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Comparative Study on Growth and Yield Response of Hybrid and Local Cultivars of White Yam (*Dioscorea rotundata* Poir.) in Edo State Nigeria

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ABSTRACT: The growth and yield response of three hybrid yams (TDr 89/02665, TDr 89/02565 and TDr 89/02677) and fifteen local white yam cultivars were evaluated in the rainforest ecology of Edo State Nigeria. The experiment was carried out in order to document the performance of the three hybrid yam in comparison with local white yam cultivars. The three hybrid and fifteen local white yam cultivars were grown in the Teaching and Research Farm of the Faculty of Agriculture, University of Benin, Benin City, Edo State, Nigeria during the 2009 planting season using a 6m single row plot per cultivar at a spacing of 1 x 1m. The experiment was laid out in a randomized complete block design with three replications. All the yam cultivars were sown in mounds using whole seed yam weighing about 0.5kg. Each cultivar was manually weeded, and NPK (15:15:15) was applied at the rate of 400kg/ha at 8 week after planting. The results showed that there was significant difference among all the white yam cultivars in the number of leaves, length of tenth internode, spininess ($P \leq 0.05$). There was no significant difference in fresh tuber yield among all yam cultivars. However, the fresh tuber yield of hybrid and local yam cultivars ranged from 14.6 – 19.2 t/ha and 8.7 – 33.7t/ha respectively. Among the hybrid cultivars, TDr 89/02677 had the greatest fresh tuber yield and was followed by TDr 89/02665 and TDr 89/02565. The fresh tuber yields of Abakaliki, Ikale, Alumako, EKpen, Oboko, Asoko, and Iyawo 1 were all greater than TDr 89/02677 (the most promising hybrid yam cultivar). Also, most of the local white yam cultivars exceeded the three hybrids in tuber dry weight. The superior performance of some of the local white yam cultivars indicated that farmers' clonal selection at farm level is an obvious reality. However, the high yield potential of the three hybrid cultivars has been confirmed from this study, and the farmers can adopt them in order to boost the genetic diversity of their planting material. Moreover, the hybrid yam cultivars are known to show tolerance to low soil nutrient status when planted early. A participatory on-farm trial of the hybrid and local cultivars is hereby recommended to speed up adoption of the hybrid varieties.

Keywords: Growth, Yield, Hybrid cultivars, Local cultivars, White yam (*Dioscorea rotundata* Poir). Edo State

Introduction

Yams (*Dioscorea spp*) play a significant role in the human diet in the tropics and they are also of socio – economic importance in the life of the growers. Yam production is a major agricultural industry in Nigeria, which accounts for the largest production in the world. With average production record of 27 metric tonnes per annum, yam is only second to cassava among the staple root and tubers grown in Nigeria (Nwosu, 2004). Analysis of crop-area-yield survey conducted in Nigeria showed that production in Nigeria stood at 25 – 30 metric tonnes per annum, grown on 2.4 million hectares of land per annum and at an average yields of 10.7 tonnes/ha (Orkwor, 2001). *D. rotundata* is believed to have originated in West Africa (Onwueme, 1978, Orkwor, 1998). Today, *D. rotundata* remains the principal yam cultivated in the West African sub region. The West African yam zone has the oldest yam culture and is the largest repository of yam biodiversity.

However the cultivation of yam is done mainly by small scale farmers who grow mostly indigenous cultivars. Low yields are reported with the world average being 8.7t/ha (FAO, 1988). The low yield of indigenous cultivars can be attributed to genetic and environmental factors such as declining soil fertility across the yam zone as a result of intensives use of agricultural lands and short fallow period.

Yams are vegetatively propagated. Improvement in yam breeding has been done by introduction and clonal selection from traditional or local cultivars. Lack of seed set has greatly restricted the spectrum of genetic variability in edible yams. Breeding by hybridization has not been possible due to poor flowering, dioecy, non synchrony of sexual phase and absence of seed set (Onwueme, 1978; Asiedu, 1992). Hence, Zoundijilekpon and Dansi (2001) observed that despite the fact that the yam is an age old African food crop, there are no hybrid varieties selected and distributed as is the case of other food crops.

The myth was however broken by the development of seven hybrid varieties of white yam (*D.rotundata*) by the International Institute of Tropical Agriculture (11TA), Ibadan in collaboration with National Root Crops Research Institute (NRCRI), Umudike. The development of the seven hybrid yam varieties is the first of its kind in yam research globally. The hybrid yam varieties are as follows: TDr 89/02677; TDr 89/02461; TDr 89/02565; TDr 89/01438; TDr 89/01213; TDr 89/02665 and TDr 95/01924. The hybrid yams are products of several years of painstaking research efforts in yam breeding by three scientists from the two research institutions (NRCRI, 2003). The hybrid varieties were developed from indigenous cultivars in order to improve yam tuber yield potential (Asiedu *et al*., 1998). The high yield potential of hybrids (13 - 27t/ha) has been confirmed and some varieties have been selected for the rain forest areas of Nigeria (Agbaje *et al*., 2002, Agbaje *et al*., 2003).

