

EVALUATION OF GUINEA WHITE YAM (*Dioscorea rotundata* Poir.) FOR YIELD AND YIELD COMPONENTS IN NIGERIA.

Bassey EE & Akpan US
Department of Crop Science
Faculty of Agriculture
University of Uyo, Uyo,
Akwa Ibom State, Nigeria.
Email: emmanuelessien@rocketmail.com
Phone: +2348024686153

ABSTRACT

A study was conducted at the Experimental Farm of the Cross River Basin Development Authority, Oku-Iboku, Itu in Akwa Ibom State in 2012 and 2013 cropping seasons. The aim was to evaluate seven genotypes of guinea white yam (*Dioscorea rotundata* Poir.) accessions at the last stage of uniform yield trial (UYT) for yield and yield components. The plant characters studied were vine length, number of branches, number of leaves, length of tubers, circumference of tubers, number of tubers per plant, fresh weight of tubers and tubers yield (t/ha). The result indentified UYT 89/02602 with highest performance in five characters: number of branches, number of leaves, length of tubers, fresh weight of tubers and tuber yield (t/ha), followed by the local cultivar, *Akpedu* as check. Similarly, UYT 89/02677 gave superior performance for vine length and number of tubers per plant. The three genotypes could be selected for and incorporated into breeding programmes for development of hybrid varieties for Itu, Akwa Ibom State, Nigeria. Also, UYT 89/02602 and UYT 89/02677 are suitable candidates for advancement to pre-release trial and eventual varietal release.

Keywords: Yam, white yam, yield, yield components, *Dioscorea rotundata*, Nigeria.

Introduction

The guinea white yam (*Dioscorea rotundata* Poir.) belongs to the family *Dioscoreaceae*, that produces edible tubers (1,2). It is considered to be indigenous to West Africa (3) and some researchers have pin pointed the Niger-Benue trough of Nigeria as its probable centre of domestication (4). The economic importance of guinea white yam is due largely to its production of large edible tuberous underground stem of high fresh weight (15 – 20 kg) (5). The freshly harvested yam tubers contain about 70% water, 25% starch, 1 – 2% protein and only traces of sugars, minerals and vitamins (6).

The guinea white yam is cherished for food and it is food of choice for traditional ceremonies and festivals. It serves as a special component of traditional gift, fine and bride price (7). Yam tubers may be baked, smoked, mashed, chipped, barbecued, roasted, fried, grilled, boiled or pounded and eaten with sauce (8). It may be peeled and dried to very low moisture content and ground into flour (9). The tubers may be cooked with beans, leaf vegetables or rice to form good delicious mixtures.

Dioscorea rotundata is estimated to account for about 79% of the total world food yam (10). It has been reported that about 90% of the global yam production comes from West Africa (11). Nigeria is the largest world producer with 35.07 million metric tonnes and the largest consumer of yam (12). Nigeria is followed, though not so close by Cote d'Ivoire with 6.9 million metric tonnes and Ghana, with 4.8 million metric tonnes (11). Guinea white yam forms an important staple food source for other tropical countries including East Africa, Caribbean, South America, India and Southeast Asia (13). It contributes significantly to the daily dietary needs of average Nigerians (14).

Due to increasing world population, mainly in developing countries of Africa, guinea white yam production is no longer meeting the aggregate demand. In order to meet annual demand, yam production will have to increase by 3 – 4 percent. At present, the production is only marginally due to lack of improved high yielding varieties (15). Difficulty in interspecific and intraspecific hybridization in yam through conventional breeding is a limitation in yam improvement (16). According to Nwachukwu (17), the procedure for yam breeding takes several stages that may span over 9 years and include hybrid seed production, clonal evaluation, preliminary yield trial, advanced yield trial, uniform yield trial and the pre-release trial and all these constitute an obstacle to yam breeding. Variability in *D. rotundata* is almost the only avenue for local farmers and consumers to obtain desired traits in yam. Therefore, the purpose of the study was to evaluate the yield and yield components of *Dioscorea rotundata* with a view to identifying superior genotypes in the last stage of uniform yield trial for advancement to pre-release trial in Itu, Akwa Ibom State, southeastern Nigeria.

Materials and Methods

The study was conducted in 2012 and 2013 cropping seasons at the Cross River Basin Development Authority, Oku Iboku, Itu in Akwa Ibom State. Itu is situated in the tropical rainforest zone of Nigeria, within latitude 5°10'N and 7°59' East of the Equator (Cross River Basin Development Authority Agrometeorological data, 2012). The treatments were guinea white yam (*Dioscorea rotundata*) genotypes at the last stage of uniform yield trial (UYT), namely: UYT 89/02475, UYT

89/02665, UYT 89/02677 and UYT 89/02602 and three land races *Nwopoko*, *Abi* and *Akpedu*. All the yam genotypes except *Akpedu* were obtained from the National Root Crops Research Institute Umudike, Nigeria. The local genotype, *Akpedu* was obtained from a yam farmer in Itu Local Government Area of Akwa Ibom State, Nigeria.

