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Effect of Accessions on the Performance of Root Components of African Yam Bean (*Sphenostylis stenocarpa* L.) in Northern Guinea Savanna, Nigeria

Dingari, J.* and Wabekwa, J. W.*
Department of Crop Production, Faculty of Agriculture, University of Maiduguri, P.M.B 1069, Maiduguri, Nigeria
Corresponding Author: jacksondingari@gmail.com
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Abstract

The effect of seven African yam bean accessions (TSs 2, TSs 4, TSs 11, TSs 23, TSs 84, TSs 96 and TSs 111) on root components of African yam bean (*Sphenostylis stenocarpa* L.) were studied in 2021 rainy season at Mubi and Yola, Adamawa State, Nigeria. Both locations were located in Northern Guinea savanna of Nigeria. The treatments were arranged in a randomized complete block design (RCBD) and replicated three times. Seeds were soaked in water for 24 hours and sown on beds measuring 3.0 m x 3.0 m at 60 cm x 60 cm in mid July, 2021. Data on plant height, plant dry weight, days to first flowering, number of tubers per plant, tuber length, tuber diameter, individual tuber weight, tuber weight per plant and tuber yield per hectare were measured at harvest using appropriate tools and methods. Data obtained were subjected to analysis of variance (ANOVA) using statistix "10.0" and the difference between treatments means were tested using Duncan's Multiple Range Test (DRMT) at 5%

level of significance. It was observed that the accessions, TSs 2 and TSs 96 recorded taller plants. TSs 2, TSs 96 and TSs 111 recorded the highest plant dry weight at harvest. The African yam bean accessions, TSs 4, TSs 11 and TSs 96 recorded the mean minimum number of days (earliest) to first flowering. TSs 11 had the highest number of tubers per plant in both locations and their mean, while TSs 2, TSs 23 and TSs 96 had the highest mean tuber length. All African yam bean accessions recorded similar higher tuber diameter, except TSs 11 which had the lower mean performance. TSs 111 recorded the highest mean individual tuber weight, and for tuber weight per plant and per hectare, TSs 11 out-weighed all other African yam bean accessions. It could be concluded from this study that the Northern Guinea savanna agro-ecology supports the performance of African yam bean, and the accession TSs 11 stands recommended for higher tuber yield herein.

Introduction

African yam bean *(Sphenostylis stenocarpa* L.) is one of the most important grain and tuberous legumes of tropical Africa. The grains and tubers are the two major organs of immense economic importance used as food in Africa with regional preferences. The seeds are preferred in the West African countries, while the tubers are preferred both in East and Central Africa (Klu *et al*., 2001). Although, its first domestication is within Africa, its precise place of origin in Africa is not yet known with certainty because its domestication has been traced to many African localities (Potter and Doyle, 1992). A study in trying to locate the possible place of origin of African yam bean, though not very conclusive favoured two independent domestications as shown by both DNA results and Linguistic data (Potter and Doyle, 1992) which indicated that African yam bean belongs to West and Central African regions where it is grown for seed and tuberous roots. From ecological stand point, African yam bean is also believed to have originated from Ethiopia and spread to many areas of tropical Africa where it is found growing in wild (Tindall, 1983). African yam bean is an ideal crop for long term food security in Nigeria (Saka *et al*., 2004), and regrettably, the crop is underutilized in Nigerians farm field despite its potentials (Saka *et al*., 2007).

African yam bean is an important legume in Africa and usually classified as a lesser-known legume of the tropical regions of the world because it is not as popular as other food legumes (Moyib *et al*., 2008). The beans contain considerable amounts of essential proteins which are comparable to those found in soybeans and are easily preserved through drying or storage in earthenware (Olasoji *et al*., 2011). Beside food security (Adewale *et al*., 2012), it contains amino acid properties (Uguru and Madukarfe, 2001), and insecticidal compounds which lowers storage losses (Okeola and Machuka, 2001).

Updates on African yam bean have so far indicated the crops promising performance in terms of both tuber and grain yield in sub-saharan Africa. However, previous researchers have laid emphasis on nutritional importance of the crop without indicating whether significant differences exist among the accessions in terms of the root yield parameters, thus this study was coined at investigating the effect of accessions on the performances of root components of African yam bean in order to increase yield in the Northern Guinea savanna of Nigeria.