These hybrid varieties were found to perform better than local cultivars in on – station trials (Agbaje and Aluko, 2009).

The results of various trials consistently identified TDr 89/02565 and TDr 89/02665 as superior in tuber yield to other cultivars in South Western Nigeria. TDr 89/02665 was noted for its field tolerance to *Meliodogyne incognita* nematode infection and resistance to yam potymosaic virus (Agbaje *et al*., 2002, 2003).

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There is need to confirm these on–station results of hybrids along with other local cultivars since yield performances are invariably influenced by genotype x environment interactions. Moreover, a comparative study of this nature would help to affirm the feasibility of the new technology (hybrid yam), and speed up its adoption by farmers. Thus, the objective of this present study was to assess the growth and yield response of hybrids in comparison with the local white yam cultivars.

Materials and Methods

The experiment was carried out at the Teaching and Research Farm of the Faculty of Agriculture, University of Benin, Benin city, Nigeria (Latitude 06^0 20'N and Longitude 05^o 31'E) and falls within the humid rain forest ecological zone. The study was carried out on a plot of land that has been under one - year fallow and was dominated by *Panicum maximum* and *Mimosa pudica*. The three hybrid varieties of white yam (TDr 89/02665, TDr 89/02565 and TDr 89/02677) and two other local cultivars (Nwopoko and Obiaturugo) were obtained from the National Root Crops Research Institute, Umudike. The other thirtteen local white yam cultivars (Abakaliki, Alumako, Airiebu, Asoko, Ekpen, Ezekunkpolo 1, Ezekunkpolo 2, Ikale, Iyawo 1, Iyawo 2, Obitullugo, Oboko, and Omi) were obtained from different farmers in different parts of Edo State.

The field was cleared and planting holes were made at a spacing of 1 x 1m. Each white yam cultivar was sown in a 6m single row plot with whole seed yams weighing approximately 500g apiece and mounded. Planting was carried out in April 2009. The experiment was laid out in a randomized complete block design with three replications. The yam plants were staked when the shoots were about 1m long. Single staking method was used in which bamboo stake of about 6m long was provided for each stand. The experimental site was manually weeded twice (at 4 and 8 weeks after planting), and NPK (15:15:15) was applied at the rate of 400kg/ha at 8 weeks after planting.

The yam plants were evaluated for several agronomic characteristics. Vine length and number of leaves (at 6weeks after planting), stem girth of 10^{th} internode, length of 10^{th} internode, and leaf area of two leaves randomly taken at the base and midway on the stake were measured at the 20^{th} week after planting (WAP). The leaf area, was obtained by the equation, LA = L x B x O.64 according to James (1992), where L and B are maximum blade length and breadth respectively. At harvest (6 months after planting), tuber fresh yield (t/ha), tuber dry weight (kg/ha), tuber length, tuber girth, number of vines, number of tubers, tubers per vine, and tuber yield per hill were determined. In order to remove the effects of variation in moisture content present in the harvested tubers, the dry weight of yam were obtained by oven drying a fresh weight sample to constant weight at 70^0C for 24 hours. The dry weight was then converted to t/ha.

All data were subjected to analysis of variance using SAS analytical package (SAS, 2002) and means were separated using Student - Newman - Keuls test.

Results

The analysis of variance for growth and tuber characters/yield among are all yam cultivars are presented in Tables 1and 2 respectively. Significant differences were observed among the hybrid and local yam cultivars in number of leaves ($P \leq 0.05$), length of tenth internode and spininess ($P \leq 0.05$) except vine length and leaf area. As for tuber characters and yield, there was no significant difference among the hybrid and local yam cultivars.

The mean values for the observed growth and tuber characters/yield are presented in Tables 3 and 4 respectively. Among the hybrid varieties, leaf number ranged from 129.5 to 239.2, with TDr 89/02677 having the highest leaf number. The range for leaf number among local yam cultivars was from 39.0 to 202.8.

In length and girth of tenth internode, the mean values of hybrid varieties ranged from 192.9cm to 208.9cm and 1.4cm to 2.0cm respectively. Among local white yam cultivars the mean values of length and girth of tenth internode ranged from 145.0 to 227.5cm and 1.2 to 3.0cm respectively. The mean values for leaf area of the hybrid varieties ranged from 34.6 to 47.8cm^2. Among local white yam cultivars, the mean values for leaf area, ranged from 17.5 to 89.0cm^2. The score for spininess among hybrid varieties ranged from 1.0 to 5.0, with TDr 89/02665 being most spiny. Among local white yam cultivars spininess ranged from 1.0 to 5.0.