The seven yam genotypes were prepared into yam setts of 200g and each genotype was properly labeled, separated and treated with Aldrex T mixed with ash at the ratio of 1:4 against insect pests, nematodes and fungal attack and spread in a cool dry place for two days. Seven baskets of similar sizes were filled with pre-treated saw dust and moistened with clean water. The yam setts of each genotype were placed separately into each of the baskets and watered daily for initiation of sprouts. Sprouts occurred within three weeks after nursery planting (12,15). The experimental area which measured 23.0m x 21m was manually cleared, tilled and ridged 1m apart and 0.5m high. The experiment was laid out in a randomized complete block design (RCBD) with four replications. Each ridge measured 5m long and the replicates were separated by 1m paths. Each plot measured 3m x 5m and consisted of three ridges. The yam sprouts were transplanted to the field at four weeks after nursery planting and planted at 1m intra and inter-rows on the crest of the ridges on Tuesday, 1st May, 2012 and Wednesday 1st May, 2013. One yam sett was planted per stand, giving 15 yam plants per plot and 420 yam plants in the entire experimental farm, equivalent to 10,000 plants per hectare.

Staking was done 25 days after field planting using the Indian bambo (18). Weeding was done manually using native hoe and machete at 1, 3 and 5 months after planting. NPK (15:15:15) fertilizer was applied 30 days after field planting at 400 kg/ha, 10cm away from the plant using the ring method (19). The ridges were mulched to reduce erosion, weed growth and to conserve soil nutrients. Similarly, cross bars were constructed to control run-off.

The yam genotypes were harvested 24 weeks after field planting, using spade, dibber and machete. Data were collected from five tagged plants at the centre of each plot. The growth characters studied were vine length (cm), number of leaves per vine, and number of branches per vine while yield data were circumference of yam tubers (cm), number of yam tubers, length of yam tubers (cm), fresh

weight of yam tubers (kg) and fresh tuber yield (t/ha). Data collected were subjected to analysis of variance using the procedure described by Gomez and Gomez (20). Means that showed significant differences were separated using the least significance difference (LSD) at 5% probability level (21).

RESULTS

Significant differences were observed for all the characters among the yam genotypes in the field ($P \leq 0.05$). The longest vines in the first month were observed in UYT 89/02677 (319.7cm), followed by UYT89/02602 (272.5cm) and UYT89/02665 (250.4cm), while the shortest vine were observed in Nwopoko (212,9cm) (Table 1). The highest number of branches at five months after planting was observed in UYT 89/02602 with 30.2 mean branches, followed by UYT 89/02677 and UYT 89/02475 with 28.6 and 24.8 mean number of branches per plant, respectively. The lowest mean number of branches per plant was observed in UYT 89/2665 (19.6).

The highest mean number of leaves at the first and fifth months after planting were observed in UYT 89/02602 with 52.4 and 346.4, respectively, though the number of leaves reduced to 86.4 in the sixth month. This observation was followed by UYT 89/02665 with 341.6 mean leaves in the 5th month of field planting while the lowest (296.1) came from UYT 89/02475.

The longest tubers were observed in UYT 89/02602 (42.8cm), followed by UYT 89/02475 with 28.0cm, while the shortest tubers (26.4cm) were produced by Abi. However, no significant difference for tuber length was observed between UYT 89/02677 and Nwopoko (Table 4). Similarly, the largest circumference of tubers was observed in UYT 89/02602 (32.7cm and 32.0 cm) for the two cropping seasons. This was followed by *Akpedu*, with 31.9cm and 31.7cm, for 2012 and 2013 cropping seasons. The shortest circumference of yam tubers was observed in UYT 89/02665 (26.7cm and 26.2cm). Significant differences were observed among the yam genotypes for the character, except for UYT 89/02475 and UYT 89/02677 and UYT 89/02602 and *Akpedu*.

