International Journal of Agriculture Innovations and Research
Volume 4, Issue 3, ISSN (Online) 2319-1473
Manuscript Processing Details (dd/mm/yyyy) :
Received : 16/10/2015 | Accepted on : 24/10/2015 | Published : 07/11/2015

Yield and Yield Components of Fluted Pumpkin (*Telfairia occidentalis* Hook) Landrace

Ann Nwonuala, Julius Obiefuna

Abstract **– A field experiment was conducted on five (5) *Telfaria occidentalis* landraces in Southeastern agroecological zone of Nigeria. The Rivers (RV) landrace out-yielded the other landraces of Enugu (EN); Anambra (AN), Abia (AB) and Imo (IM) in almost all the characters studied. They produced the longest vine at flowering ($418.1cm$ for male plants and $473.3\,cm$ for the female plants), the highest number of branches, (8.0) the highest number of nodes (89.0) at 6 weeks after planting (WAP), the highest number of leaves (93.5) at 6 WAP and at flowering (238 for the male plants and 196 for the female plants), which culminated into the highest leaf yield of $193.5kg/ha$ at 6 WAP and $482.5kg/ha$ at flowering. The RV landrace also produced the highest number of female flowers per plant (83); and consequently an agronomic potential for highest fruit yield. In order of appropriate performance, RV landrace was followed by EN, AN, IM and AB landraces.**

Keywords **– Agronomy, Fluted Pumpkin, Landrace, Performance, Tropics.**

I. INTRODUCTION

Telfairia occidentalis belongs to the genus *Telfairia* Hooker, Tribe *Joliffeae*, sub-family *Cucurbitoideae* and family *Cucurbitaceae.* It is an important vegetable of the Tropical West African. In Nigeria, it is indigenous to Southeastern Nigeria, where it is cultivated as an important nutritional and commercial vegetable. In the North Central Nigeria, it has gained acceptability and there is increase in its cultivation by small farm holders as a source of income (Ndor *et al*., 2013). Its cultivation has also spread into the Northern Guinea Savannah and into other cultures where the leaves apart from its use as vegetables are extensively used in African traditional herbal medicine for the treatment of anaemia in view of its high ferrous content which is about 700 ppm (Aiyalaagbe, 2011) and in the treatment of cough, diarrhea, tuberculosis and other bacterial infections (Egbomeji *et al*., 2006).

Recently, fluted pumpkin is associated with protection from devastating blood pressure, cholesterol and diabetes (Ugwu *et al.,* 2000). The young shoot and leaves of the plants are used to make soup because of the pleasant taste but more importantly, is the nutritional benefits of blending fluted pumpkin seeds into wheat flour for bread making (Giami, 2003). The seeds can also be eaten whole, ground or fermented into 'ogiri' which serve as condiments for making soup and source (Asiegbu, 1987). The fruit pulp which constitutes 64 % of whole fresh fruit weight can be used as feedstuff for livestock (Essien *et al.,* (1992); Egbekan *et al.,* (1998) and the pectin content of the pulp (1.0%) has been used in the production of marmalade (Egbekan *et al.,* 1998). The seeds of *Telfairia* are large and weighs 80 times more than those of melon ($0.15g - 12.50g$), and 55% of the weight of the dry seed kernel constitutes high quality non-drying oil. The increasing relevance of *Telfairia* seeds and oil as industrial raw material is creating International Trade opportunities for countries where they are grown. The high oil content makes it a potential source of raw materials for the vegetable oil industries in Nigeria, for making margarine and these justify the apparent increase in its production in Nigeria (Odiaka *et al.,* 2008). The seeds are also in high demand for consumption by nursing mothers because of their lactation promoting properties, owing to the high concentration of essential fatty acids and poly unsaturated fatty acids and iodine. The oil is also used for hair treatment as it enhances luster and hair growth (Bird, 2003). The *Telfairia occidentalis* plants according to reports can be used in bioremediation of heavy polluted soils (Obute, *et al.,* 2001).