Although no significant differences were recorded in tuber characters and yield, the results showed that mean values for number of tubers, tuber per vine, tuber length and tuber girth among hybrid varieties ranged from 4.3 to 6.7, 1.1 to 1.4, 28.5 to 32.4cm and 24.4 to 29.0cm respectively. Among local white yam cultivars, the mean values for number of tubers, tuber per vine, tuber length and girth ranged from 3.3 to 7.7, 1.0 to 2.9, 18.9 to 32.8cm and 17.2 to 35.0cm respectively. The tuber yield per hill and dry tuber yield among hybrid varieties ranged from 1.5 to 1.9kg and 3.2 to 4.6t/ha respectively. Among local white yam cultivars, the tuber yield per hill and dry tuber yield ranged from 0.9 to 3.4kg and 2.1 to 9.5t/ha respectively.

The fresh tuber yields of hybrid and local yam cultivars ranged from 14.6 to 19.2t/ha and 8.7 to 33.7t/ha respectively. Among the hybrid cultivars, TDr 89/02677 had the most fresh tuber yield and was followed by TDr 89/02665 and TDr 89/02565. The fresh tuber yield of Abakauki, lkale, Alumako, Ekpen, Oboko, Asoko and lyawo 1 were all more than TDr 89/02677 (the most promising hybrid yam cultivar). Also most of the local white yam cultivars exceeded the three hybrids in tuber dry yield.

Table 1: Analysis of Variance showing mean squares of five growth characters among hybrid and local cultivars of white yam

Source of Variation	Degree of Freedom	Vine Length† (cm)	Number Of Leaves†	Leaf Area‡ (cm^2)	Length of 10^{th} Internode‡	Spininess‡ (1 – 5)	Girth of Tenth Internode‡
Replications	2	32761.9	11033.8	11695.1*	1076.2*	0.7	0.6
Cultivars	17	4138.3	8271.8*	769.8	1177.4**	4.6**	0.6
Error	34	4956.5	3775.1	578.3	207.8	0.3	0.7
Total	53						

† at 6 Week after planting (WAP), ‡ at 20 WAP

***, * Significant at 0.01 and 0.05 level of probability respectively*

Table 2: Analysis of variance showing mean squares of tuber characters and yield among hybrid and local cultivars of white yam at 28 week after planting

Source of Variation	Degree of Freedom	Number of Vines	Number of Tubers	Tuber Per Vine	Tuber Length (cm)	Tuber Girth (cm)	Tuber Yield Per Hill (Kg)	Fresh Tuber Yield (t/ha)	Dry Tuber Yield (t/ha)
Replications	2	6.7	6.4	1.2	97.7	79.2	2.4	236.4	19.4
Cultivars	17	2.4	5.9	1.1	44.7	82.8	1.4	136.1	16.6
Error	34	3.1	6.0	0.7	39.4	55.9	1.3	132.4	13.4
Total	53								

***, * Significant at 0.01 and 0.05 level of probability respectively*

Table 3: Mean values of growth characters among hybrid and local cultivars of white yam

Cultivar	Number of Leaves†	Length of Tenth Internode‡ (cm)	Spininess (1 – 5) ‡	Leaf Area‡ (cm^2)	Vine Length† (cm)	Girth of Tenth Internode‡ (cm)
89/2677	239.2a	192.9bcdef	5.0a	45.6	200.3	1.7
Ekpen	202.8ab	145.0h	5.0a	17.5	149.8	1.1
Iyawo 2	177.7abc	184.7def	5.0a	89.0	296.5	1.6
Nwopoko	148.7abcd	172.8eg	4.3ab	28.2	231.7	1.4
89/2665	140.7abde	200.5bcde	1.0e	47.8	203.6	1.4
Airiebu	134.0bcde	186.8cdef	2.0d	43.1	232.0	1.6
Iyawo 1	132.0bcde	160.6gh	4.7ab	27.1	195.0	1.2
89/02565	129.5bcde	208.9abc	4.3ab	34.6	207.1	2.0
Obiaturugo	123.0bcde	177.0efg	4.7ab	35.2	197.7	1.7
Asoko	108.0bcde	204.5abcd	2.0d	50.4	221.0	1.6
Alumako	96.5cde	198.6bcde	4.0b	54.4	223.5	1.3
Ikale	89.2cde	214.3ab	4.7ab	45.7	203.6	1.7
Abakaliki	88.7cde	227.5a	4.0b	50.6	281.8	2.3
Ezekunkpolo 1	88.7cde	200.3bcde	3.0c	56.2	285.5	2.2
Oboko	83.2cde	197.0bcde	3.0c	21.1	215.3	1.5
Obitullugo	52.8de	196.0bcdef	3.0c	38.7	253.3	1.4
Ezekunkpolo 2	50.5ed	205.4abcd	2.0d	46.8	190.6	3.0
Omi	39.0e	207.2abcd	4.0b	48.9	203.6	1.8