In 2012 and 2013 cropping seasons however, UYT 89/02677 produced the highest number of tubers, followed by UYT 80/02475 and UYT 89/02602. The lowest number of tubers however was

produced by Nwopoko (Table 4). For fresh weight of tubers, UYT 89/02602 produced the highest mean values of 4.7 kg and 4.6 kg for the two cropping seasons, followed by UYT 89/02677 with 3.7kg and 3.9kg and UYT 89/02475 with 3.4kg and 3.3kg while the lowest tuber fresh weight was produced by *Abi* with 1.6kg and 1.4kg for the two years, respectively (Table 4). Similarly, UYT 89/02602 produced the highest fresh tuber yield of 46.6 (t/ha) and 45.4 (t/ha), for the two cropping seasons followed by *Akpedu* with 41.6 t/ha and 41.1 (t/ha), and UYT 89/02677 with 37.4 t/ha and 37.1 t/ha, while the lowest tuber yields of 16.0 t/ha and 16.2 t/ha were produced by *Abi*.

DISCUSSION OF RESULTS

Variability among the yam genotypes were observed for all the characters studied. Two yam genotypes UYT 89/02602 and the local check *Akpedu* had the longest tubers, largest tubers, highest number of leaves and highest fresh weight of tubers and fresh tuber yields. Similarly, UYT 89/02677 had superior performances in two characters namely vine length and number of tubers per plant. It was however observed that the genotype UYT 89/02602 recorded fewer leaves (86.4) at harvest compared to UYT 89/02665 with 141.2 mean leaves. According to Bassey and Harry (22) the capacity of plants to produce higher yields could be attributed not only to larger number of leaves but a combination of other genetic traits with high power of the sink. Also, the reduction in number of leaves at six months after planting in the field could be attributed to variability in physiological maturity of individual yam genotypes. Those with early leaf loss could be classified as first early maturers (FEM) in yam. Studies of Diby *et al.* (23) and Awoniyi and Omomona, (24) have shown that *Dioscorea rotundata* sheds over 90% of its leaves at full tuber maturity which may indicate physiological maturity of the plant and readiness for harvesting. Diby *et al.* (23) and Bassey and Harry (22) have shown that at two months after field planting, most tuber crops like sweet potato, cassava and yam produce larger number of leaves to kick-start tuber initiation and tuber bulking. According to them from two months stage if the plant experiences moisture stress its sink capacity to store photosynthates could be hampered and this may result in low yield. Therefore, a positive association could be established between number of

leaves, fresh weight of tubers and vine length with and tuber yield. For example, UYT 89/02602 and control (*Akpedu*) with higher number of leaves also produced higher fresh weight of tubers, higher tuber lengths, larger tuber circumference and higher number of branches in yam.

These observations suggest for breeding of yam with higher number of leaves, as a means of increasing the source capacity which could positively influence the power of the sink. All these facts agree with IITA (25) that tuber yield may correlate with certain growth characteristics such as number of leaves, leaf area index, vine length and the habit of the plant. In this study a positive association could be established between these growth characteristics and yam tuber yield, suggesting for selection of yam based on these characteristics in breeding programmes. An increase in vine length may lead to increase in number of branches, which in turn could lead to increase in number of leaves in yam. Therefore, increase in vine length in yam may increase the power of source capacity which impacts positively on the power of sink for tuber initiation and early bulking (26).

CONCLUSION

Significant differences ($P \leq 0.05$) among the yam genotypes were observed for all the characters studied. Two yam genotypes UYT 89/02602 and the local check *Akpedu* recorded the longest tubers, largest tubers, highest fresh weight of tubers and fresh tuber yields. Similarly, UYT 89/02677 recorded superior performance in two characters: vine length and number of tubers per plant. The three yam genotypes could be incorporated into breeding programmes for production of hybrid varieties for Itu environment in southeastern Nigeria. Also, UYT 89/02602 and UYT 89/02677 are suitable candidates for advancement to pre-release trial. Itu Local Government Area in Akwa Ibom State has potential for yam production using these improved cultivars. There is need for multiplication and dissemination of the yam genotypes for farmers in the area to increase productivity. This will reduce the risk of traveling to far places for yam products.

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Table 1: Vine length (cm) of yam genotypes in the field at Itu Basin in Itu, Akwa Ibom State

Yam genotypes	Months after planting (MAP) in 2012 and 2013 seasons											
	1		2		3		4		5		6	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
UYT 89/02475	236.6	234.9	273.9	276.0	322.2	324.5	334.0	335.2	346.9	346.6	346.9	346.8
UYT 89/02677	319.7	318.5	358.4	358.9	418.5	416.6	426.6	428.3	438.7	439.0	438.7	439.0
UYT 89/02665	250.4	251.3	324.2	323.8	365.1	363.9	382.4	380.6	392.7	393.4	392.8	393.4
Nwopoko	212.9	210.8	289.7	290.0	308.7	309.6	329.8	328.9	340.2	340.8	340.0	340.8
Abi	240.6	241.3	267.5	270.3	338.2	336.8	358.1	358.7	367.1	366.9	367.3	366.8
UYT 89/02602	272.5	270.8	355.6	353.9	369.4	367.6	384.0	387.2	406.6	407.1	406.7	407.0
Akpedu	244.7	244.0	266.2	267.2	371.8	370.4	389.8	389.3	392.5	398.0	397.4	398.0
LSD (P<0.05)	1.18	0.97	0.83	0.79	0.81	0.83	1.18	1.36	1.26	1.30	1.26	1.30

