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Full Length Research Paper

Evaluation of yield response of selected water yam (*Dioscorea alata L*) genotypes to different seasons

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Abstract

Six water yam *(Dioscorea alata* L.*)* genotypes were evaluated alongside a popular cultivar in the locality for yield and yield components in the wet and dry seasons of 2009 and 2010 at Iwo (Lat. 7^0 38' N, Long. 4^0 11' E), Osun state Nigeria. The experiments were laid out in a Randomized Complete Block Design (RCBD) with three replications. Results indicated significant effect of genotype on the traits studied. Among the genotypes evaluated, genotypes with potentials for high-tubers production were identified. The genotype, TDa 98/01176 produced the highest total number of tubers and number of seed tubers per plot. However, TDa 99/00240 had the highest ware tubers and total fresh tuber yield. The lowest values for these traits were obtained for *Onisumose*, a landrace genotype. There were no significant differences among the genotypes performance in 2009 cropping season compared to 2010 cropping season. The four genotypes TDa 99/00240, TDa 99/01169, TDa 99/01166 and TDa 98/01176 had the most stable high yield across the two cropping seasons. Generally, farmers would prefer to use a high yielding genotype that performs consistently across different seasons and environment. Genotype yield and stability of performance over two different cropping seasons as in the case of wet and dry seasons would be necessary for evaluation of genotype performance. In both seasons, the most outstanding genotype was TDa 99/00240 having values that were highest among the means for all the major yield traits.

Keywords: Dioscorea alata, Genotypes, Cropping Season, Evaluation, Yield components

INTRODUCTION

Yam is cultivated as a seasonal crop in the yam growing belt of Nigeria. Sustainable production and utilization of yam are important steps in enhancing food security and alleviating poverty, particularly in West Africa where it is estimated to provide more than 200 dietary calories each day for over 60 million people (Nwueke et al; 1991, FAO, 2002). According to Manyong et al; (1996) cultivation of yam has been expanding in West Africa but the traditional production systems are under increasing pressure to adapt to short fallow periods owing to limited availability of new lands to support shifting cultivation. To meet increasing demand for food yams due to increasing population, more intensive production systems are now necessary (Shiwachi et al; 2008). Yam naturally has a dormancy period; it is an important mechanism for ecological adaptation of yams. Life cycles, the lengths of growth and dormancy of yams are closely adjusted to seasonal changes (Craufurd et al; 2001). During this period, tuber does not present sprouting capacity even under favourable conditions. According to Shiwachi et al., (2008) the yam tuber dormancy has limited planting period of yam seed tubers and year round production. Shiwachi et al., (2008) indicated in their study that endogenous gibberellins (GAs) have been implicated in the tuber of dormancy mechanism in water yam (D. alata) (Park et al., 2003a; 2003b). The duration of tuber dormancy period of D. alata has been prolonged by GA3 and shortened by gibberellin inhibitors (Nnodu and Alozie, 1992; Girardin et al., 1998; Onjo et al., 2001). Traditionally, yams are propagated vegetatively from whole tubers (seed yams), larger tubers pieces (setts) or from minisetts (Otoo *et al;* 1985). According to

Craufurd et al; (2001) and Sobulo (1972) yams exhibit a sigmoid growth pattern common to most annual plants. A period of slow growth during establishment is followed by a phase of rapid exponential growth as the canopy reaches maximum area and, finally, growth rates decline as the canopy senescence. Maturity has not been well defined in yam even though it is traditionally measured by the dryness of vines (Okoli, 1980). Yam yields are influenced by numerous environmental factors such as water (soil moisture), temperature, light and photoperiod (Orkwor and Asadu, 1998). Other constraints to yam production include biotic factors such as pests and disease organisms in the field and in the store. These factors have led to decrease in production over the years and have prompted breeding activities to generate high yielding varieties with some tolerance to environmental stresses. The objective of this study was to study the feasibility of producing *D. alata* genotypes in both wet and dry seasons (planting already sprouted seedlings) in yam producing belt of southwest Nigeria.

