EVALUATION OF SLIPS OF WHITE YAM (*DIOSCOREA ROTUNDATA POIR*) GENOTYPES FOR MINI-TUBER PRODUCTION IN THE HUMID TROPICS

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ABSTRACT

The study evaluated the slips of four landraces and five hybrid varieties of white yam for growth and minituber yield in 2011 and 2012 cropping seasons at the National Root Crops Research Institute, Umudike, south east Nigeria. The experiment was laid out in a randomised complete block design with three replications. Landrace *Hembamkwase* had the longest vine (163.3cm), followed by hybrid TDr 89/02665 while Ame produced the shortest vine. Hembamkwase also out-yielded other genotypes except Ame in 2011 and Nwopoko in 2012. Generally, slips of the hybrid varieties, especially TDr 89/02665 and TDr 97/19177 performed poorly in tuber yield compared to the landraces. Mini-tuber weight showed significant and positive correlation with tuber yield while simple linear regression also showed high coefficient of association between tuber weight and yield. The higher yield associated with the landrace Hembamkwase was attributed to greater slip size, indicating that the landrace can be hybridized and the trait selected for in yam improvement.

Keywords: *Dioscorea rotundata,* yam slips, genotypes, mini-tubers

INTRODUCTION

White yam (*Dioscorea rotundata* Poir) is one of the most important species cultivated throughout the yam belt of West Africa. In most yam-producing countries, the importance of yams has been increasing with respect to food security and nutritional diversification, provision of employment, incomes, as well as alleviation of rural poverty (Baudion and Lutaladio, 1998). In traditional farming system, yam production is expensive because seed yam tubers account for about 30 per cent of the total yield and as much as 63 per cent of total variable cost incurred per season of cultivation (Kikuno, 2011). The multiplication ratio for seed yam production in the field is very low (1:10) compared, for instance to some cereals whose multiplication ratio is 1:300(Kikuno *et al;* 2007).

The technique of rapid multiplication using mini-setts and micro-setts was developed to accelerate the multiplication process (Ekanayake and Asiedu, 2003; Ikeorgu and Nwokocha, 2001; Okpara, *et al*., 2013). With low adoption of the minisett technique (Ikeorgu and Igbokwe, 2002), there is need to explore other techniques that would enhance rapid multiplication of seed yam tubers using cost effective clean and practicable methods such as slips. Yams can be propagated by vegetative methods through the use of small whole tubers (minitubers, microtubers, seed yams) or slicing big tubers into setts with viable eyes or by using mini-sett or micro-setts and lately vine cuttings or slips (Kikuno, 2011).

Yam slip is that portion of a sprouted yam tuber with a small flesh that is usually discarded when a tuber is peeled for cooking or cut into minisetts or microsetts for planting. Igwilo (2002) referred to yam slips as peel setts while Onwueme (1973) stated that growth and development of whole plants from yam slips can be achieved because the sprouting loci of yam tubers are found below the tuber periderm. The use of yam slips in propagation guarantees a higher multiplication rate that is about 20 -50 times more than the conventional method. It also reduces production cost to about 50 per cent, provides practicable, clean and healthy planting materials as well as ensures the production of more planting materials at the shortest possible time and at a cheaper cost (Dalang, 1990; IITA, 2009). This study evaluated slips of some improved and landrace genotypes for growth and tuber production in South eastern Nigeria.