Recently, based on its importance in the economy of Nigeria, the Ministry of Agriculture approved the procurement of *Telfairia occidentalis* seeds for distribution to 200 vegetable farmers in five (5) selected States of Abia, Ogun, Delta, Cross Rivers and Imo (Acha, 2013). This is an indication of the recent high trend in the demand of *Telfairia occidentalis* leaves and seeds.

The agronomy of fluted pumpkin according to Olamiyi and Akanbi (2007) has been neglected because it does not fall into the export category like most other tropical vegetable crops.

Morphotypic variations also exist in *Telfairia occidentalis* in many quantitative and qualitative characters and these pose many agronomic problems encountered when growing the crop, and to increase yield, the farmers are always constantly searching for more efficient procedures to increase the production of the vegetable grown, and the correct choice of cultivars are of very exceptional importance. Concomitantly with this, there is an urgent need to screen available genotypes in order to identify genotypes that can be used directly to develop varieties with higher proportion of plants that increase leaf yield, produce more seeds per fruits, and more fruits per plant. This will and form basis for breeding and also unmask hidden traits for the basis of selection. This work evaluated the yield and yield components of *Telfairia occidentalis* genotype in some locations in southeastern Nigeria.

II. MATERIALS AND METHOD

A. Site characteristics

The experimental site was a secondary forest which has been previously cultivated to maize before it was left fallow for one year. The dominant plant species included broad-leafed weeds and grasses like *Panicum maximum; Ageratum conyzoides, Pennisetum purpureum, Commelina*

benghalensis. Mimosa pudica, Tridax procumbens, Centrosema pubescens, Cyperus rotunda, Digitaria horizontalis, and Amaranthus spinosus. The land measuring $34\ x\ 54m^2$ $(0.18ha)$ was cleared manually and then ridged. The ridges were 30 meters long and 1 meter apart. There were a total of 20 ridges.

Experimental Design and Treatments

The experiment consisted of five (5) treatment plots which were laid out in a Randomized Complete Block Design (RCBD) replicated 4 times. There were a total of 20 plots measuring $30\ x\ 1m$ and an inter-block spacing of 4 meters. The treatments were twenty *Telfairia occidentalis* fruits of traditional landraces obtained locally from selected home gardens and markets within five states in the Southeastern agroecological zones of Nigeria. Four fruits were obtained from each of the states and named after the states thus:- Imo (IM), Abia (AB), Anambra (AN), Enugu (EN) and Rivers (RV). The four fruits from each of the states were characterized for length, width, circumference, then split open, and seeds scooped, processed, counted and bulked.

B. Preparation of planting materials and planting

Each of the seeds from the four fruits were weighed individually and 15 seeds each of uniform sizes of 12 ± 0.5 grams were selected from each fruit.

These were used for the various replicates. There were 15 seeds per plot in four replicates. These gave a total of 60 seeds per treatment. The seeds were planted on the ridges and spaced 2x2 m between and within the rows. These translated to 2, 500 seeds per ha. One seed was planted per hole of 5 cm depth.

Weeding was done manually using a hoe at 3 and 6 weeks, respectively after planting. The experiment was fertilized with NPK (20:10:10) at 3 weeks after planting using ring application method at a rate of 24g/stand which translated to 60kg/ha. No pest control method was adopted as the experimental site witnessed minimal pest attack. As the seeds germinated, and develop, plants with superior vegetative characteristics from each plot were duly tagged as potential parents (male or female).

C. Data collection and Analysis

Data were collected on days to 50 % emergence, leaf, and branch counts, leaf Area, vine length, flower bud initiation, fruit maturation, fruit weight and number of seeds per fruit. Soil samples from study sites were air-dried and sieved using a 2-mm sieve. Particle size distribution (Sand, Silt, Clay) was determined by the hydrometer method (Gee and Or,2002). Soil pH was determined in both distilled water and $CaCl_2$ solution at 1:2.5 soil to solution ratio using a Beckman Zeromatic pH meter (Hendershot *et al*.,1993).Organic carbon content of the soil was determined by the dichromatic oxidation method as outlined by Nelson and Sommers (1982). Total Nitrogen was by modified micro-Kjeldahl digestion-distillation procedure (Bremner, 1965). Available phosphorus (P) was by the method of Bray and Kurtz No.1 (Olsen and Sommers,1982). Calcium, magnesium, potassium and sodium (Ca, Mg, K, Na) were determined by I N NH_4OAC buffered at pH 7.0, extraction method (Soil Survey Staff,2010).