† at 6 Week after planting (WAP), ‡ at 20 WAP
Means with the same letter are not significantly different

Table 4: Mean values of tuber characters and yield among hybrid and local cultivars of white yam at 28 Week after Planting

Cultivar	Number of Vines	Number of Tubers	Tuber Per Vine	Tuber Length (cm)	Tuber Girth (cm)	Tuber Yield Per Hill (Kg)	Fresh Tuber Yield (t/ha)	Dry Tuber Yield (t/ha)
89/2677	5.0	5.0	1.1	28.5	24.8	1.9	19.2	4.6
Ekpen	4.0	5.0	2.2	26.1	18.9	2.2	22.2	9.0
Iyawo 2	4.0	7.0	1.8	30.2	32.2	1.7	16.9	4.0
Nwopoko	5.0	5.7	1.2	30.9	22.8	1.1	11.0	2.1
89/2665	5.0	6.7	1.4	32.4	24.4	1.7	16.9	4.2
Airiebu	5.0	5.7	1.1	32.2	22.5	3.3	33.0	9.5
Iyawo 1	2,7	6.3	2.4	22.4	19.2	1.9	19.3	6.3
89/02565	3.3	4.3	1.3	30.9	29.0	1.5	14.6	3.2
Obiaturugo	4.7	5.7	1.3	24.2	18.9	1.9	19.1	3.0
Asoko	3.0	3.0	1.0	29.8	35.0	2.0	20.0	5.6
Alumako	6.0	6.0	1.0	32.6	22.4	2.5	25.0	7.2
Ikale	5.7	7.3	1.0	31.4	23.7	3.0	29.8	9.4
Abakaliki	4.3	4.7	1.1	32.8	33.4	3.4	33.6	8.5
Ezekunkpolo 1	5.0	5.0	1.0	31.3	24.7	1.9	19.1	4.2
Oboko	4.3	4.7	1.1	26.6	28.9	2.0	20.2	6.0
Obitullugo	4.3	7.7	2.9	18.9	17.2	1.7	17.2	4.9
Ezekunkpolo 2	4.0	6.3	2.2	28.0	20.0	1.5	15.1	5.4
Omi	3.3	3.3	1.0	29.3	22.4	0.9	8.7	2.5

Discussion

The significant mean squares in number of leaves, length of tenth internodes, and spininess indicated that there was significant genetic variation among all the white yam cultivars in these growth characters. However these significant genetic differences in number of leaves and length of tenth internode did not result to significant differences in tuber characters and yield.

However, the hybrid and local cultivars showed varying differences to the other observed growth characters such as vine length at early emergence and leaf area at 20 weeks after planting. Among the hybrid and local cultivars, high leaf area value was associated with increased fresh tuber yield. The leaf area as intercepting surface of light energy plays an important role in maintaining crop productivity (Chowdhury and Ravi, 1994). It has been reported that failure to stake yams caused drastic yield reduction, probably due to less efficient display of leaves (Onwueme, 1984).

The higher tuber yields of TDr 89/02677, TDr89/02665, and some of the local cultivars such as Abakaliki and lkale, can be attributed to higher tuber number per plant along with their average tuber weight, tuber length tuber girth, and tuber yield per hill. Higher tuber yield among hybrid and local cultivars were also associated with high tuber dry yield. This relationship can be attributed to the fact that in white yam, sufficient foliage is retained till harvest to support tuber growth and dry matter accumulation (Fergusen, 1973).

The superior performance of some of the landraces indicated that farmer selection at the farm level is an obvious reality (Jarvis and Sthapit, 1999). Although fresh tuber yield of the hybrid varieties were less than some of the landraces, the range obtained from this study (14.6 - 19.2t/ha) is in line with the report of earlier studies (Asiedu *et al.*, 1998). The lower yield of the hybrid varieties in comparison with other landraces, such as Abakaliki and lkale can be attributed to environmental factor (Akoroda, 1983) and also to the fact that some of the landraces were more adapted to marginal conditions.

However, the high yield potential of the hybrid varieties has been confirmed from this study, and farmers can adopt them for their several attributes in order to boost the genetic diversity of their planting material. Ekwe (2005) reported that the hybrids have outstanding stable yield patterns and excellent cooking and pounding qualities, are suitable to mixed cropping and possess high tolerance to ravaging diseases of yams such as leaf blight, leaf spot and anthracnose. Moreover the hybrid yam cultivars are known to show tolerance to low soil nutrient status when planted early (Agbaje *et al*., 2005). A participatory on - farm trial of the hybrids and local cultivars is hereby recommended to speed up adoption of the hybrid varieties.

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