64	1.10	13.84	16.22
LSD($p<0.05$)	0.84	Ns	0.46	0.24	0.02	0.04	0.98
	2014						
	Yield components						
Treatment	No. of seed per pod	No. of ridges per pod	Length of pod (cm)	Pod dia-meter (cm)	No. of pods/ plant	Seed yield (tha^{-1})	Pod yield (tha^{-1})
Neem leaf manure (5 t ha^{-1})	57.68	10.06	55.66	44.02	2.44	39.30	30.08
Poultry manure (5 t ha^{-1})	66.66	10.08	67.91	55.22	2.60	49.80	37.83
NLM+PM (combined) (2.5 + 2.5 t ha^{-1})	89.51	11.02	81.60	75.10	4.11	62.54	50.15
Control (no manure)	35.76	9.03	40.25	34.46	1.16	14.08	16.32
LSD($p<0.05$)	0.86	Ns	0.50	0.34	0.05	0.07	0.96

NLM = Neem leaf manure; PM = poultry manure; ns = not significant

Conclusion

The application of organic-based soil amendment promoted the growth characters, yield and yield-related components of fluted pumpkin production. Convincingly, the combined treatments applied was superior to sole treatments in yield and yield-related components evaluated. It further demonstrated that combined manure application improved soil fertility and enhanced the growth and yields of fluted pumpkin. These materials can easily be sourced locally by farmers for direct application to their farms for sustainable vegetable production.

Acknowledgements

The authors are grateful to Mr. O. Akpan, (Director, Okpon Farm), Mr. B. Etefia (Pharmacy Research Farm) and Mr. I. Ini (Soil Science Department) of University of Uyo for their technical support and cooperation.

References

Agbede, O.O., 2015. Assessment, development and conservation of soil fertility: Key to national food security, 1st Public Lecture organized by Landmark University, Omu-Aran, Kwara State, Nigeria. 50p. Available at [Access date: 31.10.2018]: https://eprints.lmu.edu.ng/id/eprint/497

Agyarko, K., Rwakye, P., Bonsu, M,, Osei, B., Frimpong, K., 2006. The effect of organic soil amendments on root-knot nematodes, soil nutrients and growth of carrot. *Journal of Agronomy* 5(4): 641-646.

Akoroda, M.O., 1986. Seed dessication and recalcitrance in *Telfairia occidentalis*. *Seed Science Technology* 14: 327-332.

Akoroda, M.O., 1990. Ethnobotany of *Telfairia occidentalis* (cucurbitaceae) among Igbos of Nigeria. *Economic Botany* 44(1): 29-39.

Akoroda, M.O., 1993. Non-destructive estimation of area and variation in shape of leaf lamina in the fluted pumpkin (Telfairia occidentalis). *Scientia Horticulturae* 53(3): 261-267.

AOAC, 2016. Association of Official Analytical Chemists (AOAC) International. Official methods of analysis. 20th Edition, Washington DC. USA.

Arisah, H.M., Gad, A.A., Younes, S.E., 2003. Responses of some pepper cultivar to organic and mineral nitrogen fertilizer under sandy soil condition. *Zag-Zag Journal of Agriculture Resources* 30:1675-1699.

Awodun, M.A., 2007. Effect of poultry manure on growth, yield and nutrient content of fluted pumpkin (Telfairai occidentalis Hook F.) *Asian Journal of Agricultural Research* 1(2): 67-73.

Axtell, B., 1992. Minor oil crops. Food and Agriculture Organisation (FAO)Agriculture Service Bulletin No. 94, Rome, Italy. Available at [Access date: 31.10.2018]: http://www.fao.org/3/X5043E/x5043E00.htm#Contents

Baruah, R., Haridev, T., Talukdar, N.C., 1999. Soil chemical properties as influenced by the application of fertilizers and farm yard manure (FYM). *International Journal of Tropical Agriculture* 17:153-158

Bouyoucos, G.J., 1962. Hydrometer method improved for making particle size analyses of soils. *Agronomy Journal* 54(5): 464-465.

Dahiphale, A.V., Giri, D.G., Thakre, G.V., Gin, M.D., 2003. Effect of integrated nutrient management on yield and yield contributing parameters of the scented rice. *Annal Plant Physiology* 17:24-26.

de Souza, D.M., de Oliveira Morais, P.A., Matsushige, I., Rosa, L.A., 2016. Development of alternative methods for determining soil organic matter. *Revista Brasileira de Ciência do Solo* Vol.40.

FAO, 1999., 1999. Guidelines for the production, processing, labelling and marketing of organically produced foods. Food and Agriculture Organisation (FAO), Rome, Italy. Available at [Access date: 31.10.2018]: http://www.fao.org/organicag/doc/glorganicfinal.pdf

Gomez, K.A., Gomez, A.A., 1984. Statistical Procedures for Agricultural Research. 2nd edition. John Wiley and Sons, New York. USA. 704p.

Idem, N.U.A., Ikeh, A.O., Asikpo, N.S., Udoh, E.I., 2012. Effect of organic and inorganic fertilizer on growth and yield of fluted pumpkin (Telfairia occidentalis, Hook F.) in Uyo, Akwa Ibom State, Nigeria. *Journal of Agriculture and Social Research* 12(2):74-84.

