NIGERIAN AGRICULTURAL JOURNAL
ISSN: 0300-368X
Volume 51 Number 2, August 2020 Pg. 274-280
Available online at: http://www.ajol.info/index.php/naj

EVALUATING SWEETPOTATO SEEDLINGS POPULATION FOR NUMBER OF ROOT YIELD POTENTIAL, ROOT FLESH COLOUR VARIABILITY AND CANOPY ARCHITECTURE

[1]Nwankwo, I.I.M., [1]Ikoro, A.I., [1]Amanze, N.J., [1]Obasi, C.P., [2]Okereke, A.C. and [1]Ejalonibu, M.S.

[1]National Root Crops Research Institute, Umudike, P.M.B 7006, Umuahia, Abia State, Nigeria
[2]College of crops and Soil Sciences,
Michael Okpara University of Agriculture, Umudike, Umuahia, Abia State, Nigeria
Corresponding Authors' email: nwankwomaxwell@yahoo.com

Abstract
A field study was conducted at the western farm of National Root Crops Research Institute (NRCRI) Umudike, Umuahia, Abia State in the rainforest of Southeast Nigeria to evaluate the newly developed sweetpotato seedlings for storage root yield potential, determine the storage root fleshed colour variation and canopy architecture of the sweetpotato seedlings. Three thousand seeds from both controlled and diallel mating were collected from 12 families and raised in poly-bags that measured 4 x 6cm in size. The seedlings were later transplanted to the field at six leaf stage (that is two months after planting) in polybags at planting distance of 30 x100cm for field evaluation. The following data were collected at harvest based on single plant bases: presence of storage roots, number of storage roots per plant, flesh colour of storage roots and vine length of each plant. Results obtained indicated that seedlings with high number of large storage roots per plant may be selected as having high storage root yield potential. Sweetpotato parents used as females intend to influence their progenies in certain morphological attributes in terms of flesh root colour characteristics and seedlings discriminated into types of storage root flesh colours could be regarded as varieties and as such could be put into different domestic and industrial utilization, while the sweetpotato canopy structure that differentiated the seedlings into erect/bushy types and spreading types could be incorporated into different farming systems of the people.

Keywords: Seedlings, Families, yield potential, flesh colour and canopy architecture

Introduction
The classical method of improving sweetpotato crop is through sexual means which includes polycross and controlled crosses (Sharma, 1980 and Singh, 2016). These two principal methods were used to generate botanical seeds that are planted for field evaluation of the population. Significant progress was made in producing improved sweetpotato genotypes with higher yields, greater disease and pest's resistance and consumers' and industrialists' acceptability (Teshome and Ameti, 2010; Nwankwo, 2012). Varieties developed and released with this method have high export demand compared to varieties developed through genetic modification where genes from unrelated species may be forced to unite through unnatural means leading to a new product. Classical breeding have been used to improve the mineral content (such as iron, zinc, calcium, magnesium, etc.) and vitamins (such as Vtamin A, B, K, etc) of sweetpotato storage roots and foliage (Wolfgang, 2008). These minerals and vitamins are of health importance and should be used in profiling any crop that should be used to replace existing ones.

Iron is a trace mineral and an essential nutrient that our body requires to function properly. Iron helps with immune function; detoxification, and creation of several proteins and enzymes. Iron helps in the production of proteins such as hemoglobin; which is a complex protein used by red blood cells to carry oxygen to the cells throughout the body. When a body lacks sufficient

iron, hemoglobin or red blood cells to transport oxygen from the lungs to all the cells in the tissues, organs, bones and nerve systems; it leads to a condition called anemia. This is a condition that occurs when our blood does nott get enough iron, hemoglobin, or red blood cells to transport the oxygen needed from the lungs to our tissues. There are several types of anemia, however, iron deficiency is by far the most common.
WHO (2008), reported that over 1.6 billion people worldwide are anemic; of these, several hundred million have iron deficiency anemia. However, two types of dietary iron are of notable importance. These are heme and non-heme. Heme iron are of animal sources: meat, poultry, and seafood. Plant sources contain non-heme iron, which is not easily absorbed by the body as heme. This may be as a result of presence of certain phytochemicals in plants, including oxalates, polyphenols, tannins, and phytates which promote slower, more controlled iron absorption. To prevent iron deficiency anemia, it's important to consume the right amount of iron for our body. Different life stages have different requirements, and women need a little more than men.

