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Full Length Research Paper

Evaluation and Selection of white yam landraces (*Dioscorea rotundata L.*) clones for registration and release as varieties for farmers in Nigeria

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Abstract

Eight white yam landraces selected from a collection of 200 landraces at NRCRI- Umudike in 1997 were evaluated in different contrasting agro ecological zones with the aim of selecting high yielding disease and pest's resistant varieties for registration and release for Nigerian farmers. One cut sett each weighing 35g each was used per planting point on the ridge with 1.0m between plants and 1.0m between ridges, on a plot measuring 4x5m^2. A randomized complete block design with three replicates was used at each location. The experiments were carried out under rain fed condition and data were collected on total tuber yield, ware tuber yield and seed tuber yield. Data were statistically analyzed and mean tuber yield were separated using standard error of difference. Results based on 5% selection pressure and ranking indicated that varieties Obiaoturugo, Ekpe, Aloshi, Hembakwasa and Amola were selected for high yielding, and resistant to major field pests and diseases attacking yams in the field and therefore recommended for official documentation and release for farmers in Nigeria for commercial yam production intended for export. The agronomic performances of these white yam landrace clones indicated that they could be used as recombination materials for the yam breeders.

Keyword: white yam landraces, selected, for farmers, registration, release.

Introduction

Dioscorea species landraces may include chance seedlings which have been selected and cultivated by farmers for millennium of years (Sharrma, 1980).They could 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 although this have not been scientifically evaluated and release as varieties. The genetic variability present in the white yam population of clones is not deliberately created by man but it is naturally present and therefore referred to as landraces (Teshome and Amenti 2010). In yam growing States of Nigeria, yam farmers depend on the landraces for survival. Yam is an important food security crop for poor resource farmers. When it is planted, some varieties are harvested in piece meal by milking for home consumption and as such regarded as security crop (Nweke, 2016). The maturity period is between seven and nine months when compared with cassava, and cocoyam which take 9 to 12 months to mature (Onwueme, and Sinha, 1991). The yam tuber is prepared in several ways for eating. Yam can be boiled and eaten in some cases without salt or even eaten with Sauce. It could be fried, boiled and pounded into fufu or ground into flour for other uses such as in commercial value addition (used for bread making, biscuits, processed into starch, doughnuts, chinchin and other food products) to provide important energy. The yam tuber can be put to other uses such as a cash/export crop, livestock feed and has cultural values. It could be used in ceremonies such as marriages, funerals etc (Akintola, 2008). This makes the crop an important crop. In yam growing states, the crop has been used for income generation and for home

consumption (Nweke, 2016). As a result, many indigenous landraces of *Dioscorea rotundata* exists (Teshome and Amenti 2010).

Dioscorea rotundata is estimated to account for 79% of the total world food yam production (llTA, 1995) and Nigeria is the largest world producer of white yam 31.5 million tonnes annually (CBN, 2003) about 70% of the world food yams and consumer of yam (Ezulike *et al*, 2006). Most of the yam tubers are consumed locally. Due to increasing World population mainly in the developing countries of Africa, yam production is no longer meeting the aggregate demand. In order to meet annual demand, yam production must increase by 3-4%. At present, yam export is only marginal due to lack of officially released, high yielding disease/pest resistant varieties of *Dioscorea rotundata* (Nwankwo and Nwaigwe 2016).

Dioscorea rotundata landraces are adapted to their local areas and have developed resistance to local pests and diseases. *Dioscorea rotundata* landraces gained recognition from farmers as result of their good qualities as such could be used for genetic recombination (Nwankwo, *et al.*, 2012). Some of these landraces have superior agronomic characteristics which could qualify them for official recommendation and registration as varieties. The landraces also contain valuable sources of resistance to important diseases and pests, capable of adaptation to environments where yam is grown, and other desirable characteristics such as high dry matter content which is associated with culinary qualities preferred by consumers (Huamán, *et al*., 1999). Huaman, *et al.,* (1999) also pointed out that landraces could be a source of resistance or immunity to yam virus disease (YMV) which has been a hindrance to yam cultivation. These desirable qualities of white yam landraces (*Dioscorea rotundata*) could qualify them for official release by national varietal release committees for commercial yam production and for export.

