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Potentials of Selected Sweet Potato Landraces for Crop Improvement, Biodiversity Conservation and for Official Registration in Nigeria

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Abstract— **An investigation was conducted at the National Root Crops Research Institute, Umudike in South eastern Nigeria involving nine sweetpotato landraces and two Check varieties TIS87/0087 and UMUSPO/3with the following objectives: to evaluate the diversity that exists in the selected sweetpotato landraces and to conserve them for future usage, to identify parents that flowers and are resistance to pests and diseases of ecological origin, to select landraces in terms of high storage root yield, high dry matter content and to build up reserve of breeding materials of native species that have nutritional and industrial potential for crop improvement programme. The results indicated that variability existed among the selected sweetpotato landraces and that the significant (P<0.01) highest fresh storage root yield of 19.6t/ha was for the landrace Kwara followed by ABCHI with 19.4t/ha and which were above the two standard check varieties (87/0087 and UMUSPO/3 which yielded 17.9 and 17.1t/ha respectively of fresh root yield) in the two years combined qualified them to be selected for registration and for commercial sweetpotato production. The landraces have high dry matter content of 33.4 and 31.2% respectively which is good for industrial and domestic utilization. They are also resistant to major field pests and diseases of sweetpotato (score 1) and could be selected for inclusion in the sweetpotato germplasm for breeding purposes. The two landraces flowers and have moderate (0.47 for ABCHI) to high (0.51 for Kwara) harvest index, although lower than the two checks (1.70 for UMUSPO/3 and 0.53 for TIS87/0087) however, it was an indication of high photosynthetic efficiency per unit area. The root morphological characters of the landrace ABCHI (and other landraces collected from Abia State) have similar root biological ranking with TIS87/0087, and may be regarded as duplicate of TIS87/0087. These landraces are quite distinct from Kwara, Ex-Igbariam, UMUSPO/3 and Buttermilk. The characterization enables for an easy and quick discrimination between the landraces. The characters discriminated upon are generally highly heritable and can easily be seen by the eyes and are equally expressed in all environments. These characters were potential attributes for recognizing them for biodiversity conservation, crop improvement and for registration as official varieties in Nigeria.**

Index Terms— **Germplasm Conservation, Harvest Index, Landraces, Morphology**

I. INTRODUCTION

Sweetpotato is an important security food for poor resource farmers [8], and majority of the sweetpotato crops cultivated by poor resource farmers are landraces. Although majority of the landraces are poor yielding, however, they make significant contribution in the diet of the people or as varieties in the farming system of the people or as progenitors in breeding programme for the farmer preferred traits. In sweetpotato growing States in Nigeria, Sweetpotato farmers depend on the landraces for survival. It is planted and harvested piece meal for home consumption and as such are regarded as security crop. The maturity period is between four and five months when compared with cassava, yam and cocoyam which take 8 to 12 months to mature. Sweetpotato can be boiled and eaten in some cases without salt or even eaten with Sauce. It could be fried, roasted on fire, boiled and pounded into fufu or ground together with or without cassava and toasted into gari. In commercial value addition of sweetpotato, the storage roots could be used for bread making, biscuits, processed into starch, doughnuts, chinchin and other food products [3], [25]. This makes the crop versatile and important]11]. The crop has been used for income generation and for home consumption in sweetpotato growing states and as a result, many indigenous landraces exists. Farmers are making use of landraces which they have collected from different sources such as introduction or by chance seedlings. Reference [14] noted that landraces are adapted to their local areas and have developed resistance to local pests and diseases as a result of long time acclimatization. In addition, landraces gained recognition from farmers as a result of their good qualities and as such could be used for genetic recombination. It is based on this reason that some States in Nigeria such as Benue and Ebonyi States had been explored and found to grow a wide range of sweetpotato varieties which have been clonally evaluated, selected, and used for genetic recombination [28]. The landraces from these two States had been collected and characterized [28]. Some of these landraces have superior agronomic characteristics which could qualify them for official recommendation and release as varieties [29] and [15]. Reference [22] observed that landraces also contain valuable sources of resistance to important diseases and pests and are capable of adaptation to envirnments where sweetpotato is grown. Reference to [12] also pointed out that landraces could be a source of resistance or immunity to sweetpotato virus disease (SPVD) which is caused by sweetpotato feathery mottle virus (SPFMV) and sweetpotato chlorotic stunt virus

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(SPCSV) that has been a hindrance to sweetpotato cultivation. Landraces also have desirable characteristics such as high dry matter content which is associated with culinary qualities preferred by consumers [12]

Most countries consider sweetpotato of minor importance mainly because its use as a food has decreased considerably. Farmers in most Latin American and Caribbean countries also indicate that many sweetpotato cultivars have disappeared because the crop's use as a food has declined [21], this has led to the loss of valuable landraces. The emphasis placed on the use of early maturing cultivars to fit into the crop rotation systems of modern agriculture has also certainly caused genetic erosion of very late maturing sweetpotato varieties [24] with many desirable attributes. In countries where sweetpotato breeding programs exist, new bred varieties have replaced many native cultivars. The knowledge of landraces and landraces kept in various gene banks is of great value for the development of crop breeding programmes and also for the coordination of collection at different gene banks in the world.