Malnutrition is a major contributor to infant mortality in sub-Saharan Africa. Deficiency of micronutrients such as vitamin A, zinc (Zn) and iron (Fe) affect at least half of the world's population. In 2008, malnutrition contributes to over a third of child deaths in the world. Iron deficiency-anemia is prevalent worldwide and occurs in both industrialized and developing countries. WHO (2008), report indicates that the highest proportion of individuals affected by anemia; evidently linked to poverty is in Africa. Fortunately many countries in Africa consume sweetpotato. This crop feeds over 100 million people in the poor communities in Africa, and therefore plays a significant role in human nutrition and livelihood. Ukom *et al*., (2009), observed that the crop sweetpotato is a cheap source of protein (2-8%), carbohydrate (32%), fibre (56%) and micronutrients, especially iron (70mg/kg), zinc (33 mg/kg), and vitamin A that enhance normal body and mental growth and development. The mineral iron, provide 127% and 80% of daily estimated average requirements of children and women respectively.

The roots can also be processed into flour for bread making, starch for noodles and as raw material for industrial starch and alcohol (Ukom *et al*., 2009). Tewe *et al*., (2000), reported that sweetpotato flour is utilized in sweetening local beverages like *Kunu-zaki*, *burukutu*, and for fortifying baby foods and *fufu*/pounded yam in Nigeria. The leaves are used as vegetables in yam and cocoyam porridge and are rich in proteins, vitamins and various minerals. According to Onwueme and Sinha (1991), sweetpotato storage roots are rich in vitamins A, B, and C, and minerals such as K, Na, Cl, P and Ca. Sweetpotatoes can be put into many uses and value additions to various food forms. However, there is need to develop varieties that are high yielding, resistant to various pests and diseases ravaging sweetpotato in the field, income generation and can fit into the farming systems of the people (Onwueme and Sinha, 1991). Existing varieties are degenerating as a result of pests and diseases. Climatic change is also affecting the performance of existing varieties. The natural way of developing new varieties is by hybridization. Hybridization is one of the ways to generate variability in sweetpotatoes and as noted by Nwankwo *et al*., (2011), it is one of the revolutionary tools which tend to create genetic novelty for selection; a method used to discriminate genotypes in favour of the farmers and consumers desired needs.

This study is an attempt to provide a baseline for the development of storage roots for further investigation into the Iron (Fe) and Zinc (Zn) levels in sweetpotato seedlings developed through crosses. Previous studies on sweetpotato have shown the potential to exploit genetic variation in storage roots concentration of iron and other minerals without the general negative effect on storage root yield. Sweetpotato genotypes that maintain relatively high stable micronutrient levels in comparison to other crops in different environmental conditions are preferred. Up to date, released varieties have a range of 5 -11ppm Fe concentration and majority with concentration below 20ppm. This necessitates the need for research to develop high-Fe and Zincrich sweetpotato varieties. The aim of this present study was to evaluate the newly developed sweetpotato seedlings for storage root yield potential, determine the storage root fleshed colour variation and canopy architecture of the sweetpotato seedlings.

Materials and Methods

The field studies were conducted at the western farm of National Root Crops Research Institute (NRCRI) Umudike. Umudike is in the tropical rainforest zone of Nigeria lying between longitude $7^0 32''$ E and latitude 5^0 $29''$ N of the equator on an elevation of 122m above sea level (Agrometerological station, NRCRI-Umudike 2008 and 2009). Umudike has an annual rainfall of 1800mm to 2200mm. The rainy season which commences from March to late October is bi-modal in pattern, and comprise of early rain (March -July) and late rain (August -October), with a dry spell in August and five months of dry season. A part of the dry season is characterized by a cool dry northeastern wind. The air temperature varies from 22°C to 32°C while the relative humidity varies from 51% to 87%. The sunshine hours vary from 2.69 to 7.86 hours per day. The dominant soil is acid sandy loam in the ultisol group (FDALR, 1985).