MATERIALS AND METHODS

The experiment was conducted on the Research Farm of the National Root Crops Research Institute (NRCRI), Umudike, South eastern Nigeria, in 2011 and 2012 cropping seasons. The site is located at latitude 05º 29´ N and longitude 07º 33´ E and 122 m altitude. The soil is a sandy clay loam ultisol. The land was under one year fallow before the start of the experiment. It was mechanically prepared: slashed on 11 April, ploughed on 18 April, harrowed on 22 April and ridged on 29 April, 2011. In 2012, the land was slashed on 24 April, ploughed on 30 April, harrowed on 1 May and ridged on 8 May. A composite soil sample from representative field locations was obtained with a soil augur to a depth of 20 cm. The soil physical and chemical properties of the sites are shown in Table 1. Soil p^H was determined in 1.25 water. Organic carbon was determined by the Nelson and Sommers (1982) method and converted to organic matter by multiplying by 1.724. Total soil nitrogen was analysed by Kjeldahl method, potassium by flame photometry, available phosphorus by Bray 2 method and particle size distribution by hydrometer method (IITA, 1979).

Treatments comprised the slips of five hybrid yam varieties (TDr 89/02660, TDr 89/02665, TDr 89/02475, TDr 89/02565, TDr 97/19177) and four elite landraces (*Nwopoko*, *Adaka*, *Ame* and *Hembamkwase*). The experiment was laid out in randomised complete block design with three replications. Each plot measured 4 m x 4 m (16 m^2). Mean weight of the slips with 1 cm flesh was 35 g for TDr 89/02665, 20g for TDr 89/02660, 25 g for TDr 89/02565, 20 g for TDr 89/02475, 25 g for TDr 97/19177, 25 g for *Nwopoko, 25 g for Adaka*, 30 g for *Ame* and 45 g for *Hembamkwase* (Hemba). The yam slips were planted 15 cm apart on the crest of the ridges spaced 1 m apart on 29 April, 2011 and 8 May, 2012 to give a plant population of 66,666 plants/ha. Weeding was done manually with hoe at 4, 8 and 12 WAP. Compound fertilizer NPK 15:15:15 was applied at the rate of 400kg/ha at 8 WAP by band placement. Staking was done 6 WAP by the trellis method using 2 m high bamboo stakes. Periodic training of vines was done.
Measurements were taken on vine length (cm), number of leaves/plant and shoot dry matter at 4 months after planting (MAP). At harvest, data were taken on number of tubers/plant, tuber weight (kg) and tuber yield (t/ha). The data were subjected to analysis of variance using GENSTAT (2007) statistical package.

RESULTS AND DISCUSSION

The soils of the experimental sites were texturally sandy clay loam (Table 1). The soils were low in nitrogen in both years and were acidic. Exchangeable potassium in the soil was medium in 2011 but low in 2012. Total rainfalls for the experimental period of May through December were 1857.9 mm in 2011 and 1622.6 mm in 2012 (Table 2). In both years, monthly maximum temperature ranged from 29^{0}C to 33^{0}C while the minimum temperature ranged from 21°C to 24°C.

Crop growth attributes of the slips of improved and landrace genotypes of white yam are shown in Fig 1. Vine length differed but the number of leaves per plant did not significantly ($P>0.05$) vary among the genotypes. Vine length ranged from 94 cm to 163 cm. The landrace genotype *Hembamkwase* produced the highest vine length while *Ame* gave the shortest vine length. However, among the improved genotypes TDr 89/02665 had vine length that did not significantly differ from that of *Hembamkwase.* Similarly, significant variation in vine length had been reported by Kikuno (2011) in the propagation of clean yam tubers from vine cuttings. ExceptTDr 89/02665, all the improved genotypes had vine lengths that were significantly ($P>0.05$) shorter than that of the landrace *Hembamkwase.* The longer vine in Hembamkwase was primarily due to the larger slip size which conferred greater vigour on the cultivar. Ikeorgu (2003) similarly reported higher vine length and leaf area in yam bulbils of 26-35g and 36-50g weight than in bulbils of 10-25g.