MATERIALS AND METHODS

Field experiment was carried out at the Teaching and Research Farm, Department of Crop Science, Adamawa State University, Mubi (10° 10′N, 13° 10′E, and Altitude 599 m above sea level), and Teaching and Research Farm, Deparment of Crop Production and Horticulture, Modibbo Adama University, Yola (09° 10′N, 11° 14′E, and Altitude 582 m above sea level) during 2021 rainy season, both located in Northern Guinea savanna of Nigeria.

The treatments were seven African yam bean accessions (TSs-2, TSs-4, TSs-11, TSs-23, TSs-84, TSs-96, TSs-111). The experimental design was Randomized Complete Block Design (RCBD) and replicated three times.

Land was cleared, harrowed and marked out into beds measuring 3.0 m x 3.0 m (9.0 m^2) and the net area consisted of three central rows in each bed. An alley of 2.0 m was maintained between the replicates and 1.0 m between the beds to allow movement. Sowing was done on 17th July in Mubi and 15th July in Yola. Seeds were soaked in water for 24 hours before sowing to reduce dormancy period. Two seeds per hill were sown and spaced 60 cm x 60 cm and later thinned down to one plant per hill after seedling establishment. This gave plant population of 1,575 stands per hectare. At 6 WAS, vertical poles were provided with horizontal twines in order to serve as staking materials for the plant vines. Weeding were carried out twice at 3 and 6 WAS.

Plant height, plant dry weight, days to first flowering, number of tubers per plant, tuber length, tuber diameter, individual tuber weight, tuber weight per plant and tuber yield were measured at plant maturity, and data obtained were subjected to statistical analysis (statistix "10.0"). Treatment mean were separated using Duncan's Multiple Range Test (DMRT) at 5 % level of probability.

RESULTS

Table 1 shows that African yam bean accessions were significant for plant height, and plant dry weight at harvest, and days to first flowering. TSs 2 and TSs 96 recorded tallest plant in mean for the locations. Also, TSs 2, TSs 96 and TSs 111 had higher plant dry weight at harvest for mean of the locations. The African yam bean accessions, TSs 4, TSs 11 and TSs 96 all recorded the shortest days to first flowering in the two locations and their mean (Table 1).

Table 1: Effect of Accessions on Plant Height, Plant Dry Weight at Harvest and Days to First Flowering of African Yam Bean at Mubi, Yola and Combined Mean

Treatment	Plant Height (cm)			Plant Dry Weight (g)			Days to First Flowering		
Accessions	Mubi	Yola	Mean	Mubi	Yola	Mean	Mubi	Yola	Mean
TSs 2	246.1^{a}	258.0^{a}	252.1^{a}	126.0^{ab}	131.3^{ab}	128.7^{a}	61.0^{ab}	59.0^{a}	60.0^{a}
TSs 4	217.0^{c}	234.6^{b}	225.8^{b}	112.0^{c-e}	123.0^{bc}	117.5^{bc}	53.3^{c}	52.8^{b}	53.1^{b}
TSs 11	233.0^{b}	212.4^{cd}	222.7^{b}	105.0^{e}	108.3^{e}	106.7^{d}	49.4^{d}	54.1^{b}	51.8^{b}
TSs 23	219.0^{c}	217.1^{c}	218.1^{b}	110.0^{de}	121.7^{bc}	115.8^{c}	62.2^{a}	59.6^{a}	60.9^{a}
TSs 84	210.0^{c}	204.7^{d}	207.3^{c}	119.0^{b-d}	109.0^{de}	114.0^{cd}	60.0^{ab}	62.0^{a}	61.0^{a}
TSs 96	242.7^{ab}	248.8^{a}	245.8^{a}	121.0^{bc}	135.1^{a}	128.1^{a}	50.4^{cd}	53.0^{b}	51.7^{b}
TSs 111	209.3^{c}	203.2^{d}	206.3^{c}	131.3^{a}	120.1^{cd}	125.7^{ab}	58.3^{b}	62.1^{a}	60.2^{a}
SE ±	5.68	5.94	5.38	4.49	5.52	4.29	1.73	2.20	1.49
Sig.	***	NS	**	NS	***	*	**	NS	NS