It is important to conserve these landraces by including them in the farming menu in order to have better understanding and reliable information about the diversity of landraces in the country [7]. Furthermore, due to the constant change in climate and environment of new pests and pathogens, new genes are required by plant breeders for crop variety improvement [12]. These new genes can always come from landraces. Conservation of these landraces can ensure food security, especially to resource-poor farmers who cannot afford the improved crop varieties. Conservation and preservation strategies of these landraces need to be strengthened to avoid genetic erosion of the landraces and as [1] acknowledged, the new genes required for breeding may be found in these landraces.

There are 3 methods to obtain improved cultivars (agricultural varieties) of sweetpotato (Ipomoe batatas) for distribution to farmers. These include: Collecting, evaluating, and selecting from the local germplasm. These are ways to select superior performing accessions. Imported cultivars that have been identified were maintained in the field for subsequent evaluation and used in breeding programmes. It has been found that sweetpotato landraces used by farmers exhibited high morphological variability [3]. Conservation of landraces is important for improving food security and nutrition for the present and future human population especially for the resource poor farmers dealing in subsistence farming [18]. High crop diversity ensures adequate food supply and traits to improve yield, quality, resistance to pests and diseases and adaptation to changing environmental conditions. Reference [12] mentioned that landraces are adapted to their local areas and have developed resistance to pests and diseases; this has made them gain recognition from the resource - poor farmers. However, in most cases these landraces produce low yields that lower the sweetpotato production [9]. Similarly, [19] reported low yields and yield instability [4] due to the use of old landraces which were found to lower production by resource- poor farmers. Sweetpotato is considered a food security crop in sub-Sahara Africa where it is mainly grown on subsistence scale and provides compliant source of food before other crops mature. Reference [19] noted that in some African countries, starchy crops such as sweetpotato are the staple food whereas other countries utilize it as an additional or security food crop. Sweetpotato is a good source of carbohydrates, proteins, fiber, iron and moderately rich in vitamin C [33] which poor resource farmers have been used to sustain life. Most landraces have orange fleshed colour. The orange fleshed sweetpotato has high levels of beta-carotene which is a forerunner of Vitamin A, contributing much to human health and nutrition especially for children [33]. Diversity in landraces is assessed by measuring variation in phenotypic traits such as diversity in colour, shape of the leave and growth habit [18].Reference [17]reported that phenotypic traits have led to domestication of useful plants landraces.

According to [6], it was observed observed that increased subsistence production of sweetpotato by farmers is by the use of landraces. This has the potential to improve the food security of poor households in both rural and in urban areas and by reducing dependence on purchasing food from abroad. Use of Landraces had been encouraging farmers to pursue sustainable intensification of production through the use of improved inputs [28]. This will require a dramatic increase in the use of fertilizer, organic inputs, improved tillage systems, irrigation and conservation investments, combined with the development of well-functioning input and output markets to help farmers acquire and use improved inputs, and market their (surplus) output and reduce transaction costs and risks. Increased productivity will reduce pressure on marginal lands, as the intensification of cultivated land with landraces will reduce pressure to crop fragile marginal lands. There is a need to determine methods of identifying cost-effective ways to improve access to inputs, among other things, improving delivery, and assisting farmers to earn cash to purchase inputs and invest in infrastructure, thereby improving food security through the cultivation of landraces [20].

Poor households make use of landraces to access their food from subsistence production. Subsistence/smallholder agriculture can play an important role in reducing the vulnerability of rural and urban food-insecure households, improving livelihoods, and helping to mitigate high food price inflation through the cultivation of landraces. There is a need to significantly increase the productivity of subsistence/smallholder agriculture and ensure long-term food security by cleaning up these landraces for food production ([21] This can be achieved by encouraging farmers to pursue sustainable intensification of production through the use of improved inputs. Selecting superior high yielding landraces will assist to achieve these objectives. This investigation was initiated to evaluate the diversity that exists in sweetpotato landraces and to conserve them for future usage, to identify parents that flowers and are resistance to pests and diseases of ecological origin, to select landraces in terms of high yield, high dry matter content and to build up reserve of breeding materials of native species that have nutritional and industrial potential for crop improvement programme.