According to Singh (2016), the procedure for clonal selection of landraces is identical to that for pure line selection and superior performing clones evaluated in replicated yield trials are released as variety. It is based on this that this work was initiated to evaluate the diversity that exists in yam landraces and to conserve them for future usage, to identify landraces resistant to pests and diseases of ecological origin, to select landraces in terms of high yield, and adaptability to different environmental conditions, to build up reserve of breeding materials of native species that have nutritional and industrial potential for crop improvement programme, and to register what farmers can use to generate income through commercialization and export.

Materials and Methods

Clone selection: The landraces selected for the trials were (Aloshi, Obiaoturugo, Hembakwasi, Ekpe, Amola, Yandu, alumaco) collected from the Western, Eastern and North Central of the Country and are superior farmers' cultivars selected from a collection of 200 landraces at NRCRI-Umudike in 1997 and subsequently evaluated countrywide in different contrasting agro ecological zones. The variety 89/02665 is a hybrid and was used as a national Check.

Site description: The 8 sites where data were generated have been described briefly. Abia State: Rain Forest zones, Ebonyi State: derived Savannah, Oyo State Forest: Rain Forest, Edo State: Rain agro ecology, Benue State : Derived Savanna, Nasarawa State: Derived Savanna, Anambra State: Derived savanna, Niger State: Savanna. These locations represented humid forest, rain-forest, derived savanna tall grassland and Savanna short grassland ecologies that correspond to South-south, Southeast, Southwest, North central regions of the country.

Clone evaluation: The area for the white yam clone evaluation were cleared of existing vegetation which comprised of *Eupatorium Odorata, Panicum maximum*, sedges and other broad leaf weeds before ploughing, harrowing and then ridged. The seed bed preparation for the trial was made in form of ridges. The ridges were grouped into plots and blocks. Each plot consisted of four ridges measuring 5 x 4m long and 1.0m between ridges.

Planting: The clones were the source of the planting material. One cut sett each weighing 35g each was used per planting point on the ridge with 1.0m between plants and 1.0m between ridges, giving a plant density of 10,000 plants per hectare. All outside rows of the experimental plots had boarder plants. The seed setts were planted 10cm deep to prevent sun scotch, removal by foraging animals and by rain splash on the ridges. Seven white yam varieties plus one Check variety were used, given a total of eight varieties. A randomized complete block design with three replicates was used at each location. The experiments were carried out under rain fed condition.

Data collection and Analysis: Data were collected on total tuber yield (measured in tones per hectare), ware tuber yield and seed tuber yield. The tuber yields were statistically analyzed and mean tuber yield were separated using standard error of difference means. Data were also collected on the major field pests and diseases attacking yam crops in the field using severity rating scale of 1 to 5. Where 1=no damage/no pests present, 2=very little damage/few present (holes less than 5), 3=moderate damage/moderate number present (holes >5 and <10 present), 4=considerable damage/considerable number present (holes >15 and <20 present) and 5 = severe damage/ very high number present (holes >20). Selection index was based on 5% selection pressure for high yielding varieties across locations Nwankwo *et al*., 2013).

Results

The yield performance of these elite varieties across locations for the evaluated traits in 2014 and 2015 are presented in Table 1 and 2, and combined over the years (in Table 3). Pests and diseases severity for the years using severity rating scale of 1 to 5 are presented in Table 4.

The result of the performance of the landraces across the Agro- ecologies of yam belt in 2014 is presented in Table 1.