MATERIALS AND METHODS

Experimental Site and Genetic Material

The experiment was conducted in the 2009 and 2010 wet and dry-seasons at wet land provided by the Oba river at Iwo (Lat. 7^0 38’ N, Long. 4^0 11’ E) in the state of Osun Nigeria and it falls within the yam zone of southwest Nigeria. The wet land serves as available farm land for the off-season production of vegetables by the farmers in the community. Six improved water yam genotypes were collected from the International Institute of Tropical Agriculture (IITA), Ibadan Nigeria. The improved water yam varieties evaluated are TDa 98/01176, TDa 98/01166, TDa 98/01168, TDa 99/01169, TDa 99/00240 and TDa 297 (the Institutional check) were evaluated alongside the best locally cultivated variety called *Onisumose*. The experiment was laid out in a completely randomized block design with three replications of 4 by 5m plot size. Heaping was done manually at the spacing of 1m apart. The planting for wet season yam production was carried out in March and the dry season planting of the sprouted tubers was done by the month of December of the same year in both the experimentation years. Plots were weeded as necessary manually during the experimentation period and staking was carried out as required. NPK (15-15-15) fertilizer was applied to all the plots at the rate of 400kg/ha at 2 months after planting (MAP. Harvesting was done at 9 months after planting (MAP); the necessary agronomic data on yield were collected. The data collected on yield parameters are number of ware tubers harvested per plot (tubers above 1 kg weight), number of seed tubers harvested per plot (tubers below 1 kg weight), yield of tubers below 1 kg, yield of tubers above 1 kg, total yield of fresh tubers.

Determination of moisture and dry matter content were carried out using the method of AOAC (1997). Five grams of peeled and chopped fresh yam tuber was weighed into a dried and pre-weighed moisture can. The can with its content was dried in an oven at 105 ^oC for 24 hours. It was removed from the oven, cooled in a desiccator and weighed. The moisture content was estimated as weight loss using the formula below:

$$\% \text{ Moisture} = \frac{(\text{wt of pan + fresh sample}) - (\text{wt of pan + dry sample}) \times 100}{\text{Wt of sample}}$$

Percentage dry matter = 100 - moisture content.

The data collected were subjected to statistical analysis for the analysis of variance (ANOVA). Means were compared using Duncan’s Multiple Range Test at 0.05 level of probability when F-ratio was significant. A combined analysis of variance for the two-year data (2006 and 2007) was done using the GLM procedure in SAS (SAS Institute, 1999).

RESULTS AND DISCUSSION

Variance estimates of *D. alata* genotypes for yield and yield components:

The analysis of variance (ANOVA) in Table 1 showed that the yam genotype had significant effect ($P < 0.05$) on total number of tubers per plot, number of ware tubers per plot, number of seed tubers per plot, yield of ware tubers (t/ha), yield of seed tubers (t/ha), total fresh tubers yield (t/ha), moisture content (%) and dry matter yield (%) recorded in this experiment. Also, cropping season had significant effect ($P < 0.05$) on yield of ware tubers per plot (t/ha), yield of seed tubers per plot (t/ha), total fresh tubers yield (t/ha), moisture content (%) and dry matter yield (%). The interaction effects of the genotype and cropping season interaction were significant ($P < 0.05$) on yield of ware tubers (t/ha), total fresh tuber yield (t/ha), moisture content (%) and dry matter yield (%).