II. MATERIAL AND METHODS

The experiment was conducted at the National Root Crops Research Institute, Umudike in South eastern Nigeria. Umudike lies between (latitude 05o 29'N; longitude 07 o 38'E) and located in the humid tropical rainforest zone. There are two main seasons, namely the rainy season and the dry season (NRCRI Meteorology station 2013 and 2014). The rainy season starts in April and lasts till October with a pronounced break around August, while the dry season lasts from December through February. Temperature is constantly high with annual daily maximum and minimum of 32oC and 24oC respectively. Land clearing and ridge making were done mechanically. The soil was analyzed.

Five varieties used were Landraces collected within Abia State, four were collected outside Abia State (Kwara from Kwara state, Ex-Igbariam from Anambra State and Buttermilk from Nassarawa State and Agege from Benue State all in Nigeria). The national standard Check variety TIS87/0087 and orange fleshed variety UMUSPO/3 were used as reference varieties.

A. *Accession collection:*

The accessions were collected by farmers in those agricultural zones. Farmers were at the collection sites instructed to write the local name for the accessions or the curators' name. The accessions were established and multiplied in the nursery.

B. *Accession evaluation*

Field experiments of the accessions were conducted in 2013 and 2014 all at the Eastern experimental field of National Root Crops Research Institute, Umudike. The soils at the site of the evaluation were well drained deep ultisoil. The first and second trial of the accessions involved screening the accessions for yield and diseases such as SPVD and fungus disease like Leafspots. In the second trial of the accessions, morphological characterization of the accessions was included.

Each accession was planted in a 3x3m plot at a planting distance of 1.0m x 0.3m. The Experimental Design was randomized Complete Block Design. Each block contained 11 plots. Replicated 3 times. Plot size was 9m2 and separated from each other at a space of 1m. The planting material was 30cm long vine cuttings from symptomless terminal portion of mother vines and planted on ridges with two thirds of the cuttings stick into the soil. A virus susceptible variety UMUSPO/3 was included in the trial as a check and a source of inoculum. However, healthy planting material of all the clones except the spreader susceptible variety was used for planting the trial. Virus symptoms were scored at 2 and 4 months after planting on a scale of 1 to 5. Where 1= symptoms, 2= mild, 3= moderate, 4= severe and 5= very severe.

The experimental field was manually kept weed-free until harvested 120 days after planting. Fertilizer was NPK 15:15:15 using side application. Data were collected based on: total storage root yield, large storage root yield, small storage root yield, Total number of roots, Number of large roots and number of small roots. Data on root flesh colour and above ground biomass were collected. Pests and diseases severity score were taken. Data collected were subjected to Analysis of variance and Means separation was done using standard Error of means.

At harvest, fresh storage root yield and above ground biomass were measured in kilogram and in tonnes per hectare, number of storage root per plant per hectare, root dry matter yield and were statistically analyzed using analysis of variaance [31], root skin colour, flesh colour were compared using colour chart, the above ground morphological characteristics were described using the sweetpotato descriptor manual.

III. RESULTS

The physico-chemical properties of the soil where the accessions were grown are presented in table 1.

Table 1: Soil Physico-Chemical properties of the soil environment of the sweetpotato Accessions

Sand (%)	52.40
Slit	22.80
Texture (%)	sandy clay loam
pH (H_2o)	5.45
Available P ($mgkg^+$)	20.40
Total N (%)	0.09
Organic carbon (%)	0.99
Organic matter (%)	1.70
Ca^{2+} (coml. kg^{-1})	3.60
Mg^{2+} (coml. kg^{-1})	1.60
K^+ (coml. kg^{-1})	0.14
Na^+ (coml. kg^{-1})	0.209

The results of the soil analysis at the site of the evaluation for the two years showed that the soil was sandy loam under the soil textural classification. The soil pH which was 5.45 indicated that the soil was slightly acidic. The result also indicated that the total nitrogen content and Organic carbon content of the soil of the experimental site were low (Table 1). This showed the need for application of nutrients (NPK 15:15:15 fertilizer) to enhance the performance of the soil for crop production.

A. *Climatic Data*

The Climatic data for the two years are presented the Tables 2(a) and 2(b).