Yield and yield components of the mini-tubers as influenced by the slips of the white yam genotypes are presented in Table 3. On the average, the number of tubers harvested per plant ranged from 1.00 to 1.42 and did not vary significantly among the genotypes. However, tuber weight differed significantly among the slips of the genotypes. In 2011 cropping season, the landrace genotype *Hembamkwase* produced the highest weight of mini-tuber (230 g) while the improved varieties TDr 89/02665, TDr 89/02475 had the least (80 - 90 g). On the other hand, in 2012, the landraces *Hembamkwase* and *Nwopoko* had the highest tuber weight of 170 g, followed by *Ame* while all the improved varieties, except TDr 89/02475 (100 g), gave the lowest weight of tubers (50 - 60 g). Ikeorgu and Nwokocha (2001) had recommended tuber weight of 75 g as suitable size for seed yam production.

Mini-tuber yields varied significantly among the genotypes and mostly followed the same trends as weight of tubers. On the average, slips of the landrace *Hembamkwase* gave the highest mean tuber yield of 13.5 t/ha followed by *Ame* or *Nwopoko* while slips of hybrid yam varieties TDr 89/02665 and TDr 97/19177 had lowest yields (5.0 t/ha). Behera *et al.* (2009) and Agele *et al.* (2010) working with vine cuttings reported similar ($P<0.05$) genotypic variations in the growth and yield of white yams. The observed variation in tuber yield of the genotypes was attributed to differences in the weight of the slips, as *Hembamkwase* which had the highest mean weight of slips, gave the highest yield. Eke-Okoro *et al.* (2001) made a similar observation in their study on the growth and yield of three cassava cultivars as influenced by stake weight or size while Ndaeyo *et al* (2013) also reported higher yield with larger sett weight in cocoyam. Averaged over the two cropping seasons, the landrace *Hembamkwase* out yielded TDr 89/02660, TDr 97/19177 or TDr 89/02665 and Adaka by 43%, 63% and 32%, respectively. The mean tuber yields of 4.5 – 13.5 t/ha obtained in this study were higher than the 1.3 – 6.8 t/ha reported by Ikeorgu and Okonkwo (2010) for hybrid yam varieties using 8 g micro-setts.

In all situations, there was a significant ($P \leq 0.05$) positive correlation between tuber weight and yield and a non significant ($P \geq 0.05$) correlation between number of tubers per plant and weight of tubers per plant (Table 4). This indicates that weight of tubers can exert strong influence on yield of slips of white yam. Simple regression analysis of mini-tuber yield on yield components also showed that weight of mini-tubers per plant was an important character affecting yield (Table 5). As mean of two cropping seasons, weight of tubers accounted for 92 per cent of the variation in tuber yield.

CONCLUSION

Results from our study suggest that the landrace genotypes responded better to propagation by yam slips, due mainly to higher weight of slips. The landrace Hembamkwase gave significantly longer vines and higher mini tuber yield than most of the genotypes. Between the yield components, tuber weight showed significant and positive correlation with mini tuber yield.

Table 1: Soil physical and chemical properties of the sites for the experimental periods

Physical Properties	2011	2012
Sand (%)	67.8	68.4
Silt (%)	10.8	10.8
Clay (%)	21.4	20.8
Texture	Sandy clay loam	Sandy clay loam
Chemical Properties		
pH	4.5	4.7
Total N (%)	0.098	0.06
O M (%)	2.59	1.16
Available P (mg/kg)	20.00	30.00
Exchangeable K (Cmol/kg)	0.30	0.09
Ca (Cmol/kg)	2.0	1.6
Mg (Cmol/kg)	1.2	0.4

Table 2: Weather data of the site for the experimental periods in 2011 and 2012

Months	2011					2012				
	Rainfall	Temp. (°C)		Rel. Humidity (%)	Sunshine (Hrs)	Rainfall	Temp. (°C)		Rel. Humidity (%)	Sunshine (Hrs)
	(mm)	Max	Min	0900Hrs	3.8	(mm)	Max	Min		
May	347.7	32	23	82	3.0	233.7	33	23	81	5.4
June	239.5	30	23	81	2.1	213.0	30	23	86	3.9
July	236.5	30	22	87	1.5	362.0	29	22	91	1.8
Aug.	345.1	29	23	91	2.4	161.8	29	23	87	2.3
Sept.	424.7	30	23	90	4.5	349.0	30	22	86	3.3
Oct.	242.8	30	23	85	6.6	244.6	30	21	82	4.7
Nov.	12.0	31	23	80	7.0	58.5	31	24	82	4.1
Dec.	9.6	33	21	64		0.0	33	21	74	
Total	1857.9					1622.6				