Mean performance of *D. alata* genotypes for yield and yield components

Table 2 shows the mean values for yield and yield components of *D. Alata* genotypes grown in two different seasons and years at Iwo. The highest means number (110 and 104) of tubers harvested from both wet and dry seasons respectively were recorded for TDa 98/01176. This was not significantly different from TDa 98/01169 but differed significantly from other genotypes, and Onisumose (local variety) recorded the significantly least values of 52 and 49 from wet and dry seasons respectively . The highest means number of ware tubers

Table 1: Variance estimates for yield and yield components of *D. alata* genotypes after two years wet and dry cropping seasons at Iwo

Source	DF	Total number tubers/plot	Number of ware tubers/plot	Number of seed tubers/ plot	Yield of ware Tubers (t/ha)	Yield of seed Tubers (t/ha)	Total fresh Tuber yield (t/ha)	Moisture content (%)	Dry matter yield (%)
Replication	2	18.6	1.2	20.6	5.4	1.4	6.2	11.4	66.2
Genotype (G)	6	2344.2*	524.3*	1325.1*	83.4*	12.6*	95.7*	62.6*	195.7*
Cropping Season (CS)	1	354.7	6500.2	8433.6	1573.1*	47.3*	1004.2*	447.3*	2204.2*
G x CS	6	892.8	78.3	1085.2	42.3*	9.5	21.4*	29.5*	321.4*
Error	26	1024.1	51.3	1236.3	7.4	7.2	8.3	27.2	112.3

Note: *, means significant at 5 % level of probability

Table 2: Mean yield and yield components of *D.alata* genotypes grown for two years at Iwo

Varieties	**Total Number of tubers per plot at harvest Seasons**		**Number of ware tubers harvested per plot Seasons**		**Number of seed tubers harvested per plot Seasons**		**Yield of ware tubers above 1kg per plot (t/ha) Seasons**		**Yield of seed yams below 1kg per plot (t/ha) Seasons**		**Total fresh tuber yield (t/ha) Seasons**	
	Wet	**Dry**	**Wet**	**Dry**	**Wet**	**Dry**	**Wet**	**Dry**	**Wet**	**Dry**	**Wet**	**Dry**
TDa 99/01166	70.2b	66.6b	43.8ab	40.2ab	26.4b	22,5b	24.1ab	20.5ab	3.5b	2.9b	27.6a	23.4 a
TDa 99/01169	90.3a	85.7a	33.1bc	31.5bc	57.2a	54.2a	23.3ab	19.5ab	4.9b	3.2b	28.1a	22.7a
TDa 99/00240	74.0b	70.8b	54.8a	53.5a	19.2c	17.3c	27.4a	24.5a	1.2c	0.9c	28.6a	25.4a
TDa 98/01168	66.8b	59.5.3b	35.9c	32.7c	30.9b	26.8b	16.4c	13.1c	4.7b	2.8b	21.1c	15.9b
TDa 98/01176	110.1a	104.0a	43.7ab	41.3ab	66.4a	62.7a	15.7c	12.3c	10.5a	8.2a	25.9ab	20.5ab
TDa 297	77.2b	72.5b	42.8ab	39.8ab	34.4b	29.7b	12.2c	9.6c	3.2b	2.7b	15.4d	12.3d
TDa Onisumose (Local)	55.2c	46.9c	22.9c	19.4c	32.3b	27.5b	14.4c	11.3c	3.9b	3.3b	18.3d	14.6d

Means in the same row with different superscripts differ significantly (P< 0.05)

harvested per plot from wet and dry seasons were obtained for TDa 99/00240 that recorded 55 and 54 respectively, followed by TDa 98/01166, TDa 98/01176 and TDa 297. The values recorded from both seasons for TDa 98/01168 and TDa 99/01169 was significantly different. The lowest means number of ware tubers from wet and dry seasons were obtained for *Onisumose*, a landrace genotype. TDa 99/01169 obtained the highest means number (66 and 63) of seed tubers harvested per plot from wet and dry seasons respectively, followed by TDa 99/01169. The lowest means number of seed tubers were obtained for TDa 99/00240 from both seasons.