The mean monthly rainfall for 2013 was 171.8, mean daily sunshine hours was 5.08 while in 2014 mean monthly rainfall was 179.93 and daily sunshine hours was 4.48. Other Climatic factors that influenced the performance of the sweetpotato landraces were presented in Tables 2a and 2b. This result indicated climatic variation for the two years for the study

Table 2 (a) climatic data at the experimental sites in 2013

Month	Amount of rainfall (mm)	Number of days	Temperature		Relative Humidity %		Sunshine hours	Wind velocity	Wind direction
			Max	Min	0900hrs	1500hrs			
January	75.4	2	33.9	22.1	63	46	6.2	2	SW
February	36.5	3	33.8	23.5	72	50	4.5	2	SW
March	40.8	8	33.4	24.0	76	62	5.0	1	SW
April	92.8	9	33.1	24.0	78	65	4.8	1	SW
May	466.1	16	32.4	23.3	83	69	5.7	1	SW
June	239.4	14	30.9	22.7	84	78	3.9	1	SW
July	280.5	18	29.1	22.4	87	75	2.2	1	SW
August	237.1	15	29.3	22.6	86	75	2.3	3	SW
September	318.0	18	29.6	22.9	74	70	2.1	1	SW
October	184.8	14	31.0	22.9	84	73	4.3	1	SW
November	99.5	8	31.6	23.2	81	69	4.7	1	SW
December	90.8	7	31.6	21.6	75	60	6.2	2	SW
Total	2061.7	132	364.6	274.1	856	822	60.9		
Mean	**171.8**	**11**	**30.38**	**22.84**	**71.33**	**68**	**5.08**		

Table 2 (b) Climatic Data at the Experimental Sites in 2014

Month	Amount of rainfall (mm)	Number of days	Temperature		Relative Humidity %		Sunshine hours	Wind velocity	Wind direction
			Max	Min	0900hrs	1500hrs			
January	0.0	0	33.4	21.5	72	45	6.4	2	SW
February	43.7	2	33.9	23.2	76	49	5.2	1	SW
March	138.8	8	33.2	23.4	80	67	4.4	1	SW
April	78.7	6	33.2	23.5	79	66	5.5	2	SW
May	249.2	16	31.9	23.4	81	69	5.2	1	SW
June	281.8	12	30.5	24.2	81	74	4.9	2	SW
July	114.9	14	30.0	24.0	86	79	2.8	2	SW
August	444	20	29.6	23.3	85	78	3.1	2	SW
September	495.3	22	29.8	22.9	85	79	2.8	1	SW
October	165.1	12	31.0	23.6	82	71	4.2	1	SW
November	147.4	11	31.6	23.5	81	66	3.3	1	SW
December	0.0	0	32.7	21.8	65	47	5.9	2	NE
Total	2159.1	121	379.8	280.1	953	790	5.4		
Mean	**179.93**	**10.13**	**31.65**	**23.34**	**79.42**	**65.83**	**4.48**		

B. Mean number of tuberous roots:

The result of the mean total number of roots, number of large roots, and number of roots per plant produced by the landraces are presented in Table 3

There was non-significant (P>0.05) variation in the mean total number of roots and mean large number of roots produced by the accessions in both years. The highest mean total number of storage roots in both years was 70.3 (Kwara) and was given the rank 1, this was followed by the landrace ABOM with 59.3 tuberous roots while the least mean total number of tuberous roots was 48.0 (ABOE) and was given the rank 11 (Table 3) with grand mean of 59.5 storage roots.

Table 3: Total number of roots, number of large roots, number of roots per plant and percentage of large roots produced by the accessions

	2013			2014			Mean performance for 2013 and2014		
Accession name	Av. total number of roots/plot	Av. number of large storage roots/plot	No. of roots/plant	Av. total number of roots /plot	Av. number of large roots/plot	No. of roots/plant	Av. number of large roots in 2013 and 2014	Accession name	Av. total number of roots/plot
Agege	51.7	35.0	2.3	54.0	41.0	2.2	38.0	52.9	7
ABRO	46.7	30.0	1.1	52.2	33.7	1.5	31.9	49.5	10
ABOM	62.7	43.3	2.4	55.8	42.0	2.3	42.7	59.3	2
ABCHI	57.7	44.0	2.3	47.5	35.6	2.4	39.8	52.6	8
ABOE	52.3	36.7	2.2	48.8	37.5	2.1	37.1	48.0	11
ABEE	57.7	48.3	2.4	49.6	38.3	2.1	43.3	53.7	6
ExIgbariam	50.7	34.0	2.2	53.5	41.4	2.2	37.7	52.1	9
Buttermilk	57.0	35.7	2.3	66.4	55.6	2.4	45.7	56.3	3
Kwara	68.8	51.2	3.1	71.7	65.2	3.2	58.2	70.3	1
Tis87/0087	62.0	46.7	1.1	48.4	35.7	1.5	41.2	55.2	4
UMUSPO/3	44.6	41.5	3.1	55.8	46.4	3.2	44.0	54.6	5
Mean	55.6	40.6	2.2	54.9	42.9	2.3	41.8	59.5	-
Sig. level	Ns	Ns	-	Ns	Ns	-	-	-	-

However, mean number of storage large roots range from 31.9 for ABRO to 58.2 for Kwara with grand mean of 41.8 . Kwara landrace produced the highest number of total mean storage roots and mean number of large roots more than the two check varieties (TIS87/0087 with 55.2 mean number of total roots and mean number of large roots of 41.2, UMUSPO/3 with mean number of total root of 54.6 and mean number of large storage root of 44.0 with grand mean of 41.8 in both years combined). The number of roots per plant per accession ranged from 1.5 to 3.2. This showed that almost all the landraces had plants with at least two roots per stand, which is an indication of high yielding ability.