Means followed by the same alphabet (s) across the column are not significantly different according to Ducan's Multiple Range Test (DMRT) NS = Not significant,* = significant (P≤0.05), ** = significant (P≤0.01) and *** = significant (P≤0.001)

Data presented in Table 2 indicate that African yam bean accessions were significant for number of tubers per plant, tuber length and tuber diameter. At Mubi, TSs 4 and TSs 11 recorded highest number of tubers per plant. At Yola and mean of the locations, TSs 11 recorded the highest number of tubers per plant. For tuber length, TSs 23 had the highest tuber length at Mubi, while TSs 2 had the highest tuber length at Yola. In mean of the locations however, TSs 2, TSs 23 and TSs 96 all recorded the highest tuber length. For tuber diameter at Mubi, TSs 2 and TSs 23 recorded the highest performance. At Yola, except for TSs 11, TSs 23 and TSs 96 all other accessions recorded highest tuber diameter, but for mean of locations, all accessions were higher and similar except TSs 11 which recorded the lowest.

Table 2: Effect of Accessions on Number of Tubers Per Plant, Tuber Length and Tuber Daimeter of African Yam Bean at Mubi, Yola and Mean of Locations

Treatment	Number of Tubers/Plant			Tuber Length (cm)			Tuber Daimeter (cm)		
Accessions	Mubi	Yola	Mean	Mubi	Yola	Mean	Mubi	Yola	Mean
TSs 2	5.6^{cd}	8.8^{b}	7.2^{b}	16.2^{c}	24.6^{a}	20.4^{a}	4.7^{ab}	3.7^{ab}	4.2^{a}
TSs 4	7.3^{ab}	5.8^{e}	5.6^{bc}	14.3^{d}	18.7^{cd}	16.5^{b}	4.0^{bc}	4.1^{ab}	4.1^{a}
TSs 11	8.4^{a}	12.2^{a}	10.3^{a}	12.2^{ef}	16.3^{e}	14.3^{c}	3.1^{d}	2.8^{c}	2.9^{b}
TSs 23	4.4^{d}	5.7^{e}	5.1^{d}	20.0^{a}	20.4^{bc}	20.2^{a}	5.0^{a}	3.4^{bc}	4.2^{a}
TSs 84	5.3^{cd}	6.0^{de}	5.7^{d}	11.2^{f}	15.3^{e}	13.3^{c}	3.8^{cd}	4.3^{a}	4.1^{a}
TSs 96	5.0^{cd}	7.3^{cd}	6.2^{b-d}	18.3^{b}	22.1^{b}	20.2^{a}	4.0^{bc}	4.0^{bc}	4.0^{a}
TSs 111	6.3^{bc}	7.8^{bc}	7.1^{b}	13.3^{de}	17.3^{de}	15.3^{bc}	3.1^{d}	4.4^{a}	3.8^{a}
SE ±	0.70	0.70	0.64	0.80	1.01	1.08	0.40	0.41	0.32
Sig.	**	*	NS	NS	NS	NS	NS	**	NS

Means followed by the same alphabet (s) across the column are not significantly different according to Ducan's Multiple Range Test (DMRT) NS = Not significant,* = significant (P≤0.05), ** = significant (P≤0.01)

African yam bean accessions were significant for individual tuber weight, tuber weight per plant and tuber yield as shown on Table 3. TSs 111 revealed outstanding higher performance for tuber weight, although TSs 2 have had similar higher results in Yola. For tuber weight per plant, TSs 11 out-weighs all other accessions in the two locations and their mean, except at Mubi, where TSs 4 recorded similar highest results (Table 3). For tuber yield, at Mubi, Yola and their mean, TSs 11 recorded the highest with 3.42 t/ha, 3.99 t/ha and 3.70 t/ha respectively (Table 3).

