SOIL AMENDMENT BY HILUM ORIENTATION EFFECTS ON LEAF YIELD OF FLUTED PUMPKIN (*Telfairia occidentalis* Hook F.)

Mbah, E.U., *Ogidi, E.G.O., and Umesie, M.C.

Department of Agronomy, Michael Okpara University of Agriculture, Umudike Abia State, Nigeria.

Department of Plant Science and Biotechnology, Michael Okpara University of Agriculture, Umudike, Abia State.

*Rubber Research Institute of Nigeria, P.M.B. 02, Substation Akwete, Abia State.

ogidyke@yahoo.com

+2348037642788

ABSTRACT

The effect of soil amendment by hilum orientation and their interactions on leafy yield of fluted pumpkin were investigated at the research farm, Michael Okpara University of Agriculture, Umudike, Nigeria. The experiment was laid out as 4 × 2 factorial arranged in a completely randomized design with eight treatment combinations. The experiment was replicated three times. The treatment factors comprised four types of soil amendment (200 kg ha^{-1} NPK fertilizer, 4 t ha^{-1}poultry manure, 100 kg ha^{-1} NPK + 2 t ha^{-1} poultry manure and No fertilizer/Control) and two hilum orientations (hilum pointing up wards and hilum pointing down wards). The results from the analysis of variance on vine length, number of branches per plant, number of leaves per plant, length of internode and cumulative fresh leaf yield ha^{-1} indicated that the application of soil amendments and placement of fluted pumpkin hilum orientation techniques during planting significantly ($P<0.05$) impacted on the growth and yield parameters of the vegetable crop. The planting of fluted pumpkin with the hilum pointing downwards increased leafy yield relative to the hilum pointing up wards. The findings showed that soil amendment significantly increased leaf yield of fluted pumpkin in contrast to the hilum orientation main effect. The interaction treatment, 100 kg ha^{-1} NPK + 2 t ha^{-1} poultry manure × hilum pointing down wards produced ($P<0.05$) the highest cumulative fresh leaf yield, which was higher by 3.21 % relative to the application of 200 kg ha^{-1} NPK fertilizer × hilum pointing down wards treatment, which was the second highest cumulative leaf yield. There was a positive poly-linear relationship between vine length and leaf yield, number of branches per plant and leaf yield. The results indicated that this planting technique is encouraging, especially when the aim is to increase leaf yield in the production of fluted pumpkin. However, the findings from the study require further validation under field conditions.

Key words: Fluted pumpkin, hilum orientation, leafy yield, soil amendments.

INTRODUCTION

Fluted pumpkin (*Telfairia occidentalis* Hook F.), which is an indigenous vegetable consumed in Nigeria belongs to the family Cucurbitaceae. According to Schippers (2000) its succulent young shoots used in preparing soup is highly nutritional (FAO, 1998). The leaf extract assumes a remedy to anaemia, high blood pressure, convulsion and diabetes (Ehiagbonare, 2008) while the oil from the seed is used for cooking and in cookies formulation (Horsefall and Spiff,

2005) and in soap making (Fasuyi, 2006). The plant possesses anti-inflammatory (Oluwole *et al*., 2003) and anti-diabetic properties (Eseyin *et al*., 2005) while according to Schippers (2000), the macerated stem fibers are used as sponge.

In South eastern Nigeria, fluted pumpkin is intensively cultivated and its production and utilization has spread rapidly to other parts of the country (Akoroda, 1990). However, the leaf yield output of the crop has not been able to meet the local demand as an important menu in the diet of the people and livestock feed in the agro-ecological zone. Thus, it has become necessary to carry out research to maximize its production potentials. According to Akoroda (1990), the production of the fluted pumpkin vegetable is not capital intensive as it can be carried out as a backyard crop to provide an appreciable income to the farmers. However, a major problem limiting the production of the crop, especially in the southern agro-ecological zone of Nigeria is continued decline in soil fertility and poor soil management practices due to nature of the parent material, leaching nutrients and weathering occasioned by heavy rainfalls over a long period of time per annum (Awodun *et al*., 2007; Ogbonna, 2008; Ikeh *et al*., 2017). This is however managed by the application of soil amendments either in organic or inorganic form. Organic fertilizers are known to be effective in the maintenance of an adequate supply of organic matter into soil, with attendant improvement in soil physical and chemical conditions and enhanced crop performance (Ikpe and Powel, 2003; Ano and Agwu, 2005). Though the nutrients released are slow, it lasts longer in the soil compared to the faster nutrient-release by inorganic fertilizers that are often rapidly lost by leaching in porous soil and heavy rainfall areas (Ndaeyo *et al*., 2013). The frequent and high rate of inorganic fertilizers used have been associated with some environmental pollution, hence it is necessary to study other ways of reducing the dependence on mineral fertilizers in crop production (Ike *et al*., 2017).