C. Fresh root yield/weight:

The total fresh root weight, large fresh root weight, fresh root weight per plant and above ground fresh weight biomass performances of the landraces are presented in Table 4.

Table 4: Total fresh root weight, large fresh root weight, and fresh root weight per plot and above ground fresh weight biomass performances of the accessions in 2013 and 2014 combined

	2013		2014		2013 and 2014			
Accession name	Total fresh root yield/ weight (t/ha)	Large storage Fresh root yield/ weight (t/ha)	Total fresh root yield/ weight (t/ha)	Large storage Fresh root yield/ weight (t/ha)	Large storage Fresh root weight (t/ha	Total Fresh root yield/ weight t/ha	Rank	% Average dry matter
Agege	10.4	9.8	11.9	10.5	10.2	11.2	10	30.5
ABRO	9.6	8.8	8.3	7.0	7.9	9.0	11	27.6
ABOM	13.4	13.1	10.4	9.4	11.3	11.9	9	28.0
ABCHI	18.9	18.6	19.8	17.6	18.1	19.4	2	33.4
ABOE	12.9	12.5	13.4	12.0	12.3	13.2	7	29.6
ABEE	17.6	17.1	16.6	15.6	16.7	17.1	4	30.6
Ex-igbariam	11.9	11.5	12.9	11.5	11.5	12.4	8	34.3
Buttermilk	14.9	14.5	13.7	12.0	13.3	14.3	6	33.2
Kwara	18.4	17.2	20.8	18.7	18.0	19.6	1	31.2
Tis87/0087	19.3	18.6.	16.5	12.6	15.6	17.9	3	34.5
Umuspo/3	17.7	16.3	16.5	15.8	16.1	17.1	4	29.4
Mean	15.0	14.3	14.6	12.9	13.7	14.8		30.8
Sig.level	Ns	Ns	Ns	Ns				

ns = not significant

There was no significant (P>0.05) variation in the total fresh root weight and large storage fresh root weight performances of the landraces (Table 4). However, the landrace with the highest mean total storage root fresh weight in the two years combined was Kwara with 19.6t/ha and was given the rank 1 followed by ABCHI with 19.4t/ha and ranked second (Table 4). The yield of these two varieties were higher than that of the two check varieties (TIS87/0087 with 17.9t.ha and UMUSPO/3 with 17.1t/ha respectively) and even higher than the grand mean of 14.8t/ha. The landrace with the lowest yield for the two years combined was ABRO with 9.0t/ha which was lower than the yield of the check varieties and even lower than the grand mean and was given the rank 11.

D. Percentage Dry Matter Content

The landrace with the highest percentage dry matter content was TIS 87/0087 with 34.5% followed by Ex-Igbariam with 34.3% while the least dry matter content was from ABRO with 27.6%. (Table 4) which was lower than the grand mean of 30.8%.

E. Biomass Yield and Harvest Index

The above ground biomass (t/ha), Mean Total Fresh root weight (t/ha), Total biomass (t/ha) and Harvest index of sweetpotato landraces in 2013 and 2014 combined are presented in Table 5.

There were significant (P<0.05) variation in the yield of above ground biomass (vegetative production). The above ground biomass ranged from 10.3t/ha (Agege) to 21.8t/ha (UMUSPO/3) for the two years combined. The ratio of the root yields in t/ha and total biomass (storage roots plus above ground vegetation) gives the harvest index of a crop. The two check varieties UMUSPO/3 and TIS87/0087had the highest harvest index of 1.70 and 0.53 respectively. This was followed by the landrace Kwara with 051, while the least was ABRO with 0.35 harvest index with grand mean of 27.80t/ha.