Three thousand seeds from both controlled and diallel mating were collected from 12 families and raised in poly-bags that measured 4x6cm in size. The poly-bags were filled with topsoil mixed with poultry manure. The seedlings were transplanted to the field at six leaf stage; two months after planting in polybags at planting distance of 30 x100cm for field evaluation. The following data were collected at harvest based on single plant bases: presence of storage roots, number of storage roots per plant, flesh colour of storage roots and vine length of each plant. The storage roots will be analyzed for micro-nutrient and mineral content in a proximate analysis evaluation that will be published in another article.

Results and Discussion

Number of seedlings survived to maturity: A total of 1850 seedlings were transplanted to the field for evaluation, out of which 1353 seedlings which represented 73.1% survived. The data collected on this population is presented in Table 1. Out of the 1353 sweetpotato seedlings evaluated, 781 seedlings were full-Sib progenies which were seeds generated from controlled crosses, while 572 seedlings were half-Sib progenies which were seeds derived from diallel mating. The results of the number of storage root yield of all the families and their seedlings are presented in Table 1.

Seedlings with no storage root: Total number of seedlings without storage roots were 105 which accounted for 7.8%. This percentage was made up of 52 Full-Sib progenies and 53 Hail-Sib progenies. This group of seedlings ranged from 0 (UMUSPO/1 x Namanga) to 23 (TIS87/0087 x UMUSPO/3) in Full-Sib families, and 0 (UMUSPO/3 x OP and Nwoyorima x OP) to 34 seedlings (UMUSPO/4 x OP) in Half-Sib families. These seedlings may be regarded as non-storage root yielders and therefore should not be selected for storage root production in sweetpotato. This is because they would not produce storage roots, and may be regarded as low yielders. High storage root production is one of the objectives of sweetpotato breeding programme.

Seedlings with 1-2 storage roots per stand: A total of 1154 seedlings which represented 85.3% were made up of 461 Full-Sib progenies from seven Full-Sib families and 693 progenies from five families of Half-Sib. This group of seedlings produced storage root number with range from 1 to 2 roots per stand. The Family (TIS87/0087 x UMUSPO/3) from Full-Sib had 68 seedlings that produced number of storage roots that ranged from 1 to 2 per stand, while the family (Tio-Joe x Namanga) from Full-Sib family had 105 seedlings that produced number of storage roots that ranged from 1 to 2 roots per stand. Sweetpotato plants normally produce between one and more number of storage roots per stand. However, seedlings that produced one storage roots per stand when compared with seedlings producing many number of storage roots per stand may be regarded as low yielding.

Seedlings with 3-4 storage roots per stand: Sixty-seven seedlings which accounted for 5.0%, made up 50 Full-Sib seedlings and 17 Half-Sib seedlings produced 3 to 4 numbers of storage roots per stand. The Full-Sib family that produced 3 to 4 numbers of root per stand ranged from as low as 2 seedlings from the family of Tio-Joe x TIS87/0087 to as high as 15 seedlings from the family of TIS87/0087 x UMUSPO/3. Seedlings producing 3 to 4 storage roots per stand could be regarded as high yielders. The family in the Half-Sib had no seedling that produced 3 to 4 numbers of storage roots per stand, while the family of Nwoyorima x OP from Half –Sib that produced 6 seedlings produced 3 to 4 numbers of storage roots per stand. Many number of storage roots per stand is an evidence of high yielding. Sweetpotato seedling with high number of storage roots should be selected for further evaluation.