Table 3: Effect of Accessions on Tuber Weight, Tuber Weight Per Plant and Tuber Yield of African Yam Bean at Mubi, Yola and Combined Mean

Treatment	Tuber Weight (g)			Tuber Weight/Plant (g)			Tuber Yield (t/ha)		
Accessions	Mubi	Yola	Mean	Mubi	Yola	Mean	Mubi	Yola	Mean
TSs 2	52.9^{d}	64.1^{a}	58.5^{b}	344.7^{b}	434.7^{b}	392.2^{b}	2.25^{de}	3.47^{b}	2.86^{bc}
TSs 4	48.1^{e}	56.0^{b}	52.1^{c}	449.0^{a}	332.7^{c}	390.8^{b}	2.86^{b}	2.41^{c}	$2.64b^{bc}$
TSs 11	55.8^{cd}	53.8^{bc}	54.8^{bc}	473.7^{a}	620.3^{a}	546.5^{a}	3.42^{a}	3.99^{a}	3.70^{a}
TSs 23	60.0^{b}	48.1^{d}	54.1^{c}	249.7^{c}	264.3^{d}	257.0^{c}	1.33^{f}	1.95^{d}	1.64^{d}
TSs 84	51.9^{de}	52.6^{b-d}	52.2^{c}	304.0^{bc}	398.7^{b}	351.3^{b}	2.50^{cd}	2.74^{c}	2.62^{c}
TSs 96	58.4^{bc}	50.7^{cd}	54.6^{bc}	264.0^{c}	411.4^{b}	337.7^{b}	2.77^{bc}	3.35^{b}	3.06^{b}
TSs 111	66.0^{a}	62.1^{a}	64.1^{a}	355.7^{b}	446.3^{b}	401.0^{b}	2.12^{c}	3.19^{b}	2.65^{bc}
SE ±	1.99	4.31	2.11	28.91	25.30	31.99	0.175	0.206	0.216
Sig.	***	NS	*	**	***	***	***	***	***

Means followed by the same alphabet (s) across the column are not significantly different according to Ducan's Multiple Range Test (DMRT) NS = Not significant,* = significant ($P \leq 0.05$), ** = significant ($P \leq 0.01$) and *** = significant ($P \leq 0.001$)

DISCUSSION

African yam bean growth and development were influenced among accessions. The accessions, TSs 2, TSs 111, and TSs 96 extensively produced taller plant and plant dry weight. This indicates that the three accessions have had genetic superiority to compete among others for growth resources to attain maximum length and produce higher dry weight. Accessions that grow taller would obviously utilize solar radiation to accumulate higher dry matter, thus it is a desirable trait in breeding. Popoola *et al.* (2011) previously reported that high performing accessions of African yam bean are selected as promising parents for yield improvement. Also, Abdulkareem *et al.* (2015) reported that some accessions could show desirable characteristics like plant height and number of leaves per plant which are promising sources of genetic variability for the development of improved varieties of African yam bean. Kooistra (1994) observed that many African yam bean accessions exist with significant differences among all characteristics. Adewale *et al.* (2010) futher reported that African yam bean genotypes show wide range of variation in growth and development. TSs 4, TSs 11 and TSs 96 flowered earlier and they are superior for this particular character because late maturing accessions is likely to encounter drought and consequently poor yield.

Accession, TSs 11 was also genetically superior to others in terms of number of tubers produced per plant and weight of tubers per plant, and the two parameters influenced the total tuber yield per hectare as same accession (TSs 11) indicated higher yield superiority over others. The two parameters above are therefore yield determinants and are very useful in selection for higher yield (Adewale *et al.*, 2010). Abdulkareem *et al.* (2015) observed that African yam bean genotypes have wide range of variations in tuber yield per plant and other characteristics. Ademola *et al*. (2020) also pointed that some of the African yam bean accession exhibit high performance for other parameters that directly affect final tuber yield. Tuber yield was highest with TSs 11 which indicates its ability to compete higher to out-weigh others due to its superiority as it correlates with number and weight of individual tubers weight (Ameh, 2003; Ademola *et al*., 2020), especially in regions prevalent to intermittent drought (Opara and Omaliko, 1999). Conclusively therefore, the Northern Guinea savanna holds the prospect to higher performance of African yam bean and the accession, TSs 11 emerged more promising in this study and could be recommended for the agro-ecological zone.

CONCLUSION AND RECOMMENDATION

In this study, African yam bean revealed high performance in the Northern Guinea Savanna. It was revealed that accession, TSs 11 is suitable for tuber yield per hectare and stands recommend for higher tuber yield.

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