According to Ogbonna (2008) as well as Okunlola and Adeona (2016), in sustainable low-input agricultural systems, where nutrient depletion is a serious constraint to crop production, the use of organic fertilizers and inorganic fertilizer has been known to meet the immediate needs of soil nutrient deficit, improve the soil physical properties and enhance crop yields in tropical soils that have been exposed to loss of soil nutrients as a result of erosion, leaching, crop removal and continuous cropping.

A number of studies on the positive influence of organic fertilizers on fluted pumpkin production has been carried out in Nigeria across a range of farming systems (Awodun, 2007; Ibia and Udo, 2009; Idem *et al*., 2012). Scientific on-farm studies have demonstrated that poultry manure application has significant effect on plant growth and yield (Boateng *et al*., 2006; Adigbo *et al*., 2012, Uwah *et al*., 2016), especially in degraded and poor structured soils.

The effect of hilum orientation associated in planting techniques of fluted pumpkin is however limited. Therefore, appropriate hilum orientation in combination with plant nutrient fertilizers that are cheap, sustainable, edaphologically suitable, economically viable, culturally acceptable, environmentally friendly and compatible is considered a major method of increasing fresh leafy yield of fluted pumpkin on unit area basis.

More so, research on hilum orientation of fluted pumpkin in south eastern Nigeria in combination with soil amendments has not received any considerable attention. This research work was carried out with the aim to evaluate the effect of different types of soil amendments, hilum orientation and the interaction between the two main factors on growth and leafy yield of fluted pumpkin.

MATERIALS AND METHODS

The containerized field experiment was carried out at the research farm of Michael Okpara University of Agriculture, Umudike. The site was under fallow at the time it was cleared, ploughed and harrowed and it is located at latitude 5° 28' N, longitude 7° 33' E and 122 m above sea level. Umudike has an annual rainfall of 2,200 mm distributed over eight-month period (March to November). The rainy season is bimodal, which peaks in June/July and September with a short dry spell in August while the location has a mean annual maximum and minimum temperature of 32 °C and 23 °C with a mean soil temperature of 28.1 °C.

Agro-meteorological data of the study area covered the months of May to August, 2015 (Table 1) and was characterized by the volume of rainfall which was highest in June (371 mm) while the number of rain days was highest in August (23 days) and least in May (15 days). Maximum air temperature ranged from 27.3 °C to 32.6 °C while the relative humidity varied from 65 to 87 %.

Table 1: Agro-meteorological data of the experimental site

Month	Rainfall		Temperature (°C)		Relative humidity (%)	
	Amount (mm)	Days	Min	Max	900hrs	1500hrs
May	246.8	15	23.4	32.6	78	65
June	371.1	21	23.5	29.8	83	69
July	131.9	19	24.4	27. 3	84	78
August	361.7	23	23.2	27.3	87	76

Source: Agro-meteorological Station, National Roots Crop Research Institute, Umudike, Nigeria.

The soil physico-chemical status of the experimental site (Table 2) showed that the soil was sandy loam in texture with high sand content (80.70 %), slightly acidic (pH 5.8) reflecting the parent nature of soils of eastern Nigeria. The values of soil organic carbon, total nitrogen and exchangeable potassium were low, while phosphorous and magnesium were adequate. The fertility status was generally poor, which was reflected in poor vegetative performance of the controlled plot with no manure application and different hilum orientation. Also, the analysis of the poultry manure used in the study (Table 3) indicated moderate amount of nitrogen and phosphorus.

The experiment was a 4 × 2 factorial experiment arranged in a completely randomized design and the treatments comprised four soil amendments (no fertilizer/control, NPK fertilizer, poultry manure and NPK + poultry manure) and two hilum orientations (hilum pointing up wards and hilum pointing down wards). The 8 treatment combinations are outlined as follows: No fertilizer × Hilum pointing upwards, No fertilizer × Hilum pointing down wards, NPK fertilizer × Hilum pointing upwards, NPK fertilizer × Hilum pointing down wards, Poultry manure × Hilum pointing upwards, Poultry manure + Hilum pointing down wards, NPK fertilizer + poultry manure × Hilum pointing upwards and NPK fertilizer + poultry manure × Hilum pointing down wards.