Table 1: Performance of the Landraces across the Yam Belt agro ecologies of Nigeria in 2014

Clone Name	Abia	Oyo	Niger	Edo	Benue	Nasarawa	Anambra	Ebonyi	Mean	Rank
Yandu	12.32 (10.15)	11.73 (9.61)	7.05 (4.52)	6.97 (3.72)	11.50 (8.62)	22.56 (15.62)	13.75 (9.05)	10.04 (6.65)	11.99 (8.49)	7
Amola	20.45 (16.54)	10.95 (8.45)	21.60 (16.34)	9.45 (5.65)	14.70 (11.50)	20.56 (15.62)	14.50 (9.76)	14.00 (10.54)	17.60 (11.80)	5
Ekpe	15.98 (14.12)	15.50 (13.45)	13.50 (12.10)	11.10 (9.65)	11.50 (8.75)	23.21 (21.40)	18.25 (16.25)	13.64 (10.20)	15.34 (13.24)	6
Alumaco	12.59 (8.22)	6.95 (3.52)	12.60 (7.55)	9.89 (4.75)	13.60 (6.85)	13.40 (11.85)	17.52 (13.61)	11.87 (8.92)	10.98 (8.16)	8
Hembakwasi	19.65 (18.64)	16.50 (15.31)	18.94 (16.80)	10.60 (9.01)	16.93 (14.22)	18.96 (17.52)	21.58 (19.92)	17.66 (15.64)	19.97 (15.88)	2
Aloshi	19.45 (16.54)	12.95 (9.45)	27.60 (16.34)	9.45 (7.65)	18.70 (13.50)	21.56 (18.62)	16.50 (10.76)	17.00 (10.54)	19.52 (12.93)	3
Obiaoturugo	21.57 (18.48)	9.15 (6.75)	11.78 (8.66)	14.65 (13.51)	22.40 (21.10)	27.78 (26.34)	23.59 (21.76)	19.00 (17.00)	21.71 (16.70)	1
89/02665	22.50 (17.28)	12.15 (8.15)	13.78 (9.16)	10.62 (7.50)	23.30 (19.12)	24.79 (18.35)	25.29 (22.72)	20.00 (16.00)	19.05 (14.79)	4
Mean	18.06	11.99	15.86	10.34	16.58	21.60	18.87	15.40	17.02	
SED	6.30	4.13	6.50	7.24	9.22	5.01	4.23	6.05		
P<0.05	P<0.01	P<0.01	P<0.01	P<0.05	P<0.05	P<0.01	P<0.05	P<0.05		

Note: Total tuber yield are not in parenthesis
Ware yam tubers are in parenthesis
Ware tuber is a tuber weighing 1kg and above
Seed tuber is a tuber weighing less than 1kg

The result in Table 1 indicated significant (P<0.05) differences in the tuber yield performances of the white yam among the white yam clones that made up the landraces evaluated across the locations in 2014. The result indicated that the national check (89/02665) which is a hybrid significantly out yielded the landraces in 4 out of 8 locations /States with total tuber yields of 22.50t/ha in Abia State, 23.30t/ha in Benue State, 25.29t/ha in Anambra State and 20.0t/ha in Edo State. However, Hembakwasi from the North Central out yielded all other varieties in Oyo the Western part of the Country. It even out yielded Aloshi and Yandu indigenous to the Western part of the country and also out yielded the national Check variety (89/02665) with the total tuber yield performance of 16.50t/ha.

Also Aloshi from the Western part of the country, out yielded all other varieties including the national check variety in Niger State with total tuber yield performance of 27.78t/ha in 2014. Obiaoturugo indigenous from the Eastern part of the country out yielded other varieties in two States with total tuber yield of 14.65t/ha in Edo State and 27.78t/ha in Nasarawa State. It even out yielded varieties like Hembakwasi and Amola indigenous to North Central States of the country. It also out yielded the standard check variety with total tuber yield of 10.62t/ha in Edo States and 24.79t/ha in Nasarawa State.