Source: National Root Crops Research Institute, Umudike Agrometeorological Unit

Table 3: Yield and yield components of mini-tubers produced from slips of white yam genotypes in 2011 and 2012 cropping seasons

White yam genotype	Number of tubers/ Plant		Tuber weight (kg)		Minituber yield (t/ha)	
	2011	2012	2011	2012	2011	2012
Improved						
TDr 89/02660	1.00	0.99	0.12	0.09	8.43	6.10
TDr 89/02665	1.03	1.03	0.08	0.06	5.27	4.37
TDr 89/02475	1.04	1.06	0.09	0.10	6.03	7.07
TDr 89/02565	1.02	1.03	0.12	0.05	7.97	3.40
TDr 97/19177	1.00	1.02	0.09	0.06	6.13	3.83
Land races						
Nwopoko	1.04	1.80	0.15	0.17	10.47	9.03
Adaka	1.01	1.00	0.17	0.11	11.30	7.03
Ama	1.03	1.81	0.19	0.13	13.10	7.07
Hembamkwase	1.01	1.01	0.23	0.17	15.50	11.47
F-LSD$_{0.05}$	ns	Ns	0.055	0.0537	3.879	3.886

Table 4: 2011 and 2012 correlation coefficients of three characters in white yam genotype slips

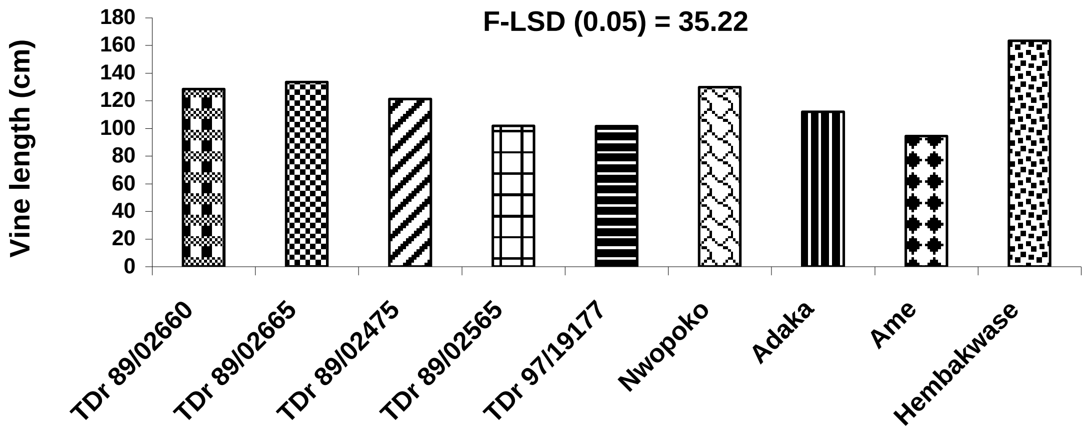
White yam genotype slip characters	Mini-tuber yield (t/ha)	Number of mini-tubers /plant	Weight of mini-tuber (kg/plant)
2011			
Mini-tuber yield (t/ha)	1.00		
No. of mini-tubers/plant	-0.031^{ns}	1.00	
Weight of mini-tuber (kg/plant)	0.926^{**}	-0.391^{ns}	1.00
2012			
Mini-tuber yield (t/ha)	1.00		
No. of mini-tubers/plant	-0.038^{ns}	1.00	
Weight of mini-tuber (kg/plant)	0.995^{**}	-0.126^{ns}	1.00