D. Data Analysis

The data collected were subjected to analysis of variance (ANOVA). Least significant difference (LSD) according to Gomez and Gomez (1984) was used to compare treatments means.

III. Results and Discussion

The climatic data for the study area during the growing season are presented on Table 1. The mean maximum temperature for 2013 ranged from $30.4\ to\ 36.5℃$. with the lowest temperature of $20.0℃$ recorded on January. The rainfall pattern also showed the rains became regular from March/April and peaked in May and June and terminated in February in 2012 while in 2013 the peaked period started in June and July.

Table 1: Climatic data of the experimental area for 2012 and 2013

Month	Temperature ℃				Rainfall (mm)		Relative Humidity %	
	2012		2013		2012	2013	2012	2013
	Max	Min	Max	Min				
January	34.1	23.8	33.7	20.1	317.0	156	60.1	59.0
February	36.3	23.2	36.4	24.7	00.0	00	53.0	55.0
March	34.0	24.5	36.5	22.0	205.0	215.1	57.3	58.2
April	32.5	24.2	35.0	25.2	308.0	230.5	75.3	75.1
May	32.4	23.6	33.6	24.8	540.9	254.0	74.2	77.0
June	30.5	23.5	32.1	23.0	514.8	290.4	82.0	76.5
July	29.7	23.0	30.4	23.5	310.9	289.3	77.0	77.5
August	29.1	23.2	30.9	23.0	325.0	200.5	79.2	79.0
September	31.0	23.4	30.8	23.3	239.6	265.2	78.4	78.1
October	31.9	23.3	31.2	23.7	254.2	190.5	76.2	79.2
November	32.2	23.5	33.3	24.5	157.4	150.0	76.3	76.9
December	33.4	24.1	35.5	23.2	397.0	124.0	63.2	61.0
Total	387.1	283.3	397.5	281.0	3569.8	2365.5	852.2	852.5
Mean	32.3	23.6	33.3	23.4	297.5	197.1	71.2	71.0

Source: Federal Ministry of Aviation Meteorology Unit, Owerri, Imo State.

Table 2: Physico-chemical Properties of Soils in the study sites (mean values)

Soil properties	Unit	Values (2012)	Values (2012)
Sand	g/kg	670	680
Silt	g/kg	28	29
Clay	g/kg	311	311
Texture	-	Sand Clay Loam	Sandy Clay Loam
pH in H_2O	-	5.2	5.0
pH in 0.01m $CaCl_2$	-	4.7	4.6
Organic carbon	g/kg	12.9	12.8
Total nitrogen	g/kg	2.4	2.0
Available phosphorus	mg/kg	5.49	5.50
Exchangeable Sodium	cmol Kg^{-1}	0.33	0.32
Exchangeable potassium	cmol Kg^{-1}	0.10	0.11
Exchangeable calcium	cmol Kg^{-1}	0.63	0.62
Exchangeable magnesium	cmol Kg^{-1}	0.59	0.57
Cation exchange capacity	cmol Kg^{-1}	2.90	2.92

Soils of the experimental sites were high in sand-sized particles and was texturally classified as sandy clay loam. The soils were slightly acidic, low in organic matter and low in exchangeable basic cations (Table 2). These findings were consistent with earlier studies in the agroecology (Onweremadu, 2006; Onweremadu *et al.*,2007). High soil acidity limits availability of plant nutrients especially soil phosphorus. Low organic carbon content coupled with low value of total nitrogen may constrain luxuriant yield in fluted pumpkin. In a similar study, Onweremadu *et al.*(2008) observed that low organic carbon adversely affected soil quality particularly macroaggregation. In addition to the above, values of basic cations of Ca,Mg and K which constitute secondary macronutrients were low.