However, when the performance of the white yam clonal landraces were ranked across locations, the result indicated that Obiaoturugo performed more than all the other varieties across locations and among the varieties with mean total tuber yield of 21.71t/ha and ware tuber of 16.70t/ha and was ranked 1st. This was followed by Hembakwasi with mean total tuber yield of 19.97t/ha and ware tuber yield of 15.88t/ha and was ranked 2nd. Aloshi came 3rd with 19.52t/ha of total tuber yield and 12.93t/ha of ware tuber yield. However, 89/02665, the national check variety came 4th with 19.05t/ha of total tuber yield and 14.79t/ha of ware tuber yield.

The result of Performance of the white yam Landraces across the Agro ecologies of yam belt in 2015 is presented in table 2.

Table 2: Performance of the Landraces across the Yam Belt agro ecologies of Nigeria in 2015

Clone Name	Abia	Oyo	Niger	Edo	Benue	Nasarawa	Anambra	Ebonyi	Mean	Rank
Yandu	11.02 (8.32)	9.13 (7.41)	17.05 (14.31)	13.97 (11.25)	14.65 (12.10)	18.56 (15.85)	11.75 (8.78)	9.04 (7.32)	15.48 (10.67)	8
Amola	19.45 (17.20)	11.95 (8.64)	21.00 (19.00)	11.45 (8.24)	12.10 (9.55)	21.56 (18.68)	17.50 (14.55)	14.74 (11.63)	16.22 (13.44)	5
Ekpe	16.18 (4.31)	14.60 (9.86)	12.54 (11.08)	12.60 (10.11)	14.15 (12.96)	22.23 (20.78)	17.45 (15.25)	15.60 (14.31)	15.67 (12.33)	6
Alumaco	15.55 (13.66)	11.90 (8.65)	13.50 (11.42)	10.85 (6.75)	12.61 (8.68)	14.46 (11.98)	14.32 (12.71)	9.87 (8.01)	12.88 (10.23)	7
Hembakwasi	29.65 (27.40)	17.80 (15.24)	29.94 (27.85)	9.80 (7.50)	18.55 (16.22)	19.06 (17.00)	22.50 (21.20)	18.00 (17.00)	20.66 (18.68)	3
Aloshi	13.45 (18.64)	14.91 (12.40)	27.60 (14.32)	19.45 (18.60)	19.70 (15.50)	23.16 (18.72)	22.50 (22.76)	24.00 (19.64)	20.60 (17.57)	4
Obiaoturugo	28.57 (26.84)	13.15 (11.48)	15.78 (13.60)	20.15 (19.20)	24.00 (23.00)	25.18 (24.18)	25.52 (23.53)	25.00 (24.00)	22.17 (20.73)	2
89/02665	30.65 (27.40)	18.80 (14.24)	27.94 (19.25)	10.60 (7.55)	22.55 (17.23)	24.16 (17.10)	25.50 (18.25)	22.05 (17.35)	22.78 (17.30)	1
Mean	20.57	14.03	20.67	13.61	17.29	21.05	19.63	17.29	15.73	
SED	10.02	5.32	4.53	7.00	6.21	6.20	4.01	9.23		
Sig. level	P<0.05	P<0.05	P<0.01	P<0.05	P<0.05	P<0.05	P<0.01	P<0.01		

Note: Total tuber yield are not in parenthesis
Ware yam tubers are in parenthesis
Ware tuber is a tuber weighing 1kg and above
Seed tuber is a tuber weighing less than 1kg

The performance of the white yam landraces in the 2015 field evaluation indicated significant (P<0.05) variation in the total tuber yield across locations and among the white yam landraces. The check variety (TDr89/02665) out yielded other varieties with a total tuber yield of 30.65t/ha and 18.80t/ha in two States (Abia and Oyo States respectively). On the other hand, Obiaoturugo out yielded other varieties including the national check in 5 out of 8 States with the following yields: 20.15t/ha (Edo State), 24.0t/ha (Benue State), 25.18t/ha (Nasarawa State), 25.52t/ha (Anambra State) and 25.0t/ha (Ebonyi State).