The highest means yield of ware tubers from wet and dry seasons 27.4 and 24.5 t/ha respectively were obtained for TDa 99/00240. However, this was not statistically different from 24.1 and 20.5 t/ha obtained from wet and dry seasons respectively for TDa 99/01166 and 23.3 and 19.5 t/ha obtained from wet and dry seasons respectively for TDa 99/01169 (Table 2). Thelowest means yield of ware tubers from both seasons were obtained for TDa 297 and followed by 'Onisumose', the popular landrace in the locality. The highest means yield of seed tubers from wet and dry seasons 10.5 and 8.2 t/ha were obtained for TDa 98/01176 while the lowest means 1.2 and 0.9 t/ha from wet and dry seasons respectively were recorded for TDa 99/00240. The highest means of total fresh tubers yield were obtained for TDa 99/00240 that recorded 28.6 and 25.4 t/ha from wet and dry seasons respectively, this was followed by TDa 99/01169 (28.1 and 22.7 t/ha respectively) and TDa 99/01166 (27.6 and23.4 t/ha respectively), while the institutional check; TDa 297 had the lowest total fresh tuber yield (15.4 and12.3 t/ha respectively) these were

Table 3. Cropping Season effects on the performance of *D.alata* genotypes grown for two years at Iwo

Variables	Wet season	Dry season	LSD $_{0.05}$
Total Number of tubers per plot at harvest	77.7	72.3	NS
Number of ware tubers harvested per plot	39.6	36.9	NS
Number of seed tubers harvested per plot	38.1	34.4	NS
Yield of ware tubers above 1kg per plot (t/ha)	19.1	15.8	1.6
Yield of seed yams below 1kg per plot (t/ha)	4.6	2.9	1.2
Total fresh tuber yield (t/ha)	23.6	19.3	2.5
Moisture content (%)	74.1	68.8	2.7
Dry matter yield (%)	23.5	27.1	1.7

NS: Non-significant

less than the values 18.3 and 14.6 t/ha respectively recorded for *Onisumose* a local variety. The improved genotypes out yielded both the Institutional check (TDa 297) and the popular landrace (*Onisumose*) indicating a possible adoption of the new genotypes instead of the landraces. This result is expected because hybrids have been known to perform better than their unimproved counterparts. According to Obi (1991), hybrids are products of two or more parents of good agronomic characteristics and in most cases should perform better than either of their parents.

Multiple tuber production is a desirable characteristic necessary for commercial yam seed production. The ability of some genotypes, especially TDa 98/01176 to consistently produce multiple tubers profusely in wet and dry seasons indicates their potential value to commercial seed production. This characteristic would ensure availability of planting materials and would reduce cost of materials for field production on per hectare bases as suggested by Okoli and Akoroda (1995) and Orkwor and Asadu (1998). In addition, low setts multiplication ratio of yam and dormancy impede breeding and selection programmes. For example, it will take several generations and seasons to obtain enough planting materials to evaluate a few clones of yam (Okoli and Akoroda, 1995).

The TDa 99/00240 produces the highest yield of ware tubers in relation to the lowest yield of seed tubers responsible for the highest total fresh tubers yield produced by the genotype. The significant difference in the yield performance of the genotypes in the two cropping seasons when compared was attributed to the level of adaptability of the genotypes to different prevailing biotic and abiotic factors. There is a strong indication that selecting genotypes based on mean yield of one cropping season alone would be inappropriate. Genotype yield and stability of performance over two different cropping seasons as in the case of wet and dry seasons would be necessary for evaluation of genotype performance. In both seasons, the most outstanding genotype was TDa 99/00240 having values that were highest among the means for all the major yield traits. Practical integration of yield and stability performance as a parameter in selection programs is valuable and greater emphasis on it would benefit breeders and farmers, as it will indicate the best environmental treatment for good performance of crop varieties (Egesi *et al.*, 2005).