Table 5: Above ground biomass (t/ha), Mean Total Fresh root weight(t/ha), Total biomass (t/ha) and Harvest index of sweetpotato accessions in 2013 and 2014 combined

Accession name	Above ground biomass (t/ha) 2013	Above ground biomass (t/ha) 2014	Above ground biomass (t/ha) 2013 and 2014	Mean Total Fresh root weight t/ha 2013 and 2014	Total Biomass	Harvest Index
Agege	11.1	9.4	10.3	10.05	20.35	0.49
ABRO	20.2	10.4	15.3	8.09	23.39	0.35
ABOM	14.2	8.9	11.6	10.72	22.32	0.48
ABCHI	17.8	21.0	19.4	17.39	36.79	0.47
ABOE	16.8	12.6	14.7	11.84	26.54	0.45
ABEE	27.1	13.3	20.2	15.38	35.58	0.43
Ex-igbariam	10.3	14.2	12.3	11.20	23.50	0.47
Buttermilk	12.7	14.0	13.4	12.86	26.26	0.49
Kwara	15.2	14.2	14.7	15.42	30.12	0.51
Tis87/0087	18.0	16.5	17.3	16.07	33.37	0.53
UMUSPO/3	12.0	13.5	12.8	21.8	12.8	1.70
Mean	16.34	11.5	14.9	12.90	27.80	0.46
Sig.level	P<0.05	P<0.05	P<0.05	P<0.05		

F. Morphological assessment of the root flesh and skin colour of the landraces

The result of the morpahological assessment of the sweetpotato root flesh and skin colour of the landraces are presented in table-6

Table 6: Morphological assessment of the root flesh and skin colour of the landraces

							Pest	Diseases	
Accession name	Predominant skin colour	Secondary skin colour	Predominant flesh colour	Secondary flesh colour	Root shape	Flowering	Root weevil	SPVD	Leaf spot
ABEE	6	6	2	2	5	3	1	1	1
ABRO	6	6	2	2	5	3	1	1	1
ABOM	6	6	2	2	5	3	1	1	1
ABCHI	6	6	2	2	5	3	1	1	1
ABOE	6	6	2	2	5	3	1	1	1
TIS87/0087	6	6	2	2	5	3	1	1	1
Agege	7	7	2	2	8	5	1	1	1
Kwara	3	0	7	3	2	3	1	1	1
Buttermilk	1	0	2	8	3	5	1	1	1
Ex-igbariam	2	0	4	8	8	3	1	1	2
UMUSPO/3	4	4	8	4	2	3	2	3	1
ABEE	6	6	2	2	5	3	1	1	1
ABRO	6	6	2	2	5	3	1	1	1
ABOM	6	6	2	2	5	3	1	1	1

Note: skin colour 1=white,2=cream,3= 0range, 6=purple, 7=red **Secondary skin colour**, 6=no secondary skin colour, 0= mixed with orange, 4= predominant orange, **Predominant flesh colour** 2 = cream, 4 =yellow, 7=mixed orange, 8=orange, **Secondary flesh colour**, 2= cream, 3=orange, 4= yellow, 8 yellow, **Root shape**, 5= obvate, 3 =round, 8= enlongate, 2= oblong. Flower habit 3= flowers. 5= non flowering. **Pests and Disease score**: Where 1= no symptoms, 2= symptom mild, 3=symptom moderate, 4= symptom severe and 5= symptom very severe. SPVD = Sweetpotato virus diseases

Results in Table 6 showed variation in skin or peel colour and variations in flesh colour of the landraces. Five principal characteristics (5 root morphological characteristics) were analyzed using the mathematics of information theory. Each column is a character while each row is a state or a landrace. Where the code (figure) change is a variation in the above or below character. The root morphological characters of the landrace from ABEE to TIS87/0087 (Check variety) were the same and started discriminating from Agege to UMUSPO/3 (Table 6). From the result, it was observed that all the landraces collected from Abia State have similar root biological ranking with TIS87/0087, and may be regarded as duplicate of TIS87/0087. These accessions are quite distinct from Kwara, Ex-Igbariam, UMUSPO/3 and Butter milk

G. *Flowering*

The result also indicated that all the landraces flowered (Score 3) throughout the two cropping seasons except buttermilk and Agege (score 5) (Table 6). The accessions that flowered could be selected for genetic improvement of the sweetpotato crop.

H. *Pests and diseases*

There were no severity of attack of pests and diseases on the crops in the first and second year except the mild attack of root weevil pest on the root of UMUSPO/3 (Score 2), may be as a result of time of harvest and mild infection of leafspot on Ex-Igbariam (Table 6).

IV. DISCUSSION

The total amount of rain in 2013 was 2061.7mm and mean sunshine hours for the days was 5.08 hours while in 2014 the amount of rain was 2159.1mm and daily average sunshine hours was 4.48 hours. The variability in the climate for the two years may have had considerable influence on the performance of the sweetpotato landraces during the experimental period. (Tables 2a and b). Discernible character variation existed among fresh tuber yield, tuber dry matter yield, number of tubers produced per plant and tuber surface texture per plant. According to [30], variations in crop yield depends on the plant characters, the climatic factors, soil factors and so on. Part of the observed variation of a trait of a crop is due to environmental conditions and is not heritable. Also, most of the superficial traits of individual crops are not heritable. They are due to environmental effects in the sense that they are not genetically determined. The environmental variations in the two years influenced the number of storage roots and storage root weight performance of the various sweetpotato landraces (Tables 2a and 2b). Therefore the best yield comes from a particular variety in a compatible environment.