Seedlings with 5-6 storage per stand: The number of seedlings which produced 5 to 6 number of storage root per stand accounted for only 2.0% of all the seedlings planted (Table 1). This percentage includes 18 seedlings from Full-Sib families and 9 seedlings from the families of Half-Sib families. The families in the Full-Sib that had their seedlings produced no storage roots between 5 to 6 per stand were the families of UMUSPO/4 x TIS87/0087, and Tio Joe x TIS87/0087, while the families that their seedlings produced the highest number of storage roots between 5 to 6 per stand was TIS87/0087 x UMUSPO/3, and Nwoyorima x UMUSPO/4. Half-Sib family with the highest number of seedlings that produced 5 to 6 storage roots per stand was UMUSPO/3, while the families with no seedlings producing same number of storage roots per stand were UMUSPO/4 x OP and Ex-Igbariam. The families with seedlings that produced 5 to 6 numbers of storage roots per stand per 1000plants per hectare were regarded as high yielding genotypes compared to seedlings producing one storage root per stand per 1000plants per hectare.

***Seedlings with 7-8 storage roots per stand*:** None of the seedlings from all the families in both the Full-Sib and Half-Sib produced number of storage roots up to 7 to 8 per stand. This limit indicates the highest all the families could produce. Therefore, the potential number of storage root yield of all the families both Full-Sib and Half-Sib was between 5 to 6 storage roots per stand per yield per hectare should be selected for further advancement. Seedlings with such number of storage roots for every 1000plants per hectare should be selected as high yielding genotypes (Table 1).

Storage root colour characteristics: The storage root colour characteristics of the sweetpotato seedlings evaluated are presented in Table 2. The flesh colour of the storage roots of the sweetpotato genotypes were used to discriminate the seedlings into varieties (Nwankwo, and Njoku, 2019).

Table 1: Number of storage yield potential of the sweetpotato seedlings evaluated

Families	Family root flesh trait	Number of seedlings planted	Seedlings with no storage roots	Seedlings with 1-2 roots per stand	Seedlings with 3-4 roots per stand	Seedlings with 5-6 roots per stand	Seedlings with 7-8 roots per stand	Vine length <1.0m	Vine length >1.0m
TIS87/0087 x UMUSPO/3	Cream x orange	112	23	68	15	6	0	21	91
Namanga x 87/0087	Orange x cream	116	3	100	11	2	0	55	61
UMUSPO/1 x Namanga	Orange x Orange	112	0	97	12	3	0	14	98
Nwaoyorima x UMUSPO/4	Cream x Orange	110	4	96	4	6	0	0	110
UMUSPO/4 x TIS87/0087	Orange/cream	118	19	96	3	0	0	13	105
Tio-Joe x TIS87/0087	Orange x Cream	101	0	99	2	0	0	0	101
Tio–Joe x Namanga	Orange x Orange	112	3	105	3	1	0	6	106
Sub-Total	**Full-Sib**	**781**	**52**	**461**	**50**	**18**	**0**	**109**	**672**
UMUSPO/3 x OP	Orange	114	0	106	4	4	0	7	104
UMUSPO/4 x OP	Orange	121	34	87	0	0	0	38	83
Ex-Igbariam x OP	Yellow	110	6	101	3	0	0	3	107
Nwaoyorima x OP	Cream	111	0	103	6	2	0	0	111
TIS87/0087 x OP	Cream	116	13	96	4	3	0	4	112
Sub-Total	**Half-Sib**	**572**	**53**	**693**	**17**	**9**	**0**	**52**	**517**
	GRAND TOTAL	1353	105	1154	67	27	0	161	1189
	Mean		6.8	96.2	5.6	2.3	0	13.4	99.1
	%		7.8	85.3	5.0	2.0	0.0	11.9	88.0

Note: OP= Open pollinated

Table 2: Root flesh colour characteristics of the sweetpotato seedlings from various families evaluated