Cropping season effect on the performance of *D. alata* genotypes for yield and yield components

D. alata genotypes performed significantly better during the wet season than dry season for yield of ware tubers per plot (t/ha), yield of seed tubers per plot (t/ha), total fresh tubers yield (t/ha) and moisture content (%). However, *D. alata* genotypes performed significantly better during the dry season than wet season for percentage dry matter yield (Table 3). The higher values were recorded for yield of ware tubers per plot (19.1 t/ha), yield of seed tubers per plot (4.6 t/ha), total fresh tubers yield (23.6 t/ha) and moisture content (74.1%) during the wet season compared to lower values recorded for yield of ware tubers per plot (15.8 t/ha), yield of seed tubers per plot (2.9 t/ha), total fresh tubers yield (19.3t/ha) and moisture content (68.8%) during the dry season. The reverse was the case for percentage dry matter yield, the higher value of 27.1% was recorded for dry season compared to 23.5% recorded for wet season production. These results indicated that yam production is best during the wet season. But, the ability of the genotypes to produced higher dry matter yield in the dry season could be due to the fact that they were able to receive enough sunshine because of longer sunshine hours compared to what they were able to receive during the wet season. Hence, the rate of photosynthesis might be higher during the dry season compared to wet season. This would encourage better accumulation of photosynthetrate which hence translated to production of higher dry matter.

Cropping season effect on the performance of D. alata genotypes for moisture content and dry matter yield of D.alata genotypes grown for two years

In terms of percentage moisture content, the most responsive genotypes in wet and dry seasons in

Table 4: Mean moisture content and dry matter yield of *D.alata* genotypes grown for two years at Iwo

Varieties	Moisture content (%) Seasons		Dry matter yield (%) Seasons	
	Wet	Dry	Wet	Dry
TDa 99/01166	79.4a	73.6a	22.5c	26.3b
TDa 99/01169	74.7a	68.7ab	24.7b	27.8b
TDa 99/00240	83.9a	75.8a	29.2a	32.8a
TDa 98/01168	72.3ab	68.5b	24.4b	28.4b
TDa 98/01176	64.8c	58.3c	20.8c	24.3c
TDa 297	72.8ab	67.5b	23.7b	28.2b
TDa Onisumose (Local)	70.9b	67.9b	19.2d	22.2d

Means in the same row with different superscripts differ significantly (P< 0.05)

descending order are TDa 99/00240, TDa 99/01166 and TDa 99/01169 (Table 4). In the two cropping seasons, these three genotypes were stable in performance giving the highest percentage moisture content. However, the highest percentage dry matter yield means of 29.2 and 32.8% were given by TDa 99/00240 in wet season and dry season respectively. Higher dry matter yield is a desirable characteristic necessary for commercial yam production. The ability of some genotypes, especially TDa 99/00240 to consistently produced tubers with higher dry matter yield in wet and dry seasons indicates their potential value to commercial tuber production. In tuber crops processing, it has been observed that low peel loss and high dry matter content usually enhance the yield of the secondary product (Okaka and Okechukwu, 1993; Okaka and Okaka, 2001). The obtained tuber dry matter content of most of the experimental genotypes especially TDa 99/00240 compared favourably with 27 - 35% dry matter content given by Degras (1993) for typical *D. alata* genotypes.

CONCLUSION

Yam cultivation in dry season is still under investigation, this study shows the feasibility of producing some improved genotypes of *D. alata* in both wet and dry seasons in southwest Nigeria. Amongst these improved genotypes TDa 99/00240, TDa 99/01169 and TDa 99/01166 gave high fresh tuber yield. Based on significant genotype by cropping season interaction effects on mean fresh tuber yields, they are recommended genotypes for further evaluation of dry season yam production across different ecological zones. Since yam remains a major staple food in Nigeria based on its cultural role and contributing immensely to rural and regional economies, this has called for a concerted effort to curb decline in production. The major challenge before researchers therefore, is to evolve ways of increasing the dry season yam production. This would not only ensure the continuous availability of yam for the ever increasing population, it would also improve the income earning capacity of the resource-poor farmers responsible for producing the bulk of the yam in Nigeria. Generally, farmers would prefer to use a high yielding genotype that performs consistently across different seasons and environment. Genotype yield and stability of performance over two different cropping seasons as in the case of wet and dry seasons would be necessary for evaluation of genotype performance. In both seasons, the most outstanding genotype was TDa 99/00240 having values that were highest among the means for all the major yield traits.

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