Results obtained also indicated that most of the landraces had more than one storage roots per stand. In Sweetpotato, root yield depends on the number of storage roots per plant as observed by [32]. Landraces with high number of large storage roots should be selected as commercial crop. It could also be selected for genetic recombination in transferring the genes for high number of large roots to their progenies. High number of storage roots could be an indicator of sink/bulking capacity in sweetpotato. However, the variation in the grand mean number of roots in both years may be attributed to climatic conditions. This showed that Climatic factors influenced the number of tuberous root produced by the sweetpotato landraces in both years (Table 3). Landrace with large number of storage roots far below the two check varieties and far below the grand mean should not be selected for commercial sweetpotato production. Large storage roots is for marketing and weighed above 100g while less than 100g is for small roots and could be used in feeding animals such as pigs and cows. Number of roots per plant per landrace and per plot is a function of yield and an indication of the performance of a variety [27] and [10].

The result indicated that the least root yield/root weight in both years was 9.0t/ha (ABRO) while the highest fresh root yield of 19.6t/ha was for Kwara followed by ABCHI with 19.4t/ha and were above the two standard check varieties (87/0087 and UMUSPO/3 which yielded 17.9 and 17.1t/ha respectively of fresh root yield in the two years combined. Landraces with high root yield should be selected for commercial sweetpotato production. However, the change in ranks of the number of storage roots and weight of storage roots is an indication that number of storage roots is not directly related to weight of storage root yield. Although number of storage root yield is a function of yield, it does not indicate the amount of fresh starch yield of the storage roots. Nevertheless, landraces were grouped into three classes. According to [16] sweetpotato breeding programme, high yielding (18.0 - 30t/ha), moderately yielding (11.0 - 17 t/ha) and low yielding (less than 11.0t/ha). Landraces like ABCHI and Kwara are high yielding ones, producing mean total fresh root yield of 19.4 and 19.6t/ha respectively in both years. Six landraces plus the two landraces are grouped under moderately yielding clones while ABRO was grouped under low yielding (Table 3). Landraces with high root yield should be selected for commercial sweetpotato production as well as included in the breeding programme since one of the objectives of breeding programmes is to enhance the fresh root yield potentials of crop progenies [25].

High yielding landraces generally have a higher harvest index than low yielding genotypes [17]. Although the second check variety UMUSPO/3 was included among moderately yielding varieties however, it has high harvest index of 1.70 per unit area which indicated that the variety have high efficiency in storage root formation relative to its biological yield. Cultivars with high harvest index have high root yield/weight per unit area. Harvest index gives an indication of the relative distribution of photosynthates between the storage root and the rest of the plant. Genotypes with high harvest index should be selected since this will increase yield per unit area. Although [17] observed that selection of genotypes based on both total biomass and root yield depends on crop management and environment, however, very high 'above ground biomass' is an indication of the crops ability to suppress weeds infestation in sweetpotato cultivated fields while the high harvest index is an indication of high photosynthetic efficiency which resulted into high root yield per unit area.

The variation in dry matter content makes selection among the genotype for processing possible. According to national Agricultural Research Organization [16] dry matter content of 30% or more for storage root of sweetpotato is regarded as very high. High dry matter is a function of starch contents and has been reported as very important attributes that influence sweetpotato consumers' preferences and industrial utilization. have also reported strong significant and positive correlation that exists between dry matter and starch content and between dry matter and flour contents which confirmed that dry matter content is a strong function of starch content which is the carbohydrate consumed. Most sweetpotato consumers prefer above 30% dry matter content for sweetpotato processed for food [25] .However, 6 out of the 11 sweetpotato landraces evaluated had dry matter content above 30% and even more than the grand mean of 30.8%. Landraces with dry matter content above the grand mean should be selected for inclusion in the germplasm collection for food and for selection as parents for genetic improvement for dry matter content of low dry matter sweetpotato crop. High dry matter content for sweetpotato genotypes has been the dream desire of sweetpotato breeders for the improvement of dry matter content of orange fleshed genotypes hence the quest for high dry matter parent landraces. According to [5] high dry matter content could be inherited, and heritability is a measure of the correspondence between phenotypic values and breeding values. High heritability estimate suggests that superior parents tend to give the best progeny and so is used by breeders as prediction tool to predict the performance of the offspring from that of their parents [2].

