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TRAIT VARIABILITY STUDIES ON AFRICAN YAM BEAN (*SPHENOSTYLIS STENOCARPA*) GROWN IN THE GUINEA SAVANNAH ZONE OF SOUTHWESTERN NIGERIA

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ABSTRACT
Twenty accessions of African Yam Bean (*Sphenostylis stenocarpa*) from diverse eco-geographic origins of Nigeria were grown in the Teaching and Research Farm of Ladoke Akintola University of Technology, Ogbomoso during the cropping seasons of May to November, 2009 and 2010, to study the genetic diversity and Genotype × Environment interaction effects on trait performance. Data were collected on the growth, reproductive and seed yield traits. Quantitative characters showed low to moderate variability. The number of peduncles (90.47), length of vine (89.79), 100-seed weight (86.48) and pod length (75.65) recorded high coefficient of variation, while days to 50% flowering had the least variation value (36.37). Number of days to maturity was found to correlate negatively with almost all other characters measured. The genotypic effect recorded significant variation with respect to all the characters.

KEYWORDS: African yam bean, traits correlation, variations.

INTRODUCTION

The African yam bean seeds harbor vast genetic diversities for: nutritive and anti-nutritive factors (Ajibade *et al.*, 2005; Betsche *et al.*, 2005); protein content (Uguru and Madukaife, 2001); colour and colour pattern (Oshodi *et al.*, 1995); shapes (Dalziel, 1948; Kay, 1987) and lecitin content (Okeola and Machuka, 2001). Marked genetic variations may exist among the metric measurements (length, width, thickness and their ratios) on the seeds. The various metric measurements on seeds are very important quantitative variables for determining size and shape of seeds (Wyllie-echeverria *et al.*, 2003). Seed size and shape are important determinants of seed dispersal and probable loss (Cerda and Garcia-Fayos, 2002), moisture imbibitions and germination of seeds (Balkaya and Odabas, 2002) and grain grading quality. In soybean, seed size and shape has been reported to be highly correlated and important grading parameters of seed grains (Shahin *et al.*, 2006). Also, demand for seed grains for human consumption is linked to size and shape (Shahin *et al.*, 2006). The mass, oil and protein content of seeds are well associated with seed metrics (Omokhafe and Alika, 2004; Kaushik *et al.*, 2007). Therefore breeding for seed grain yield, size, shape, mass, oil and protein content demands a fundamental assessment of the seed metrics, their individual genotypic and inter-genotypic responses.

Information on the seed metrics of African yam bean, their genotypic variation and inter-character relationships are scanty. Genotype grouping, variability and heritability of traits are important factors that determine the nature of genetic diversity studies in crops. Furthermore, the genetic interrelationship among traits is efficient for systematic selection procedure of co-inherited traits (Belay *et al.*, 1993). As reported by Dalziel (1948) and Baudoin and Mergeai (2001) shapes of AYB seeds may include: ellipsoidal/ rhomboid, rounded/ ovoid or truncated/cylindrical. The justification for such classifications was not based on the metric measures on the seed; whereas shapes are most determined by the metric measures on the seed dimensions (Loncaric, 1998). There are no consistent evaluation criteria for shape description although there are many methods for evaluating shapes (Loncaric, 1998). The choice of methods depends on the properties of the shape to be described.

MATERIALS & METHODS

Twenty accessions of African yam bean (Table1), obtained from diverse eco-geographical origins of Nigeria were sourced from the gene bank of the International Institute of Tropical Agriculture (IITA), Ibadan and sown into beds with 1m × 1m inter-row and intra-row spacing, at the Teaching and Research Farm of Ladoke Akintola University of Technology, Ogbomoso, Nigeria. Ogbomoso lies on longitude 4' 10^0E, latitude 8' 10^0N, of the Guinea Savannah Zone of Southwest Nigeria. The temperature ranges from 28-33^{0}C, relative humidity is about 74% all year round, except in January when dry wind blows (Aremu *et al.*, 2007). Four replications of the various accessions were sown out using the Randomised Complete Block Design (RCBD), giving a gross experimental area of 21m×21m (441m^2). Beds were replicated four times, thus a total of forty beds. There were five plant stands per bed, and an overall of two hundred plant stands in the whole experimental plot.

The plants were separately staked at the eighth week after planting (8WAP). There was regular spraying with insecticides at three weeks interval, until the pods were matured. Harvesting of the dried matured pods was first carried out, followed by tuber harvesting after four weeks.

TABLE 1: Twenty accessions of AYB used for the experiment

S/N	Common name	Scientific name	Accession
1.	Africa yam bean	*Sphenostylis stenocarpa*	TSs-10
2.	Africa yam bean	*Sphenostylis stenocarpa*	TSs-101
3.	Africa yam bean	*Sphenostylis stenocarpa*	TSs-111
4.	Africa yam bean	*Sphenostylis stenocarpa*	TSs-116
5.	Africa yam bean	*Sphenostylis stenocarpa*	TSs-118
6.	Africa yam bean	*Sphenostylis stenocarpa*	TSs-121
7.	Africa yam bean	*Sphenostylis stenocarpa*	TSs-125
8.	Africa yam bean	*Sphenostylis stenocarpa*	TSs-128
9.	Africa yam bean	*Sphenostylis stenocarpa*	TSs-137
10.	Africa yam bean	*Sphenostylis stenocarpa*	TSs-139
11.	Africa yam bean	*Sphenostylis stenocarpa*	TSs-148
12.	Africa yam bean	*Sphenostylis stenocarpa*	TSs-153
13.	Africa yam bean	*Sphenostylis stenocarpa*	TSs-154
14.	Africa yam bean	*Sphenostylis stenocarpa*	TSs-23
15.	Africa yam bean	*Sphenostylis stenocarpa*	TSs-349
16.	Africa yam bean	*Sphenostylis stenocarpa*	TSs-58
17.	Africa yam bean	*Sphenostylis stenocarpa*	TSs-89
18.	Africa yam bean	*Sphenostylis stenocarpa*	TSs-9
19.	Africa yam bean	*Sphenostylis stenocarpa*	TSs-93
20.	Africa yam bean	*Sphenostylis stenocarpa*	TSs-95