Table 2: Physcio-chemical properties of the soil before planting

Soil characteristics	Value
Textural class	Sandy loam
Physical properties	
Sand (%)	80.70
Silt (%)	9.60
Clay (%)	9.70
Chemical properties	
pH in water	5.8
Salt	4.59
Total P (mg kg^{-1})	25.4
Total N (%)	0.082
Organic carbon (%)	0.82
Organic matter (%)	1.41
Exchangeable calcium (cmol kg^{-1})	2.80
Exchangeable magnesium (cmol kg^{-1})	1.98
Exchangeable potassium (cmol kg^{-1})	0.070
Exchangeable N (cmol kg^{-1})	0.142
Total exchangeable acidity (cmol kg^{-1})	0.88
ECEC	5.68
Base saturation (%)	85.49

Source: Soil Science Laboratory, National Roots Crop Research Institute, Umudike Nigeria

Table 3: Chemical properties of the poultry manure used for the study

Type of nutrient	Contents (%)
Nitrogen	1.30
Phosphorus	1.39
Potassium	0.50
Sodium	0.36
Calcium	6.68
Magnesium	1.92
Organic carbon	45.89
Organic matter	20.1

Source: Soil Science Laboratory, National Root Crops Research Institute, Umudike, Nigeria.

The NPK fertilizer (20:10:10) was applied at the rate of 200 kg ha^{-1}, which was equivalent to 40 kg ha^{-1} (N), 20 kg ha^{-1} (P) and 20 kg ha^{-1} (K) based on native fertility of the soil and yield level of fluted pumpkin as recommended by Idem *et al*. (2013) while poultry manure was applied at the rate of 4 t ha^{-1}, which was equivalent to 52 kg ha^{-1} (N), 55.6 kg ha^{-1} (P) and 20 kg ha^{-1} (K). The combined application of NPK + poultry manure was at the rate of 2 t ha^{-1} for poultry manure and 100 kg ha^{-1} for NPK fertilizer. The control had no fertilizer treatment. Each soil amendment treatment was homogenously mixed with 15 kg of containerized soil, which was placed in a sack bag and there were three replications.

The fluted pumpkin seeds were planted at 15 cm depth at one plant per pot. During planting, the hilum of each seed was orientated in the soft soil by placement either pointing downwards or upwards depending on the soil amendment treatment combination. Hand picking of weeds was carried out at 2 week-intervals from 2 weeks after planting. All the experimental plants were used to determine the length of vines, number of leaves per plant and number of branches per plant at 4, 6, 8 and 12 weeks after planting. The first leaf and stem yield were evaluated at 7 weeks after planting, while subsequent harvests were at intervals of 10 days. A total of six harvests was carried out and the cumulative yield obtained by weighing each harvested produce on a sensitive balance.

Data collected were subjected to factorial analysis of variance in completely randomized design using SAS analytical program (SAS Institute, 2007) and significant differences in the treatments' means were obtained using Fisher's least significant difference (F-LSD) at 5 % probability level of significant according to Snedecor and Cochran (1980) and Obi (2002).

RESULTS AND DISCUSSION

The analysis of variance of vine length, number of branches per plant and number of leaves per plant (Table 4) at different ages indicated that except number of branches per plant at 6 WAP, hilum orientation (hilum positioned to point up-wards or down-wards in the soil) of fluted pumpkin seeds had non-significant ($P>0.05$) effect on all the measured variables at the other sampled ages. Soil amendment significantly ($P<0.05$) affected vine at 4, 8 and 12 WAP, number of branches per plant at 12 WAP and number of leaves/plant at 6 and 8 WAP contrary to measured variables at the other sampled ages. The interaction between hilum orientation and soil amendment indicated non-significant effect on all the sampled variables (vine, number of branches per plant and number of leaves per plant) at different ages except vine at 12 WAP.

Among the soil amendments (Table 5), combined application of NPK and poultry manure gave longer vines which were closely followed by the application of poultry manure while the no fertilizer (control pot) application had the shortest vine. However, NPK fertilizer application gave the highest number of branches per plant and number of leaves per plant at 6 and 8 WAP relative to the other soil amendments, especially the no fertilizer (control) plot.

The findings in the study indicated a general increase in vine length, number of leaves per plant and length of internode at 12 WAP compared with the control plot and it could be due to mineralization of nutrients, which enhanced many aspects of plant physiological stages involving photosynthesis, root growth and development of structural tissues such as longer vines and increased internode lengths. These results corroborated similar findings by Ojetayo *et al*. (2011), Okunlola and Adeona (2016) as well as Ikeh *et al*. (2017) who reported enhanced growth parameters in crops grown in amended soils. Furthermore, the enhanced vegetative growth could be due to the absorption of nitrogen as a result of the presence of phosphorous which promotes root production as asserted by Ndaeyo *et al*. (2013) on *Talinum triangulare*, Akata *et al*. (2016) on *Capsicum fruitescens* and Ike (2017) on *Telfairia occidentalis* in their previous works on soil amendments.