At flowering, the vine length meters of the male and female plants varied significantly within and between the landraces. The female plants of all the landraces had longer vines than the males. Females and males of RV landrace however had the longest vines (473.1cm and 418.1cm) while females and males of AB landrace had the shortest (279.5cm and 251.8cm) Table3.

Table 3: Stem Parameters of the Different Genotypes at 6WAP and at Flowering

	Vine Length (cm)			No. of Branches per Plant			No. of Nodes per Plant			Internode Length (cm)		
Land Race	6WAP	Flowering		6WAP	Flowering		6WAP	Flowering		6WAP	Flowering	
		Male	Female		Male	Female		Male	Female		Male	Female
Enugu (EN)	158.3	271.7	352.3	7.0	15.0	13.0	78.5	115.0	110.0	7.7	9.6	8.6
Anambra (AN)	111.3	304.6	375.3	5.3	16.0	15.0	62.0	132.0	135.0	6.5	9.4	8.8
Abia (AB)	81.3	251.8	279.5	6.0	13.0	12.0	66.0	132.0	129.0	5.4	7.9	10.8
Imo (IM)	120.3	337.0	397.3	5.0	24.0	13.0	54.0	95.0	149.0	6.1	10.3	9.6
Rivers (RV)	142.3	418.1	473.3	8.0	25.0	15.0	89.0	221.0	180.0	6.8	7.7	6.8
LSD $_{(0.05)}$	26.20	55.70	162.3	2.09	6.26	4.49	17.22	72.10	91.29	1.46	1.32	1.50

The Rivers (RV) landrace also produced the highest number of branches, nodes, leaves, the longest petioles and the largest leaf area (Table 4). The increase in leaf area is relatively high among the landraces and also between the sexes (Table 4). The female plants had larger leaf area than the males with exception of Abia (AB) landrace where the males leaf area was larger than the females (Table 4).

The number of flowers per plant varied among the different landraces. The RV landrace initiated the highest number of females flowers and this led to the highest number of fruits per treatment (Table 5). This is followed by AN and AB landraces. The least number of flower and fruit initiation per plant was IM landrace. The RV landrace produced the largest fruit but the highest number of seeds per fruit was produced by EN landrace, while RV with the biggest fruit had the least number of seeds per fruit (Table 5).

Wright, (1975) reported that characteristics such as growth rate and branch size are under the control of genes as well as the environment and that plants from moister regions had potential genes for rapid growth and greener foliage when moved from their moister region to drier areas. Similarly, apart from the moist-dry superiority trend in plants, there were also genetic variability among plants separated by distance, according to him, plants 40 to 75

International Journal of Agriculture Innovations and Research
Volume 4, Issue 3, ISSN (Online) 2319-1473

Table 4: Leaf Parameters of the different Genotypes at 6WAP and at Flowering

	No. of Leaves Plant $^{-1}$			Leaf Area Plant $^{-1}$ (cm^2)			Petiole Length Plant $^{-1}$ (cm)			Leave Yield Per plant^{-1}		Leave Yield per Hectare (kg)	
	6WAP	Flowering		6WAP	Flowering		6WAP	Flowering		6WAP	Flowering	6 WAP	Flowering
Landrace		Male	Female		Male	Female		Male	Female				
Enugu (EN)	83.3	132.0	122.3	67.8	140.3	206.5	6.9	8.6	7.9	67.6	95.0	169.0	237.5
Anambra (AN)	66.5	145.0	151.8	38.8	105.3	259.3	6.4	8.1	8.9	43.3	88.0	123.3	220.0
Abia (AB)	70.5	132.0	140.0	38.8	192.1	163.0	6.1	8.4	11.1	50.8	183.8	127.0	459.5
Imo (IM)	58.3	215.0	165.0	31.8	107.2	223.3	5.5	7.2	9.9	43.2	192.5	108.0	481.3
Rivers (RV)	93.5	238.0	196.0	79.0	165.7	393.3	7.6	9.0	10.1	77.4	193.0	193.5	482.5
LSD $_{(0.05)}$	17.70	51.15	83.36	29.37	50.3	3.38	1.38	1.77	2.95	13.09	20.06	20.06	18.18