However, TDr89/02665 was ranked 1st in its performance across the location and among the landraces with total tuber yield of 22.78 t/ha and ware tuber yield of 17.30t/ha. This was followed by Obiaoturugo with total tuber yield of 22.78t/ha and ware tuber yield of 20.73t/ha. Hembakwasi was 3rd with total tuber yield of 20.66t/ha and ware tuber yield of 18.68t/ha. Yandu came last with 8th position having total tuber yield of 15.48t/ha and 10.67t/ha of ware tuber yield (Table 2). The result of the performance of the landraces across the agro-ecologies of yam belt zones combined is presented in Table 3.

Table 3: Performance of the Landraces across the Yam Belt agro ecologies of Nigeria combined

Clone Name	Abia	R	Oyo	R	Niger	R	Edo	R	Nasarawa	R	Benue	R	Anambra	R	Ebonyi	R	Mean across locations	Rank
Yandu	11.67 (9.24)	8	10.43 (8.51)	7	12.05 (9.42)	8	10.47 (7.49)	5	20.56 (15.74)	6	13.08 (10.36)	7	12.75 (8.92)		9.54 (6.99)	8	13.74 (9.58)	7
Amola	19.95 (16.87)	4	11.45 (8.55)	5	21.30 (17.67)	3	10.45 (6.95)	6	21.06 (17.15)	5	13.40 (10.53)	5	16.00 (12.16)		14.37 (11.09)	6	16.93 (12.62)	5
Ekpe	16.08 (9.22)	6	15.05 (11.66)	3	13.04 (11.59)	7	11.85 (9.88)	3	22.72 (21.09)	3	12.83 (10.86)	8	17.85 (15.75)		14.62 (12.26)	5	15.51 (12.79)	6
Alumaco	14.07 (10.94)	7	9.43 (6.09)	8	13.05 (9.49)	6	10.37 (5.75)	7	13.93 (11.92)	8	13.11 (7.77)	6	15.75 (13.16)		10.87 (8.47)	7	11.93 (9.20)	8
Hembakwasi	24..65 (23.02)	3	17.15 (15.28)	1	24.44 (22.33)	2	10.20 (8.26)	8	19.01 (17.26)	7	17.74 (15.22)	4	22.04 (20.56)		17.83 (16.32)	4	20.32 (17.28)	3
Aloshi	16.45 (17.59)	5	13.93 (10.93)	4	27.60 (15.33)	1	14.45 (13.13)	2	22.36 (18.67)	4	19.20 (14.50)	3	19.50 (16.76)		20.50 (15.09)	3	20.06 (17.33)	4
Obiaoturugo	25.07 (2.66)	2	11.15 (9.12)	6	13.78 (11.13)	5	17.40 (16.36)	1	26.48 (25.26)	1	23.20 (22.10)	1	24.71 (22.65)		22.00 (20.10)	1	21.94 (18.67)	1
89/02665	26.58 (22.34)	1	15.48 (11.20)	2	20.86 (14.21)	4	10.61 (7.53)	4	24.48 (17.73)	2	22.93 (18.18)	2	25.40 (20.49)		21.03 (16.68)	2	20.92 (16.05)	2
Mean	19.32		13.01		18.27		11.98		21.33		16.94		19.25		16.35		17.67	
SED	9.01		6.32		7.06		4.45		8.22		5.41		4.83		9.47			
Sig. level	P<0.05		P<0.05		P<0.05		P<0.05		P<0.05		P,0.05		P<0.05		P<0.01			
Locations	2		7		4		8		1		5		3		6			

Note: Total tuber yield are not in parenthesis
Ware yam tubers are in parenthesis
Ware tuber is a tuber weighing 1kg and above
Seed tuber is a tuber weighing less than 1kg
R= Rank