Table 4: Analysis of variance showing significance (F pr.) of the main and interaction effects of hilum orientation (HO) and soil amendment (SA) on two response measurements examined at different growth ages of fluted pumpkin

Source of variance		Response variables										
		Vine length (cm)				Number of branches per plant			Number of leaves per plant			
	DF	4	6	8	12	6	8	12	4	6	8	12
Hilum orientation (HO)	1	0.481ns	0.631ns	0.455ns	0.409ns	0.041*	0.733ns	0.676ns	.781ns	0.712ns	0.804ns	0.749ns
Soil amendment (SA)	3	0.043*	0.292ns	0.013*	0.070*	0.269ns	0.206ns	0.147*	0.322ns	0.118*	0.018*	0.986ns
HO x SA	3	0.490ns	0.405ns	0.518ns	0.180*	0.269ns	0.481ns	0.773ns	0.625ns	.600ns	0.488ns	0.802ns

ns =not significant and * = P < 0.05.

Table 5: Effect of soil amendment on vine length, number of branches per plant and number of leaves per plant of fluted pumpkin at some sampled growth ages

Soil amendment (SA)	Vine length (cm)		Number of branches per plant	Number of leaves per plant	
	4	8	12	6	8
			WAP		
No fertilizer (control)	17.8	50.7	6.33	18.3	18.3
NPK fertilizer	28.6	75.1	8.67	27.0	29.8
Poultry manure	17.8	76.8	5.50	19.0	29.7
NPK + poultry manure	38.1	84.3	7.67	25.2	29.2
Mean		71.7	7.04	22.4	26.8
$LSD_{(0.05)}$	15.82	19.73	2.935	12.22	7.94
SED	7.47	9.30	1.384	5.76	3.74

Data analyzed with Least Squares Means and means separated with LSD.
WAP = Weeks after planting.

The results shown in Table 6, which assessed the effects of hilum orientation on number of branches per plant indicated that hilum pointing down wards gave more number of branches per plant, which was higher by 36.07 % relative to hilum pointing up wards at 6 WAP. However, the trend was not consistent at the other sampled dates.

Table 6: Effect of hilum direction on number of branches per plant at 6 weeks after planting

Hilum orientation	Number of branches per plant
Pointing up wards	1.17
Pointing down wards	1.83
Mean	1.50
$LSD_{(0.05)}$	0.637

Data analyzed with Least Squares Means and means separated with LSD.
WAP = weeks after planting.

Analysis of variance (Table 7) of length of internode, cumulative fresh leaf yield, cumulative fresh stem yield and leaf stem ratio indicated that hilum orientation slightly ($P<0.05$) affected leaf stem ratio in contrast to the other measured variables in the study. Soil amendment exhibited highly significant difference with cumulative leaf yield while it significantly affected length of internode at 12 WAP and leaf vine ratio relative to the other variables except length of internode at 8 WAP, which was slightly significant. The interaction between hilum orientation and soil amendment indicated that except length of internode at 4 WAP and cumulative stem yield, the other variables (length of internode at the other sampled ages, especially at 8 WAP, cumulative fresh leaf yield and leaf-stem ratio) exhibited various levels of significance. The findings corroborate previous studies indicating that fluted pumpkin hilum pointing downwards consistently produced increased cumulative fresh leaf yield irrespective of the soil amendments as asserted by Akoroda (1990) and Odiaka *et al*. (2008) who attributed this enhanced vigour leading to increased yield to hilum ease of penetration into the soil, faster anchorage and accessibility to nutrient absorption.

Table 7: Analysis of variance showing significance (F pr.) of the main and interaction effects of hilum orientation (HO) and soil amendment (SA) on five response measurements examined

Source of variance	Df.	Response variables						
		Length of internode (cm)				Cumulative Fresh leaf yield (t ha^{-1})	Cumulative Fresh stem yield (t ha^{-1})	Leaf vine ratio
		4	6	8	12			
		WAP						
Hilum orientation (HO)	1	0.222ns	0.239ns	0.581ns	0.731ns	0.596ns	0.327ns	0.166*
Soil amendment (SA)	3	0.580ns	0.229ns	0.031*	0.007**	<0.001***	0.417ns	0.010**
HO x SA	3	0.255ns	0.013*	<0.001***	0.003**	0.135*	0.427ns	0.060*

ns =not significant, * = P < 0.05, ** = P < 0.01, and *** = P < 0.001. WAP = Weeks after planting.