Table 5: Reproductive Yield and Yield Components of Genotypes

Land race	No. of Female Flowers Per Plant	% of Aborted Flowers or Unmatured fruit	No. of Matured Fruit per Treatment	Mean Fruit Length (cm)	Mean Fruit Width (cm)	Mean Fruit Weight (kg)	No. of Seeds per Fruit
EN	62	96.8	80	68	31	6.2	84
AN	72	94.4	55	60	25	4.8	71
AB	65	93.8	70	64	30	4.8	66
IM	57	96.5	50	41	12	6.5	54
RV	83	96.4	100	64	48	8.6	48
LSD $_{(0.05)}$	5.91	1.74	7.61	14.63	9.10	1.81	22.41

miles apart when grown together in the same place, grew 10 to 25% faster in all traits than plants brought together from the same are (Wright, 1975). The findings of this study agree with the above statements, hence the observed superior performance of RV landrace. The males of AB landrace instead of the female; had larger and broader leaves, the females however instead of the males had shorter vines (Table 3). This findings deviated from earlier reports that the female plants out yielded the male in edible leaf portion, total number of branches and reduced post flowering growth (Asiegbu, 1983) but agrees with reports of Schipper (2000), and Okafor, (1981). The growth rate of either male or female plant depends wholly or partially on the landrace and the genetic status or heredity of the plant. The increase in yield components and leaf area, number of nodes, leave yield of RV landrace formed the basis for the selection of RV landraces for further testing and evaluation. The finding that leaf yield components have direct effects on yield agrees with the work of Gwanama and Nichitertein (1996), and Sarkar, (2000). The major genetic characteristics that determine the yield of the different landraces are photosynthetic efficiency, seed size ability to take up soil nutrients and respond to fertilizer. This makes yield a multigene trait (Namkoong, 1979). Thus the increase in yield of RV landrace was dependent on the interaction of these multigene which were dominant or partially dominate the different phrases of growth and yield of *Telfairia occidentalis.* The percentage of aborted flowers among the landraces ranged from 96-98% meaning that only about 2-4% of the female flowers were able to set fruit and this resulted, in low fruit yield. The EN landrace had the highest percentage of aborted or immature female flowers. This was followed by IM, RV, AN and AB landraces and these affected the fruit yield of the different landraces. According to Sugiyama, (1998), abortion of female flowers and low fruit setting ratio in cucurbits are caused by weather conditions characterized by a low temperature and little sunshine. Loss in fruit yield was also due to inefficient pollination scheme (viable pollen grains, presence of receptive stigma, and sufficient pollen transfer to the stigma (Gruben, 1977). *Telfairia occidentalis* depend on sufficient pollen transfer to the stigma by their pollinators (Bees and ants). Ants are very slow pollinators and the activities of the bees are being affected by low temperature and insufficient food supply (nectar and pollen grains). Bees cannot use their wings at temperatures lower than 25℃ which can be attained at night in the Southeastern agroecological zone. The time of flowering of the different cultivars ranged from 88 to 121 days for the males and 95 to 149 days after planting for the females. This implies that flowering was during the peak of the rainy season when pollinators are absent or inactive due to low temperature, wet weather and little sunshine. The net effect is that lots of the flowers are aborted (96-98%) or remained unpollinated resulting in the low fruit yield of only 2 - 4%.

IV. Conclusion and Recommendation

Owing to the economic value of *Telfairia occidentalis* Hook in Nigeria, especially in Southern part of Nigeria, attention was drawn to the improvement of this important vegetable. Incidentally, high rate of cross-pollination in the *Telfairia occidentalis* germplasm had led to each landrace having its own peculiar genotype.

This situation stresses the need for a comprehensive study of the different landrace ex-situ to dictate the origin of the best genotype for the improvement of *Telfairia occidentalis.* The Rivers (RV) landrace out-yielded the

other landrace in the Southeastern agroecological zone, for all the characteristics studied. In the order of appropriate performance, RV was followed by EN, AN, IM and AB landraces. The RV landrace are better suited for IM environment for high yield of *Telfairia occidentalis* and this forms additional income for growers of this important vegetable.