Families	Root flesh colour of parents	Number planted	White fleshed	Cream fleshed	Orange fleshed	Yellow fleshed	Purple fleshed	Brown fleshed	Intermediate orange/yellow
TIS87/0087 x UMUSPO/3	Cream x orange	112	0	89	23	0	0	0	0
87/0087 x Namanga	Orange x cream	116	0	95	20	1	0	0	0
UMUSPO/1 x Namanga	OrangexOrange	112	0	0	109	3	0	0	0
Nwaoyorimax UMUSPO/4	Cream xOrange	110	0	12	9	89	0	0	0
UMUSPO/4 x TIS87/0087	Orangexcream	118	0	22	95	1	0	0	0
Tio-Joe x TIS87/0087	Orange xCream	101	0	3	98	0	0	0	0
Tio–Joe x Namanga	OrangexOrange	112	0	0	99	13	0	0	0
Sub-total	**Full-Sib**	**781**	**0**	**221**	**453**	**107**	**0**	**0**	**0**
UMUSPO/3 x OP	Orange	114	0	0	108	2	1	0	4
UMUSPO/4 x OP	Orange	121	0	0	120	1	0	0	0
Ex-Igbariam x OP	Yellow	110	0	5	17	79	0	0	9
Nwaoyorima x OP	Cream	111	3	78	9	11	0	0	10
TIS87/0087 x OP	Cream	116	1	79	4	22	0	2	8
Sub-total	**Half-Sib**	**572**	**4**	**162**	**258**	**114**	**1**	**2**	**31**
	GRAND-TOTAL	1353	4	383	711	221	1	2	31
	%	=	0.4	28.3	53.0	16.2	0.07	0.14	2.3

Note: OP= Open pollinated

***Number of seedlings with white fleshed storage roots*:** Full-Sib progenies comprising 781 seedlings had different storage roots characteristics that differentiated them into varieties. All the seedlings of the full-Sib families had no seedlings with white flesh characteristics and the families in the Half-Sib which comprise of 572 seedlings both of which had 4 seedlings, which represented 0.4% seedlings that had storage roots with white flesh characteristics. The family with the highest number of seedlings with white fleshed storage root was Nwoyorima x OP, while the family with the least number of seedling with white fleshed storage root characteristics was TIS87/0087 (Table 2). The parent Nwoyorima and TIS87/0087 had cream fleshed storage roots.

***Seedlings with cream fleshed storage roots*:** The seedlings that produced cream fleshed storage roots were 383, which accounted for 28.3% seedlings, evaluated for their storage fleshed colour characteristics. The Full-Sib families with 221 seedlings had cream fleshed storage roots. The family that produced the highest number of seedlings which was 95 seedlings with cream fleshed storage roots wasTIS87/0087 x Namanga, while the family UMUSPO/1 x Namanga had no seedlings with cream fleshed storage roots. The parent UMUSPO/1 has light orange fleshed root, while Namanga has orange fleshed colour. However none of their progenies produced cream fleshed colour from their parents. Namanga (male) being orange fleshed was crossed with TIS87/0087 (female); a cream fleshed parent had 95 progenies with cream fleshed colour. This was an indication of maternal influence The Half-Sib family with a total of 162 seedlings produced seedlings with cream fleshed characteristics. UMUSPO/3 x OP and UMUSPO/4 x OP did not produce any seedling with cream fleshed trait. However, TIS87/0087 produced as high as 79 seedlings with cream flesh storage root. UMUSPO/3 and UMUSPO/4 were parents with deep orange flesh, while TIS87/0087 had cream fleshed storage roots. Their progenies seem to inherit storage flesh root colour from their maternal parents. Sweetpotato parents used as females intends to influence their progenies in certain morphological attributes in terms of flesh root colour characteristics.

***Seedlings producing orange fleshed storage roots*:** The total number of seedlings that produced orange fleshed storage root was 711. This figure represented 53.0% of all the seedlings from various families that were evaluated. In the full-Sib families, 453 seedlings produced orange fleshed storage roots. The highest number of seedlings which was 109 was from the family of UMUSPO/I x Namanga, while the least number of seedlings (9) were produced by the family of Nwoyorima and UMUSPO/4; all were orange fleshed parents except Nwoyorima, which has cream fleshed characteristics. The Half –Sib families had a total of 258 seedlings which produced orange fleshed storage roots. The family of UMUSPO/4 x OP produced 120 seedlings, which was the highest number of seedlings with orange fleshed roots, while the least number of seedlings (4) from Half-Sib families of TIS87/0087 x OP. Pollens from an unknown parent might have fertilized the ovule resulting in the orange flesh colour characteristics from a parent with cream fleshed storage roots.