The interaction between hilum orientation and soil amendment (Table 8) showed that combined application of NPK and Poultry manure to fluted pumpkin with the hilum pointing downwards had the longest vine length at 12 WAP compared to the other interactive treatments. Furthermore, the results indicated that irrespective of the soil amendment, fluted pumpkin with hilum orientation pointing downwards, consistently gave the highest vine length, length of internode at the sampled ages, cumulative fresh leaf yield ha^{-1} and leaf:vine ratio. The length of internodes recorded between 6 and 12 WAP ranged from 5.00 to12.07 cm with the application of NPK to fluted pumpkin with the hilum pointing downs having the highest consistent length of internodes at the sampled ages.

Table 8: Interaction of hilum orientation and soil amendment on vine length (12 WAP), length of internode, cumulative fresh leaf yield and leaf:vine ratio of fluted pumpkin

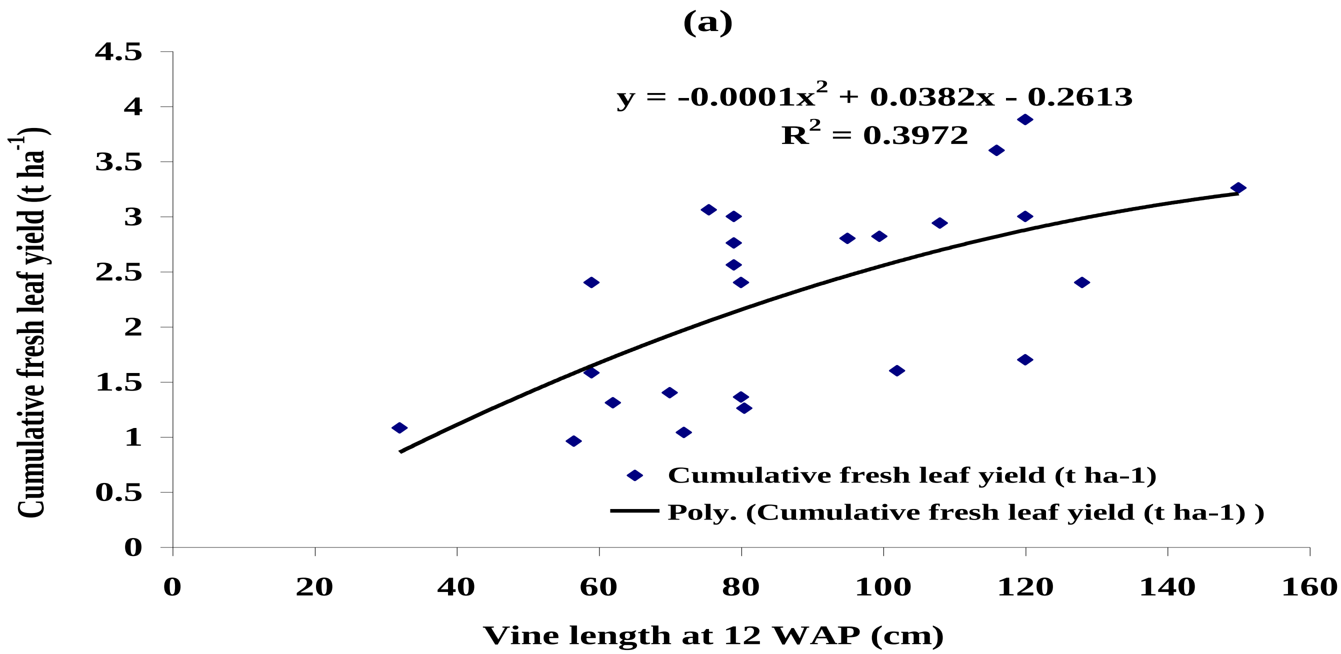
Soil amendment (SA)		Hilum orientation (HO)	Vine length (cm)	Length of internode (cm) 6 WAP	8 WAP	12 WAP	Cumulative fresh leaf yield (t ha^{-1})	Leaf:vine ratio
No fertilizer (control)	×	Pointing up wards	56.3	4.57	5.00	5.33	1.10	1.11
		Pointing down wards	64.3	6.83	8.23	8.17	1.80	2.25
NPK (15:15:15)		Pointing up wards	106.3	7.50	7.67	8.00	2.82	2.32
		Pointing down wards	107.8	11.67	12.07	10.23	3.02	4.15
Poultry manure		Pointing up wards	84.0	8.10	7.17	6.17	1.31	1.26
		Pointing down wards	87.5	9.33	9.00	8.33	2.86	2.69
NPK + Poultry manure		Pointing up wards	79.3	6.93	7.00	7.97	2.23	1.94
		Pointing down wards	121.7	10.83	11.27	10.67	3.12	2.70
Mean			88.4	8.22	8.42	8.18	2.66	2.30
$LSD_{(0.05)}$			36.66	3.987	2.760	2.425	0.973	1.450
SED			17.29	1.881	1.302	1.144	0.459	0.684