The AB landraces with short vine length and internodes should be monitored further for future production of bush type *Telfairia occidentalis* that might improve crop management and respond to high density planting. The different landraces should be further tested in multilocational trials for agroecological adaptation confirmation of the landraces.

REFERENCES

[1] Acha, E. (2013). Boosting the cultivation of fluted pumpkin in Nigeria. New Agency of Nigeria (NAN) Features. (7) No 231.

[2] Aiyelaagbe, I. O. O. (2011). Nigeria Horticulture facing the challenges of Human health and Agricultural Production. Proceedings of 29th Annual conference, Horticultural Society of Nigeria, Markurdi. 24-29, July 2011, Nigeria.

[3] Asiegbu, J. E. (1983). Effects of method of harvest and interval between harvests on edible leaf yield in fluted pumpkin. *Scientia* Hortic., 21: 129-139.

[4] Bird, S. R. (2003). African oils: Health and Beauty from the motherland. (online). http//:www.islamonline.net./English/Science/2003/10/article105.

[5] Bremner, J.M.(1996). Nitrogen Total In: Sparks D.L (ed.) Method of soil analysis part 3chemical method SSAS Book series No.5 Am Soc Agron Madison WI .pp 1085- 1121

[6] Edmond, J. B., Senn, T. L., & Andrews, F. S. (1980). Fundamentals of Horticulture. 2nd Ed., New York, McGraw-Hill Book Company.

[7] Egbekan, M. K., Ada-Suleiman, E. O., & Akinyeye. O. (1998). Litiligation of fluted pumpkin fruit (*Telfairia occidentalis)* in marmalade manufacturing plant. Foods for human nutrition. 52(2): 171-176.

[8] Egbomeji, M., Hawe, B. O. & Egbagbe, G. (2006). Studies on the chemical composition of seeds of Curcubitaceae and their suitability in food. International Biodeteriotion. 26(2) 65-70.

[9] Essien, A. I., Ebana, R. U., & Udo, H. B. (1992). Chemical evaluation of the pod and pulp of the fluted pumpkin (*Telfairia occidentalis)* fruit. Science Direct. http//: www.sciencedirect.com/sicence/article/pii/03088146929011N.

[10] Gee, G.W, and Or, D. (2002). Particle size analysis. In: Dane, J.H, Topp G.C(eds). Method of soil analysis, Part 4, Physical methods. Soil Sci. Am. Book Series No 5, ASA and SSSA, Madison, WI.pp. 255-293.

[11] Giami S. Y. (2003). Effects of germination on bread-making properties of wheat-fluted pumpkin (*Telfairia occidentalis)* seeds flour blends. Plants foods for human nutrition. 58:1-9

[12] Gomez, K. A., & Gomez, A. A. (1984) Statistical Procedures for Agricultural research. 2nd Ed. John Wiley and Sons New York.

[13] Grubben, G. J. H. (1977). Tropical vegetables and their genetic resources. International Board for Plant Genetic Resources. FAO, Rome.

[14] Gwanama., & Nichitertein, K. (1996). Leaf yield component and Nutritional quality of Zambian pumpkin Landraces. *Genetics and Breeding*, *Cucurbitaceae.* News letter. (96), 1-4

[15] Vienna, Austria.Hendershot, W.H., Lalande, H. and Duquette, M. (1993). Soil reaction and exchangeable acidity. In: Soil sampling and methods of analysis. Carter, M.R (Ed.). Can. Soc. Soil Sci., Lewis publishers London.pp.141-145.

[16] McLean, E.V., (1982). Aluminum,. In: Page, A.L., Miller, R.H. and Keeney, D.R.(eds.). Methods of Soil Analysis, Part 2, American Society of Agronomy, Madison, WI. pp. 978-998.