The combined mean performance of the landraces indicated significant (P<0.05) variability in the tuber yield performance of the yam landraces. Among the landraces evaluated in both years 2014 and 2015, the combined analyses showed that TDr 89/02665 the national check was ranked 1st only in one state (Abia State) with 26.58t/ha of total tuber yield above the grand mean yield of 19.32t/ha. Hembakwasi was ranked 1st in Oyo State with mean total yield of 17.15t/ha above the grand mean of 13.01t/ha. In Niger State, Aloshi was ranked 1st with mean total tuber yield of 27.60t/ha far above the grand mean of 18.27t/ha of total tuber yield. However, Obiaoturugo was ranked 1st in 5 out of 8 locations/States with total tuber yields far above their respective locations grand mean (Table 3). The result of their mean total tuber yield across locations and among the landraces was ranked, Obiaoturugo was ranked 1st with total tuber yield of 21.94t/ha above the grand mean of 17.67t/ha and mean ware tuber yield of 18.67t/ha.

The check variety was ranked 2nd with mean total tuber yield of 20.92t/ha above the grand mean of 17.67t/ha and ware tuber yield of 16.05t/ha. The landrace Hembakwasi was ranked 3rd with total mean tuber yield of 20.32t/ha above the grand mean of 17.67t/ha and ware tuber yield of 17.28t/ha. The mean yield across the locations indicated that Alumaco was ranked 8th with mean total tuber yield of 11.93t/ha far below the grand mean of 17.67t/ha. The highest yield of Hembakwasi in Oyo State was ranked 1st. Aloshi was 1st in Niger, 89/02665 came 1st in Abia State while Obiaoturugo consistently came 1st in 5 States (Edo, Nasarawa, Benue, Anambra and Ebonyi States).

The result in Table 3 indicated that all the landraces will perform well in Nasarawa State (ranked 1st), followed by Abia State (ranked 2nd). Anambra State was ranked 3rd while Niger State was 4th locations were the landraces could individually perform well. Most of the yam landraces may not do well in Edo State which ranked 8th as a result of soil type which was hydromorphic (soils in wet environment). However, since not all the landraces are location specific they may be registered and release for commercial yam production including for export.