Data in interaction analyzed with Least Squares Means and means separated with LSD.
WAP = Weeks after planting

The interaction between the two factors indicated that the application of NPK + poultry manure on fluted pumpkin with the hilum pointing downwards gave the highest cumulative fresh leaf yield ha^{-1} closely followed by the application of NPK on fluted pumpkin with the same hilum orientation, which was higher by 64.7 and 63.6 per cent relative to no fertilizer application (control) on fluted pumpkin with hilum pointing up wards, respectively. However, the highest leaf:vine ratio was recorded when NPK fertilizer was applied to fluted pumpkin with hilum orientation pointing down wards.

The interactive effect of soil amendment and hilum orientation increased cumulative fresh leaf yield and leaf:vine ratio, especially under NPK + poultry manure × hilum pointing downwards closely followed by NPK × hilum pointing downwards treatments. The significant high response of fluted pumpkin with hilum pointing downwards at planting to NPK + poultry manure application was due to increased availability of the mineralized nutrients in the soil resulting from the positive synergy between poultry manure and the applied inorganic fertilizer (NPK). The findings corroborated similar reports by Ossom *et al.* (1997) on *Telfairia occidentalis* in Indiana, Adeniyan and Ojeniyi (2005) on *Zea mays* in Ibadan, Ogbonna (2008) on *Solanum melongena* in Nsukka, Ogunlade *et al*. (2011) on *Solanum macrocarpon* in Ibadan and Orji *et al*. (2017) on *Xanthosoma sagittifolium* in Umudike who submitted that integrated application of poultry manure and NPK fertilizers showed exceptional increase in soil chemical properties, especially the essential elements (NPK) and improved the structure of the soil thereby enhancing plant growth and invariably yield.

The relationship between vine length and cumulative fresh leaf yield of fluted pumpkin was poly-linear and positive (Fig. 1a) indicating increase in leaf yield·ha^{-1} by 84.4 % as vine length increased upwards and then started to flatten as the length increased beyond 150 cm while the number of branches per plant also exhibited positive poly-linear relationship with cumulative fresh leaf yield in the cropping season (Fig. 1b). However, the correlation coefficients of the two regression graphs were weak. This indicated that vine length and number of branches per plant contributed positively in increasing the leaf yield of fluted pumpkin, hence their maintenance should be accorded priority during production of the crop.