[17] Nam Koong, G., Snyder, E.B., & Stonecypher, R. W. (1966). Heritability and gain concepts for evaluating breading systems such as seeding orchards. *Silvae Genet*., 15: 76-84.

[18] Ndor, E., Dauda, S. N., & Garba, M. N. (2013). Growth and yield performances of *Telfairia occidentalis* Hook F. (fluted pumpkin) under organic and inorganic fertilizer on ultisols of North Central Nigeria. International Journal of Plant and Soil Science 2(2): 212-221.

[19] Nelson, D. W. and Sommers, L. E. (1982). *Total carbon, organic carbon and organic matter.* In Page, A. L., Miller, R. H.and Keeney, D. T. (eds.) Methods of soil analysis, chemical methods, ASA and SSA, Madison, WI.pp. 1085 – 1121.

[20] Obute, G. C., Wegwu, M. O., & Akaninwor, J. O. (2001). Determination of lead accumulation and toxicity in *Telfairia occidentalis* Hook in the Niger Delta. J. Appl. Sci. Environ Mgt. 5(2): 85-88.

[21] Odiaka, N. I., Okoroda, M. O., & Odiaka E. C. (2008). Diversity and production methods of fluted pumpkin (*Telfairia occidentals* Hook F.). Experience with vegetable farmers in Makurdi, Nigeria. African Journal of Biotechnology, (7). 8

[22] Okafor, J. C. (1981). Woody plants of nutritional importance in the traditional farming systems of the Nigerian Humid Tropics, Ph.D. thesis. Univ. of Ibadan.

[23] Olsen, S.R and L.E. Sommers (1982). Phosphorus. In: Methods of soil Analysis part 2. Edited by A.L Page; R, H Miller and D.R Keeney. Madison Wl., Am. Soc. Agron. Pp 803-830.

[24] Onweremadu, E. U. (2006). Assessment of mined soils in erosion – degraded farmlands in southeastern Nigeria. *Estudio Biologia* 28: 59 – 67

[25] Onweremadu, E. U., Onyia, V. N.and Anikwe, M. A. N. (2007). Carbon and nitrogen distribution in water-stable aggregates under two tillage techniques in Fluvisols of Owerri area, Southeastern Nigeria. *Soil & Tillage Research* 97: 195 – 200.

[26] Onweremadu, E.U., F.O.R. Akamigbo and C.A. Igwe. 2008. Soil quality morphological index in relation to organic carbon content of soils in southeastern Nigeria. Trends Appl. Sci. Res., (1): 76-82.

[27] Onweremadu, E. U.; S. K. Osuaku, A. C. Udebuani and M. Lekwa.2011.Carbon sequestration in soils of three land use types in Owerri area, SoutheasternNigeria. Nig. J. Agric. Food and Environ. 7(3):20 -24.

[28] Sarkar, A. (2000). Modern handbook of Agricultural Science. NAT offset press. Meecnet.

[29] Soil Survey Staff(2010).Keys to soil taxonomy.Eleventh edition.USDA/NRCS.338pp.

[30] Stalker, H. T., & Murphy, J. P. (1992). Plant & breading in the 1990's. Wallingford. U.K CABI.

[31] Sugiyama, K. (1998). Varietal differences in female flower bearing ability and evaluation method in watermelon. TARG 32: 267-273.

[32] Wright, J. W. (1976). Introduction to forest genetics. Academic Press. New York. 463pp.

AUTHOR'S PROFILE

Ann Nwonuala

M.Sc. (Agronomy) – Kuban Agricultural University, Rasnodar, Russia
Ph.D (Plant Breeding) – Federal University of Technology, Owerri, Imo State, Nigeria.
Present Position: Senior Lecturer & Head of Department, Crop/Soil Science Department,
Rivers State University of Science and Technology
Email: nwonuala.ann@ust.edu.ng
Mobile: 08063554993

Julius Obiefuna

M.Sc. (Agronomy) – University of Nigeria, Nsuka
Ph.D (Horticulture) – University of Nigeria, Nsuka
Professor of Horticulture (Agronomy)
Email: juliusobiefuna@yahoo.com
Mobile: 08030963452