***Seedlings with yellow fleshed storage roots*:** Full-Sib and Half-Sib gave 221 seedlings which represented 16.2% of all the seedlings evaluated for their storage flesh root colour. The Full-Sib family with the highest number of seedlings (107) with yellow flesh trait was from the family of Nwoyorima x UMUSPO/4. The following families had no seedling and storage root colour yellow: Nwoyorima x UMUSPO/4 and Tio-Joe x TIS87/0087 respectively. The Half –Sib families contributed 114 seedlings with yellow fleshed storage root colour. Ex-Igbariam x OP family accounted for 79 seedling which was the highest number of seedlings with yellow fleshed, while UMUSPO/4 produced least number of seedling (1) with yellow flesh storage roots (Table 2).

***Purple fleshed storage roots*:** Full-Sib with total of 781 seedlings and Half-Sib comprising 572 seedlings produced 0.07% of purple fleshed storage root seedlings. However, none of the Full-Sib seedlings produced purple fleshed genotypes. The purple fleshed seedlings was observed among one of the progenies from the family of UMUSPO/3 x OP (Table 2).

***Brown fleshed storage root seedling*:** All the families from both Full-Sib with total of 781 seedlings and Half-Sib comprising of 572 seedlings produced 0.14% of brown fleshed storage root seedlings. None of the seedlings from the seven families that made up Full-Sibs seedlings produced brown fleshed storage roots. Brown fleshed storage root was observed in the Half-Sib within the family of TIS87/0087; where two seedlings produce brown fleshed storage roots.

***Mixed/Intermediate fleshed storage roots*:** The 1353 seedlings from various families (Full-Sib and Half-Sib) accounted for 2.3% of seedlings with brown fleshed storage roots. None of the seedlings from Full-Sib families produced mixed/intermediate fleshed storage roots, while at the Half Sib families, the family of UMUSPO/4 produced no seedlings with mixed/intermediate fleshed storage roots. The family that produced the highest number of seedlings with mixed/intermediate fleshed storage roots was Nwoyorima x OP. This type of fleshed roots may result since the parents were allowed to mate at random.

Flesh colour variation in sweetpotato is very important. It used to isolate the genotypes into varieties. It is also used to assign the genotypes into different utilities. For example, the Orange fleshed genotypes could be used for medication such as in the treatment of wounds and HIV patients since the orange fleshed genotypes are used to boost immunity and healthy eye sight as a result high vitamin A content. Industrialists use it for the manufacture of baby foods. Orange fleshed genotypes together with Purple fleshed genotypes contain anti-oxidant which reduces aging of cells. White fleshed and cream fleshed storage roots could be used industrially for the manufacture of starch, animal feed and processed into *gari*.

Canopy architecture**:** The canopy structure of the sweetpotato seedlings were graded into two types: seedlings with vine length above 1.0m and those with vine length below 1.0m (Huaman *et al*., 1999). All the seedling vine length were measured at harvest (4 months after planting), when the crops were fully matured. A total of 161 seedlings from all the families measured less than 1.0m, out of which the Full-Sib seedlings were 109, while the Half-Sib seedlings were 52. The seedlings that measured above 1.0m in vine length totaled 1189, which were made up of 672 seedlings from genotypes that are spreading types. Erect type of sweetpotato are bushy in growth, may be used in inter-cropping, not very high yielding and lacked the ability to smother weeds and cover the soil for erosion control. Production of seed vines for storage root production and fodder for animals are low. The Spreading types are high yielding, some produce storage roots at the nodes when in contact with the soil. They are planted sole, has the capability to smother weeds (Eneji, 1995), and could be used for erosion control in erosion prone areas. Its large foliage production could be used as fodder for animals and may scale through in areas that require dual purpose sweetpoato varieties. These types of genotypes readily generate more seed vines for storage root production.