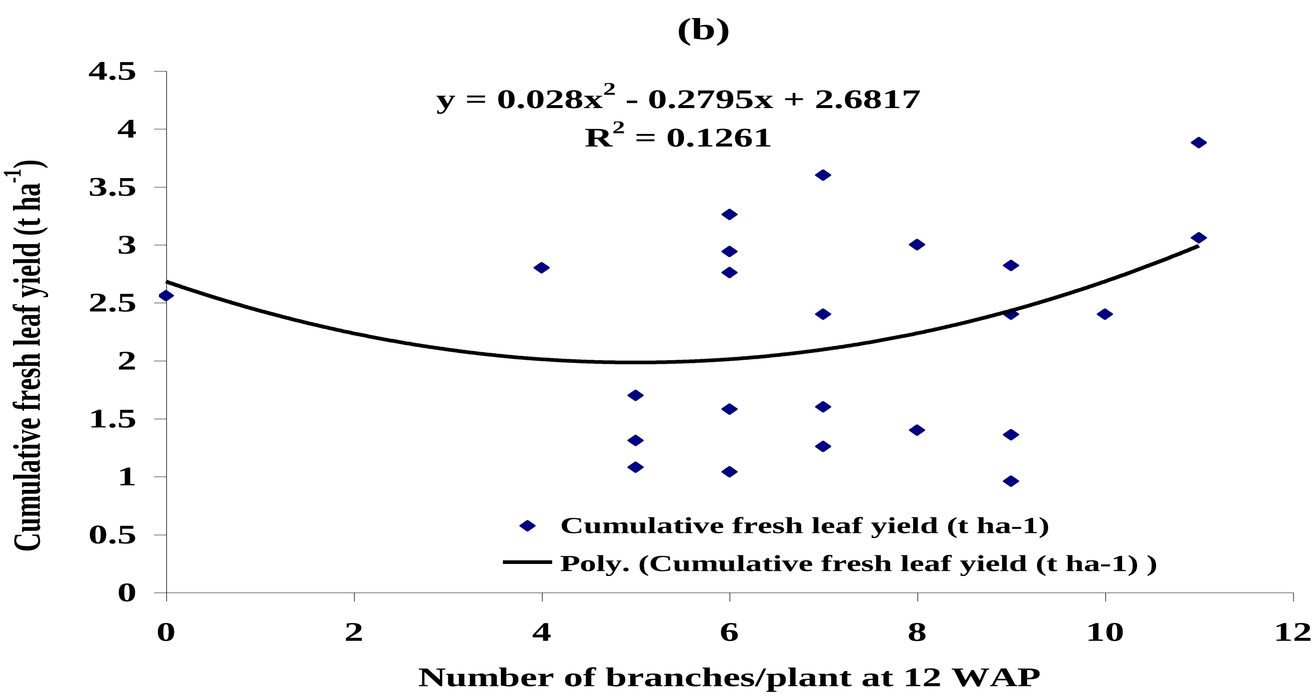


Fig. 1: Relationship between vine length (cm) and cumulative fresh leaf yield (t·ha^{-1}) (a) with quadratic regression curve and relationship between number of branches/plant and cumulative fresh leaf yield (b) with quadratic reciprocal model.

CONCLUSION

The use of soil amendment and hilum orientation techniques in fluted pumpkin production as observed from the study has shown its positive impact on the growth and yield of the vegetable crop. The planting of fluted pumpkin with the hilum pointing downwards exhibited better growth performance. However, the interaction treatment, NPK + poultry manure × hilum pointing down wards gave the highest cumulative fresh leaf yield. Hence, the findings indicated that this method is encouraging, especially when the aim is on increased leaf-yield production. However, the findings from the field-pot experiment require further validation under rain-fed field conditions.

REFERENCES

Adeniyan, O.N. and Ojeniyi, S.O. (2005). Effect of poultry manure, NPK 15:15:15 fertilizer and combinations of their reduced levels on maize growth and their chemical properties. *Nigerian Journal of Soil Science*, 15: 34-41.

Adigbo, S.O., Fabunmi, T.O. and Odedina, J.N. (2012). Effect of poultry manure on the shelf and proximate composition of freshly harvested leaf of fluted pumpkin (*Telfairia occidentalis* Hook F.). *Proceedings of the 8nd Annual Conference of Organic Agriculture*, University of Calabar, 5th–9th Nov., 2012, pp. 85-95.

Akata, O.R, Ikeh, A.O., Akpan, E.A. and Ndaeyo, N.U. (2016). Effect of empty palm fruit bunch ash and inorganic fertilizer and their combination on the growth and yield of chili pepper (*Capsicum fruitescens* L.). *Proceedings of 3rd National Annual Conference of Crop Science Society of Nigeria*, University of Nigeria, Nsukka, 27th–31st Sept., 2016, pp 422-426.

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

Ano, A.O. and Agwu, J.A. (2005) Effect of animal manure on selected soil chemical properties. *Nigerian Journal of Soil Science,* 15: 14-19.

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

Boateng, S.A., Zickermann, J. and Kornaharens, M. (2006). Poultry manure effect on growth and yield of maize. *West African Journal of Applied Ecology*, 9: 1-11.

Ehiagbonare, J.E. (2008). Conservation studies on *Telfairia occidentialis* Hook F. indigenous plant used in ethno-medicinal treatment of anemia in Nigeria. *African Journal of Agricultural Research*. 3(1): 74-77.

Eseyin, O.A., Ignosaoiyi, A.C., Forah, E.O., Nkop and Agboke, A. (2005). Hypoglycemic activity of *T. occidentalis* in rats. *Journal of Pharmacy and Bio-resources*, 2: 6-42.

FAO (1998). *Traditional Food Plants*. Food and Nutrition Paper. Pp. 489.

Fasuyi, A.O. (2006). Nutritional potentials of some tropical vegetable leaf meals: chemical characterizations and functional properties. *African Journal of Biotechnology*, 5: 49-53.

Horsefall, M. and Spiff, I.A. (2005). Equilibrium sorption study Al^{3+} Cu^{2+} and Ag^{+} in aqueous solution by fluted pumpkin (*T. occidentalis* Hook F.). *Nigerian Journal of Horticultural Science*,17:20-26.

Ibia, T.O. and Udo, E. J. (2009). *Guide to fertilizer use for crops in Akwa Ibom State, Nigeria*. Sibon books Limited, Festac, Lagos, Nigeria. pp 11-101.