Table 2: Number of branches of yam genotypes in the field at Itu Basin in Itu LGA, Akwa Ibom State

Yam genotypes	Months after planting (MAP) in 2012 and 2013 cropping seasons											
	1		2		3		4		5		6	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
UYT 89/02475	3.6	3.5	14.0	14.6	20.4	20.2	22.6	22.4	24.8	24.6	24.8	24.6
UYT 89/02677	8.0	7.9	20.0	20.6	24.9	25.0	26.5	26.3	28.6	28.4	28.6	28.5
UYT 89/02665	4.6	4.6	12.8	12.4	16.5	16.2	17.9	17.9	19.6	19.8	19.6	19.8
Nwopoko	5.3	5.6	16.8	16.8	18.9	18.6	20.16	20.4	22.4	22.4	22.4	22.4
Abi	4.4	4.6	12.0	12.2	17.0	17.3	20.5	20.2	23.8	23.6	23.8	23.7
UYT 89/02602	8.6	8.6	20.8	21.0	25.9	25.9	28.5	28.4	30.2	30.0	30.2	30.0
Akpedu	3.4	3.5	17.2	17.5	19.5	19.6	20.4	20.0	22.4	22.1	24.4	22.2
LSD (P<0.05)	0.03	0.04	0.4	0.03	0.27	0.26	0.15	0.16	0.26	0.24	0.27	0.26

Table 3: Number of leaves per plant of yam genotypes in the field at Itu Basin in Itu LGA, Akwa Ibom State

Yam genotypes	Months after planting (MAP) in 2012 and 2013 cropping seasons											
	1		2		3		4		5		6	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
UYT 89/02475	19.6	19.4	220.8	221.6	298.7	299.0	320.4	321.2	296.1	295.6	109.6	109.1
UYT 89/02677	46.2	45.9	289.5	290.2	342.6	324.9	360.1	360.4	339.4	339.8	76.4	77.0
UYT 89/02665	28.9	28.2	236.7	236.0	346.2	345.7	369.9	369.6	341.2	341.6	141.2	141.2
Nwopoko	30.6	30.0	270.6	269.9	318.4	318.0	326.6	326.1	301.2	300.8	62.4	63.1
Abi	26.4	25.8	230.4	231.3	358.8	358.9	372.4	373.0	326.4	327.0	120.4	120.2
UYT 89/02602	52.4	52.0	269.4	269.2	359.8	359.6	389.7	390.1	346.4	346.2	86.9	86.4
Akpedu	19.8	19.6	240.2	240.0	349.5	349.8	390.4	371.2	340.1	341.0	114.6	114.8
LSD (P<0.05)	2.56	2.52	3.04	3.01	2.21	2.46	2.60	3.04	2.45	3.06	1.59	1.66

Table 4: Yam tuber length (cm), circumference of yam tubers (cm), number of yam tubers/plants, fresh weight of yam tubers (kg) and fresh yam tuber yield (t/ha)

Yam genotype	Tuber length (cm)		Circumference of tubers (cm)		Average no of tubers/plant		Fresh weight of tubers (kg)		Fresh tuber yield (t/ha)	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
UYT 89/02475	38.0	37.2	28.9	39.2	1.5	1.6	3.4	3.3	31.4	31.0
UYT 89/02677	34.7	33.1	29.0	28.6	1.7	1.6	3.7	3.9	37.4	37.1
UYT 89/02665	34.0	34.0	26.7	26.2	1.2	1.4	2.2	2.1	21.9	22.0
Nwopoko	34.9	33.6	30.5	30.4	1.1	1.0	3.0	3.0	30.1	29.8
Abi	26.4	27.4	28.1	28.3	1.3	1.5	1.6	1.4	16.0	16.2

UYT 89/02602	42.8	43.6	32.7	32.0	1.5	1.6	4.7	4.6	46.6	45.4
Akpedu	35.8	35.9	31.9	31.7	1.3	1.4	3.0	3.1	41.6	41.1
LSD (P<0.05)	0.60	2.56	1.03	1.04	0.10	0.11	0.04	0.04	3.42	3.51