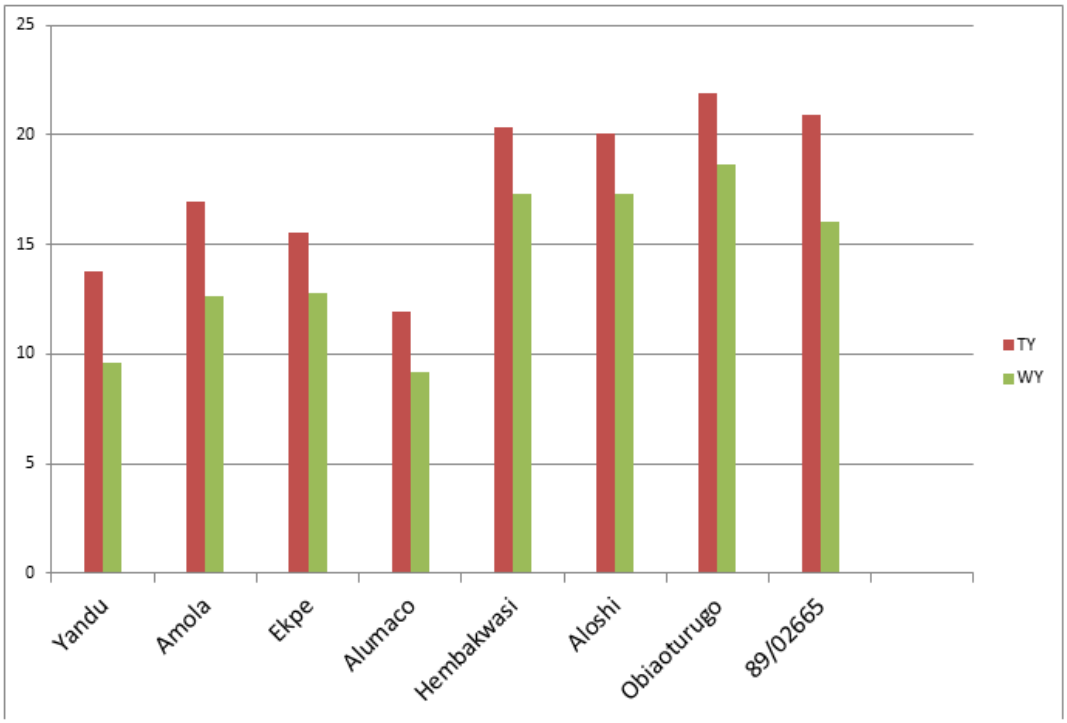

Figure 1: showing the total tuber yield and ware tuber yield of the selected landraces
Note TY = Total tuber yield
WY= Ware tuber yield

The result in figure 1 showed significant variation in the total tuber weight of the tubers and the tuber weight of the ware yam from the various landraces.

Pests and Diseases Test: Pests and Diseases reactions of the landraces: The mean response of the landraces to biotic stress in 2014 and 2015 Nationally Coordinated Crop Improvement trials combined are presented in Table 4.

Table 4: Mean response of the landraces to biotic stress in 2014 and 2015 NCRP trials combined

	Diseases				Pests						
Clone Name	Yam mosaic virus	Anthrac-nose	Leaf spot	Die-back	Yam beetle	Crickets	Termites	Nema-todes	Mealy-bugs	Scale insects	Millipedes
Yandu	2.2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Amola	2.3	1.0	1.0	1.0	1.0	1.0	1.0	2.0	2.0	1.0	1.0
Ekpe	1.3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Alumaco	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Hembakwasi	1.2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Aloshi	1.0	1.2	1.0	1.0	2.0	1.0	1.0	2.0	1.0	1.0	1.0
Obiaoturugo	1..0	1.2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
89/02665	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Mean	1.4	1.1	1.0	1.0	1.0	1.0	1.0	1.3	1.0	1.0	1.0
Sig. level											

Note:
1=no damage/no pests present
2=very little damage/few present (holes less than 5)
3=moderate damage/moderate number present (holes >5 and <10 present)
4=considerable damage/considerable number present (holes >15 and <20 present)
5 = severe damage/ very high number present (holes >2

Diseases reactions: The mean performance of the pests and diseases reactions indicated that there was very little to moderate reactions of pests and diseases attack on the landraces hence the severity rating of 1.0 for most of the diseases to 2.3 severity rating for Yam Mosaic Virus (Table 4). This indicated that the selected landraces for registration and documentation were tolerant/ resistant to most of the major pests and diseases attacking yam crops in the field. However, the mean diseases rating of 1.4 for viruses showed that most landraces (such as Yandu, Amola and Hembakwasa) had mild infection of viruses and could be said to be tolerant to virus diseases when the mean tuber yield were compared with the grand mean except that of Yandu.

Pests reaction: The mean pests reactions which ranged from 1.0 to 2.2 showed that there was very little to moderate reactions of pests attack on the landraces selected hence the severity rating of 1.0 for most of the pests and diseases to 2.2 severity rating for Yam nematode with mean of 2.3 showed mild attack of pests in the field especially for Aloshi and Amola (severity rating of 2.0).