**, correlation is significant at the 0.01 level; ns, correlation is non-significant.

Table 5: Regression Estimates of mini-tuber yield on stand count at harvest, number of tubers per plant and weight of tubers per plant (kg) in 2011 and 2012 cropping seasons

	2011			2012		
	Estimate	S.e	t-Probability	Estimate	S.e	t-Probability
Mini-tuber yield (t/ha)	-9.195	1.086	$<0.001^{***}$	-8.313	0.622	$<0.001^{***}$
No. of mini-tubers/plant	0.0003	0.0023	0.913	10.001	0.0041	0.792
Mini-tuber weight (kg/plant)	68.714	0.985	$<0.001^{***}$	66.351	1.986	$<0.001^{***}$
	$R^2 = 0.998$			$R^2 = 0.987$		
Mini-tuber yield (t/ha)	13.287	20.845	0.530	7.186	4.070	0.090
No. of mini-tubers/plant	-3.814	20.210	0.852	-0.645	4.144	0.878
	$R^2 = 0.001$			$R^2 = 0.001$		
Mini-tuber yield (t/ha)	0.180	0.199	0.592	0.561	0.540	0.309
Mini-tuber weight (kg/plant)	68.034	1.357	$<0.001^{***}$	57.230	4.665	$<0.001^{***}$
	$R^2 = 0.990$			$R^2 = 0.858$		

S.e, Standard error of means; P<0.001***, Significant at 0.001 level.



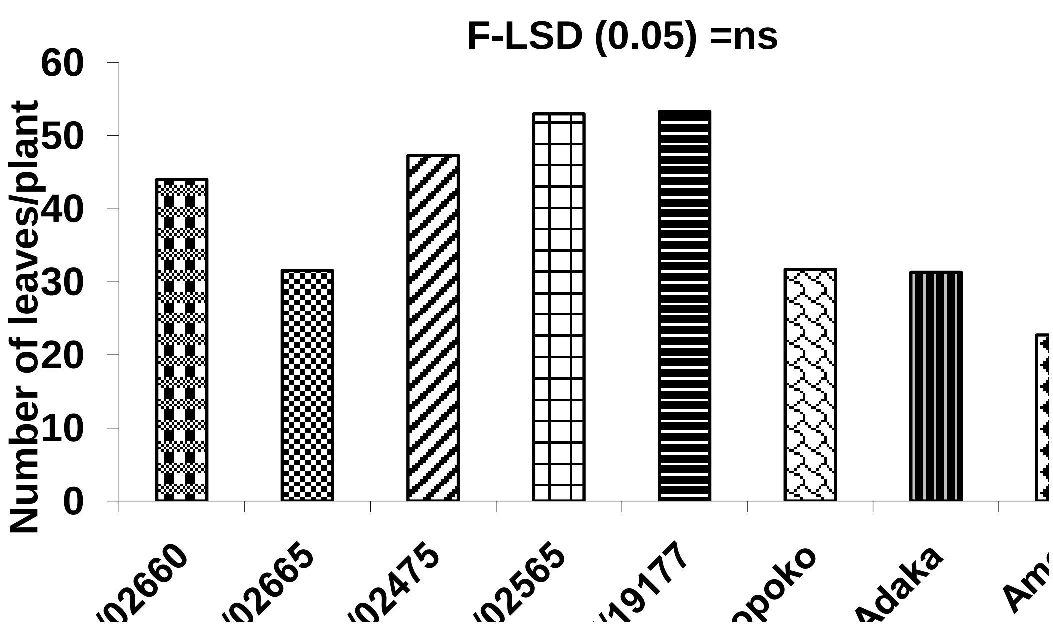


Figure 1. Vine length (cm) and number of leaves per plant of yam slips of some improved and land race white yam genotypes at 20 weeks after planting.

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