Conclusion

Sweetpotato seedlings with high yielding number of root potential per plant should be selected for further advancement and evaluation. Seedlings with large storage root number may be selected as having high storage root yield potential. Seedlings with different types of storage root flesh colours could be put into different domestic and industrial utilization, while the sweetpotato canopy structure that differentiated the seedlings into erect and spreading types could be incorporated into different farming systems of the people.

References

Eneji, A. E., Agboola, A. A. and Isola, O. (1995). The weed suppressive ability of sweet potato in a cassava + maize + sweet potato intercrop. *Nigerian Journal of Weed Science*, 8:13-18.

FDALR, (1985). Federal Department of Agriculture and Land Resources, Imo State of Nigeria.

Huamán, Z., Aguilar, C. and Ortiz, R. (1999). Selecting a Peruvian sweetpotato core collection on the basis of morphological, Eco-geographical and disease and pest reaction data. *Theoretical and Applied Genetics*, 98:840-845.

Nwankwo, I.I.M. (2012). Performance Of Introduced and Locally Bred Orange Fleshed Sweetpotato Varieties in the Rainforest Ecology of Southeastern Nigeria. *International Journal of Applied Research and Technology;* 2 (6): 48 - 54.

Nwankwo, I.I.M., Afuape, S.O., Echendu, T.N.C and Nwaigwe, G.O (2011). Sweetpotatobreeding at NRCRI- Umudike In: Root and Tuber Crops. Research for food security and empowerment. Pp.249 -25.

Nwankwo, I.I.M. and Njoku, T.C (2019).P A Review of the Variability in the Flesh Root colour of Sweetpotato as Evidence of Varietal Differentiation and their Uses. In Isong, A., Onwhughalu, J. T., Eze, J. T., Gbadeyan, S. T., Umar, F. A., Abubakar, H. N., Ismaila, A., Bassey, M. S., Kolade, M. O., Uyokei, U., Bello, O. L. (eds), Building a Resilient and Sustainable Economy through Innovative Agriculture in Nigeria. Proceedings of the 53rd Annual Conference of the Agricultural Society of Nigeria held at the National Cereals Research Institute, Badeggi, Nigeria. 21st – 25th October, 2019. Pp.1-5.

Onwueme, I. C. and Sinha, T. O. (1991). Field crop production in Tropical Africa, principles and practice (pp. 267-275). CTA (Technical Centre for Agriculture and Rural Cooperation) Ede, The Netherlands.

Sharrma, A.K. (1980). The Principles and Practice of plant breeding. Oxford University press. New Delhi.IPSIO. 345pp.

Singh, B.D. (2016) .A text Book of Plant Breeding. Kalyani Publishers. Ludhiana, New Delhi. Pp316 - 326.

Teshome, A, and Amenti, C. (2010). On farm participatory evaluation and selection of sweet potato (Early, Medium and Late set) varieties at Adami Tulu Jiddo Kombolcha District. *Int. J.Agric*., 2(4): 1-5.

Tewe, O. O., Abu, O. A., Ojeniyi, E. F. and Nwokocha, N. H. (2000). Status of Sweet potato production, utilization and marketing in Nigeria. In M. O. Akoroda, & J. M. Ngere (Eds.), Proceedings of the Triennial Symposium of the International Society for Tropical Root Crops, African Branch (ISTRC – AB). Pp. 65-74.

Ukom, A. N., Ojimelukwe, P. C. and Okpara, D. A. (2009). Nutrient composition of selected sweet potato [Ipomoeabatatas (L.) Lam] varieties as influenced by different levels of nitrogen fertilizer application. *Pakistan Journal of Nutrition*, 8 (11): 1791-1795. http://dx.doi.org/10.3923/pjn.2009.1791.1795.

Wilson, J.E., Pole, F.S ., Smit, N.E.J. and Taufatofua, P. (1989). Sweetpotato breeding. IRETA publications, Apia, Western Samoa.

Wolfgang. G, Mwanga, R. Andrade, M, and Dapaah, H. (2008). Unleashing the potential of sweetpotato in Sub-Saharan Africa: Current challenges and way forward Challenge Theme Paper 1: Sweetpotato Breeding