Ikpe, F.N., Powel, J.M., 2002. Nutrient cycling practices and changes in soil properties in the crop-livestock farming systems of western Niger Republic of West Africa. *Nutrient Cycling in Agroecosystems* 62(1): 37-45.

Jackson, M.L., 1967. Soil chemical analysis. Englewood Cliffs, Prentice Hall Inc. New York.

Lokanadhan, S., Muthukrishnam, P., Jeyaraman, S., 2012. Neem products and their agricultural applications. *Journal of Biopesticides* 5: 72-76.

Lombin, L.G., Adepetu, J.A., Ayolade, A.K., 1991. Organic fertilizer in the Nigerian agriculture, present and future, F.P.D.D Abuja, pp. 146-162.

Longe, O.G., Faniru, G.O., Fetuga, B.L., 1983. Nutritional value of the fluted pumpkin (*Telfaria occidentalis*). *Journal of Agricultural and Food Chemistry* 31(5): 989-992.

McLean, E.O., 1965. Aluminium In: Method of soil analysis Part 2 Chemical and microbiological properties. Black, C.A., Evans, D.E., White, J.L., Ensminger, L.E. and Clark, F.E. (Eds.). Agronomy No. 9, American Society of Agronomy, Madison Wisconsin, USA. p. 927-932.

Moyin-Jesu, E.I., Atoyosoye, B., 2002. Utilisation of agricultural wastes for the growth, leaf and soil chemistry composition of cocoa seedlings in the nursery. *Pertanika Journal of Tropical Agricultural Science* 25(1): 53-62.

Moyin-Jesu, E.I., Micah, O., Akinola, M.O., 2012. Comparative evaluation of modified neem leaf and wood ash extracts on soil fertility status growth and fruit yields of tomato (*Lycopersicon esulentum* L). *Global Journal of Bio-science and Biotechnology* 1(2):271-276.

Ogbonna, P.E., 2008. Effects of combined application of organic and inorganic fertilizer on fruits yield of eggplant (Solanum melongena). 42nd Annual Conference in Agricultural Society of Nigeria (ASN). 19-23 October 2008, Abakaliki, Nigeria. Book of Proceedings, pp.236-250.

Olasantan, F.O., 1994. Fertilizer use in vegetable production in Nigeria. *Outlook Agriculture* 23(3): 213-222.

Orluchukwu, J.A., Ossom, E.M., 1988. Effect of management practice on weed infestation, yield and nutrient concentration of the fluted pumpkin, Telfairia occidentalis Hook. *Tropical Agriculture* 65(4):317-320.

Oyekunle, O.J., Abosede, O.T., 2012. Growth, yield and nutritional compositions of fluted pumpkin (Telfairia occidentalis) as affected by fertilizer types on Ogbomoso, South West Nigeria. *Bulletin of Environment, Pharmacology and Life Sciences* 1(9):81-88.

SAS, 2002. SAS Institute, SAS User's Guide: Statistics, version 9.1e SAS Institute, Cary. NC. USA.

Schipper, R.R., 2000. African indigenous vegetables: an overview of the cultivated species. National Resources International Limited, Aylesford, United Kingdom. 214p

Sharma, M., Pandey, C.S., Mahapatra, B.S., 2008. Effect of biofertilizers on yield on nutrient uptake by rice and wheat in rice-wheat cropping system under organic mode of cultivation. *Journal of Eco-Friendly Agriculture* 3(1):19-23.

Singh, A., Singh, R.D., Awasthi, R.P., 1996. Organic and inorganic sources of fertilizers for sustained productivity in rice (Oryza sativa)-wheat (Triticum aestivum) sequences on humid hilly soils of Sikkim. *Indian Journal of Agronomy* 41: 191-194.

Srinivasan, R., Rao, K.J., Sailaja, V., Kalaivanan, D., 2014. Influence of organic manures and fertilizers on nutrient uptake, yield and quality in cabbage-baby corn cropping sequence. *Journal of Horticultural Sciences* (1):48-54.

Syers, J.K., Williams, J.D.H., Walker, T.W., 2012. The determination of total phosphorus in soils and parent materials. *New Zealand Journal of Agricultural Research* 11(4): 757-762.

Udoh, D.J., Ndon, B.A., Asuquo, P.E., Ndaeyo, N.U., 2005. Crop production techniques for the tropics. Concept Publication Ltd., Lagos, Nigeria. 464p.

Uwa, O., 2013. The Impact of organic and inorganic manure on the cultivation of pumpkin (Cucurbita maxima). *IOSR Journal of Pharmacy and Biological Sciences* 8(1):18-20.

UCCDA, 1998. Uyo Capital City Development Authority (UCCDA), Yearly Report of Uyo Capital City: Akwa Ibom State, Nigeria. pp.24-26.

Vethanayagam, S.M., Rajendran, S.M., 2010. Bioefficacy of neem insecticidal soap (NIS) on the disease incidence of bhendi, Abelmoschus esculentus (L.) Moench under field conditions. *Journal of Biopesticides* 3(1): 246-249.

Vimala, P., Illias, M.K., Sabbiah, H., 2006. Effect of rates of organic fertilizer on growth, yield and nutrient content of cabbage (Brassica oleracea var. capitata) grown under shelter. *International Symposium on Greenhouses, Environmental Controls and In-house Mechanization for Crop Production in the Tropics and Sub-Tropics - ISHS Acta Horticulturae* 710: 391-397.