Discussion

The significant ($P<0.05$) variation in tuber yield among the white yam landraces showed that there were variation in yield which indicated yield differences in the white yam landrace clones. The white yam landrace clones evaluated yielded higher outsider their area of nativity which showed that they can do better outside their area of origin and therefore could be adapted and adopted in other areas of the country. However, the change in rank of most of the landraces in each of the years indicated that they were affected by location effect. Singh (2016) reported that the variation present within a clone does not have genetic basis, he added that it could originate only due to the environment and genotype by environment interaction. However, some landraces such as Obiaoturugo were consistent in their rank in some locations and may be regarded to be less affected by environmental factors. This also confirmed Singh (2016) observation that the variation present within a clone is environmental and as such non-heritable. Since most of the landraces are location specific, they could be registered and documented as varieties that could perform in those locations. Hembakwasi which is from North Central Savanna agro-ecology was ranked 1st in Oyo State in Rainforest Agro-ecology with mean total yield of 17.15t/ha above the grand mean of 13.01t/ha. Also Aloshi from Rainforest Western part of the Country was ranked 1st in Niger State in North Central Savanna Agro-ecology with mean total tuber yield of 27.60t/ha far above the grand mean of 18.27t/ha of total tuber yield .For the fact that many of the landraces performed well outside their native homes is an indication that they could do well outside their place of origin (Table1).

According to Singh (2016) when a genotype/strain/species of a plant is taken to a new environment from a foreign country or from one region to another within the same country where it was not grown before and released, it is a new variety. He further said that these genotypes during their years of cultivation are imposed by natural forces like climatic, soil, biological (e.g diseases, insect pests etc), and other factors of the environment. All these factors therefore determine their course of evolution. In course of time, most of the genotypes become more adapted to the prevailing environment and the population retains considerable genetic variability. Singh (2016) reported that this is a rapid and cheapest way of releasing a superior crop variety. It is a very quick and economic method of crop improvement and could be introduced and released directly as a variety (Singh 2016).

For the fact that the national check (TDr89/02665) out yielded the landraces in most of the locations (Table 1) and across the locations was not surprising since the national check was a hybrid white yam which was selected and officially released in Nigeria in 2003 for outstanding yield performance. According to Singh (2016), a hybrid utilized its hybrid vigour to perform more than the unimproved white yam landrace clones. He further reported that hybrid vigour or heterosis is the superiority of F_1 hybrid in certain traits over both of its parents in terms of increased yield, faster growth, increased pests and diseases resistant/tolerance, improved quality, earlier flowering/maturity, increased reproductive ability and more adapted to environmental variations which is highly desirable in many crops. The hybrid vigour of the check variety may include increased number of leaves per plant which led to increased leaf area which, not only that it assisted in suppressing weeds by spreading and smouldering weeds which are competitors for nutrients and space also, absorbs sun irradiation for high photosynthetic efficiency and translocation of photosynthates to the sink which is the tuber thereby leading to high tuber yield.

The white yam clone landraces selected and evaluated for pests and diseases response showed marked resistant/tolerance to most of the field pests and diseases. Hence Sharma, (1980), made a point when he pointed out that landraces could be a source of resistance or immunity to yam virus disease (YMV) which has been a hindrance to yam cultivation. However, not only to yam mosaic disease but could be a source of resistance to leaf spot disease, anthracnose disease and die-back diseases of yams in the field. Although the pedigree of these white yam landraces are not known but have been selected by farmers over the years depending on their superior agronomic and food quality and farmers have been using them for a long time. These varieties are close to or equally better than released hybrid varieties. The greater percent of what farmers have in the field and use in feeding the nation and use to generate income through commercialization are these varieties. Breeders included them in their hybridization block as parents for their

desirable agronomic qualities. Therefore there is the need to officially document and register them as varieties.

Conclusion

Based on 5% selection pressure, the varieties Obiaoturugo, Ekpe, Aloshi, Hembakwasa and Amola have been selected for high yielding and resistant to major field pests and diseases attacking yams in the field. The agronomic performances of these white yam landrace clones indicated that they could be used as recombination materials by the yam breeders and are therefore recommended for official recognition and registration in different parts of the country for food and income generation. These white yam clones based on their performance could be used for commercial yam production intended for export.

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