Results also showed variation in skin or peel colour and in the flesh colour of the storage roots of sweetpotato landraces. The characterization enables an easy and quick discrimination between landraces. The characters discriminated upon are generally highly heritable, can be easily seen with the naked `eye and are equally expressed in all environments [16] However, []16) reported that many of the 'evaluation traits' are those that are susceptible to environmental differences but are generally useful in crop improvement and may involve complex biochemical or molecular characterization. These include yield, agronomic performance, stress susceptibility, biochemical and cytological traits. Although, consumers prefer skin colour that is white to pink. Skin colour of sweetpotato roots do not add to the taste of the roots. The white or cream skin colour only appeals to the eye. Ex-Igbariam, buttermilk and Kwara have skin colours ranging from white to cream. This suggested additional reasons why these varieties are popular with farmers. Sweetpotato breeders should breed and select for skin colour preferable in an area. Since it will lead to high income generation for the farmers in those areas. Sweetpotato varieties that have yellow to orange flesh colour are of high nutritional value than white or cream fleshed colour. This is because of the appreciable amount of beta-carotene content it have which is the precursor for vitamin A necessary for clear eyesight and improving the health of children under five years of age and good for pregnant and lactating mothers [6], Cream fleshed varieties could be used in other food processing such as boiling and eating, roasting, garri-making and other value additions ([23] Smooth shapes are preferred to cracks, rough and wrinkled because of the ease in processing especially during peeling and washing of the roots.

There were no severity of attack of pests and diseases on the crops for the two years may be as a result of time of harvest. Conditions favouring the infection of these diseases such as high humidity should be avoided. Therefore planting during heavy rains under shades should be completely avoided. However, the variety UMUSPO/3 was moderately infected by sweetpotato virus disease (SPVD) (Score 3). According to [28] , vegetative propagation, which is usually the taking of vine cuttings from a previous crop increases the risk of a buildup of viruses. UMUSPO/3 is an orange fleshed variety and virus diseases form the most important biotic production constraint in orange fleshed sweet potato and are regarded second to sweet potato root weevil in destructiveness. Most orange fleshed sweet potato-infecting viruses, however, show only mild or no symptoms when in single infection and the damages caused by sweet potato viruses are mostly through synergistic mixed infections. Since most of the Landraces do not show any virus symptoms, it indicated that the landraces are resistant to field sweetpotato virus diseases (Table 6) and could be selected as female parent during breeding programme to confer SPVD resistance to its progenies.

Most of the sweetpotato landraces flowered and that is the only easy means of conveying their desirable traits to their progenies is by genetic recombination while those that did not flower could be treated to flower by grafting or girdling.

V. CONCLUSION

The results of the evaluation indicated that variability existed among the selected sweetpotato landraces and that the significant (P<0.01) highest fresh storage root yield of 19.6t/ha was for the landrace Kwara followed by ABCHI with 19.4t/ha and which were above the two standard check varieties (87/0087 and UMUSPO/3 which yielded 17.9 and 17.1t/ha respectively of fresh root yield) in the two years combined qualified them to be selected for registration and for commercial sweetpotato production. The landraces had high dry matter content of 33.4 and 31.2% respectively which is good for industrial and domestic utilization. They are also resistant to major field pests and diseases of sweetpotato (score 1) and could be selected for inclusion in the sweetpotato germplasm for breeding purposes. The two landraces have moderate (0.47 for ABCHI) to high (0.51 for Kwara) harvest index, although lower than the two check varieties (1.70 for UMUSPO/3 and 0.53 for TIS87/0087) however, it was an indication of high photosynthetic efficiency per unit area. The root morphological characters of the landrace ABCHI (and other landraces collected from Abia State) have similar root biological ranking with TIS87/0087, and may be regarded as duplicate of TIS87/0087. These landraces are quite distinct from Kwara, Ex-Igbariam, UMUSPO/3 and Buttermilk. The characterization enables for an easy and quick discrimination between the landraces. The characters discriminated upon are generally highly heritable and can easily be seen by the eyes and are equally expressed in all environments These characters were potential attributes for recognizing them for biodiversity conservation, crop improvement and for registration as official varieties in Nigeria.

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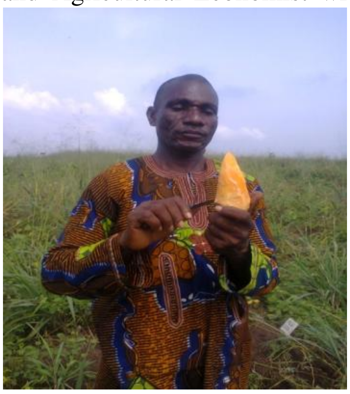

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