Idem, N.U.A., Ikeh, A.O., Asiko, N.S. and Udo 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.

Ike, A.O., Etokeren, U.E., Essien, I.E., Peleyju, K.O. and Udo, E.I (2017). Agronomic response of fluted pumpkin (*Telfairia occidentalis* Hook F.) to organo-mineral fertilizers in rainforest ecology of southeastern Nigeria. *Nigerian Journal of Crop Science*, 4(2): 7-14.

Ikpe, F.N. and Powel, J.M. (2003). Nutrient cycling practices and changes in soil properties in the crop livestock farming system of West Niger Republic of West Africa. *Nutrient Cycling Agroecosystems*, 62: 37-45.

Ndaeyo, N.U., Ikeh, A.O., Nkeme, K.K., Akpan, E.A. and Udoh, E.I. (2013). Growth and foliar yield of water leaf (*Talinum triangulare* Jacq.) to complementary application of organic and inorganic fertilizer in an Ultisol. *American Journal of Experimental Agriculture*, 3(2): 324 – 355.

Obi, I.U. (2002). *Statistical methods of detecting differences between treatment means and research methodology issues in laboratory and field experiments.* AP Express publishers VED, Nsukka, Nigeria. 117 pp.

Odiaka, N.I., Akoroda, M.O. and Odiaka, E.C. (2008). Diversity and production methods of fluted pumpkin (*Telfairia occidentalis* Hook F.); Experience with vegetable farmers in Makurdi, Nigeria. *African Journal of Biotechnology*, 7(8): 944-954.

Ogbonna, P.E. (2008). Effect of combined application of organic and inorganic fertilizers on fruit yield of eggplant (*Solanum melongena*). *Proceedings of 42nd Annual Conference of Agricultural Society of Nigeria*, 19th-23rd Oct., 2008, 236-250.

Ogunlade, M.O., Adeyemi E.A., Ogunleti, D.O. and Ibiyomi, P.S. (2011). Effect of cocoa pod husk, urea fortified cocoa pod husk and NPK fertilizers on the growth and yield of *Solanum macrocarpon*. *International Journal of Organic Agriculture Research and Development*, 3: 1-8.

Ojetayo, A.E., Olaniyi,J.O., Akanbi, W.B. and Olabiyi, T.I. (2011). Effect of fertilizer types on the utritional quality of cabbage varieties before and after storage. *Journal of Applied Biosciences*, 48: 3322-3330.

Okunlola, A.I. and Adeona A.P. (2016). Effects of fertilizer types on the growth, yield and pigment concentration of black nightshade (*Solanum Nigrum*) in Southwestern Nigeria. *International*

Journal of Research in Agriculture and Forestry, 3(I2): 12-16.

Oluwole, F.S., Falade, A.O. and Ogundipe, O.O. (2003). Anti-inflammatory effect of some common vegetables. *Nigerian Journal of Physiology*, 18: 35-38.

Orji, K.O., Mbah, E.U. and Muoneke, C.O. (2017). Effect of integrated plant nutrient management on growth and yield of tannia (*Xanthosoma sagittifolium* (L)) at umudike, southeastern Nigeria. *Proceedings of the 4th National Annual Conference of the Crop Society of Nigeria*, Sept 10 – 14, 2017. University of Uyo.

Ossom, E.M., Ethothi, C.U. and Rhykerd, C.L. (1997). Influence of K fertilizer levels and plant density on the yield and mineral content of the leaves and vines of the fluted pumpkin, *Telfairia occidentalis* Hook. *Proceedings of Indiana Academy of Sciences*, 106(1–2): 135-143.

SAS Institute Inc. (2007). SAS/STAT® users' Guide, Ver. 8, 4th ed., Scholars Academic and Scientific Publishers, SAS Institute, Cary, North Caroline, U.S.A.

Schippers, R.R. (2000). *African indigenous vegetables: an over view of the cultivated species*. Revised edition on CDROM. National Resources International Limited, Aylesford, United Kingdom. 222 pp.

Snedecor, G.W. and W.G. Cochran (1980). *Statistical Methods*, 7th ed. Iowa State University Press, America. 507 pp.

Uwah, D.F., Obok, E.E. and Atim, S.N. (2016). Growth and edible leaf yield of fluted pumpkin (*Telfairia occidentalis* Hook F.) in response to poultry manure and NPK fertilizer in Calabar. *Proceedings of the 3rd National Annual Conference of Crop Science Society of Nigeria*, University of Nigeria, Nsukka, 27th–30th Sept., 2016, pp. 519-525.