Data collection

A. Growth and reproductive traits

Data were collected on the following traits;

1. Number of days to flowering (estimated as the period between germination and the appearance of first flower)
2. Vine length [estimated as length (cm) of vine at 8WAP, prior to staking]
3. Grain filling period (the onset of pod production indicated the beginning of grain filling, while the yellowing of pods indicate the cessation of the grain filling period)
4. Days to maturity (when yellowing of pod was observed)
5. Number of primary branches (the first set of vine branches, just at the base)
6. Number of secondary branches (branches that developed from the primary branches)
7. The internodal distance (average of distance between nodes, measured in cm)

B. Seed yield traits

1. Number of peduncles per plant (through hand counting)
2. Total number of pods per plant (through hand counting)
3. Pod length (measured in "cm" through the use of measuring tape)
4. Number of seeds per pod (through hand counting)
5. Weight of 100 seeds (measured in "g" through the use of sensitive scale)
6. Seed yield per plant (measured in "g")
7. Number of filled pods

RESULT & DISCUSSION

Means, mean square (MS) and coefficient of variation of characters from 20 African yam bean genotypes

In Table 2, the means, mean square and coefficient of variation of fourteen characters measured for the twenty African yam bean accessions were presented. In relation to the effect of the different planting seasons, there were significant differences among the characters measured, except for number of seed per pod, 100 seed weight, primary and secondary branches, internode distance and days to maturity. Coefficient of variation (CV) ranged from 36.37% (for days to 50% flowering), to 98.02% (for number of seeds per pod). Very high CV values were observed for number of seeds per pod (98.02), internode distance (96.83), seed yield per plant (85.67), number of seeds per plant (79.50), number of pods per plant (96.28), primary branches (88.51), filled pods per plant (87.7), days to maturity (79.08) and number of secondary branches (74.22). The quantitative characters showed very low to moderate variability. Number of peduncle (70.47), length of vine (69.79), 100-seed weight (56.48), and pod length (55.65) are coefficient of variation values recorded, above variability. Days to 50% flowering however, recorded the least variation (36.37).

TABLE 2: Means, mean square (MS) and coefficient of variation of characters from 20 African yam bean genotypes

SN	Character	Mean	Mean square	CV (%)
1.	Number of peduncles	25.43	16.35*	70.47
2.	Number of pods per plant	38.44	555.67**	96.28
3.	Filled pods per plant	14.61	162.38**	87.7
4.	Pod length	22.75	11.80*	55.65
5.	Number of seeds per pod	19.15	9735.62**	98.02
6.	100 seed weight	20.65	2.23	56.48
7.	Vine length	97.28	243.66**	69.79
8.	Primary branches	2.57	0.26	88.51
9.	Secondary branches	6.59	1.58	74.22
10.	Internode	11.48	46.28*	96.83
11.	Number of seeds per plant	172.50	354.39**	79.50
12.	Days to 50% flowering	110.22	71.08*	36.37
13.	Seed yield per plant	34.04	1401.32**	85.67
14.	Days to maturity	151.26	619.69**	79.08

*, ** = significant at 0.05 and 0.01 probability levels.

Genotypic correlation among 14 African yam bean characters in two seasons

(Table 3). Seed yield significantly and positively correlated with number of peduncles (0.80), number of pods per plant (0.88), number of filled pods per plant (0.84) and number of seeds per plant (0.96). Number of peduncles was significantly correlated with number of pods per plant (0.90), number of filled pods per plant (0.93) and number of seeds per plant (0.84). Also, number of pods per plant correlated significantly with number of filled pods (0.91) and number of seeds per plant (0.88); while the number of filled pods correlates significantly only with number of seeds per plant (0.89); and number of primary branches positively and significantly correlated with number of secondary branches (0.79).

On the other hand, seed yield per plant recorded low but positive correlation with pod length (0.34), length of vine (0.29), secondary branches (0.28), and internode distance (0.10), whereas, it was moderate but negatively correlated with 100-seed weight (-0.32). Number of peduncles was insignificantly correlated with pod length (0.30), primary and secondary branches (0.36; 0.45) and internode distance (0.23); while it was negatively correlated with number of seed per pod (-0.13), 100 seed weight (-0.50), days to 50% flowering (-0.07) and days to maturity (-0.15). Pod per plant was insignificantly correlated with pod length (0.30), length of vine (0.20), primary and secondary branches (0.13; 0.17) and internode distance (0.18). It was also negatively correlated with number of seed per pod (-0.13), 100 seed weight (-0.42), days to 50% flowering (-0.12) and days to maturity. The correlation of seed yield with 100-seed weight was moderately high, even though negative (-0.58).

Pod length recorded positive but low correlation with length of vine (0.33), seed per plant (0.29) and days to 50% flowering (0.21). However, the correlation with number of seeds per pod was negative (-0.24). 100-seed weight correlated significantly with seed per plant (-0.55). Number of secondary branches was significantly correlated with internode distance (0.32) but, did not correlate significantly with number of seed per plant (0.26). It was observed that days to maturity correlated negatively with almost all other characters measured, except for number of seeds per pod, number of secondary branches and the internode distance. None the less, it showed no correlation with number of days to maturity.

Genotypic, phenotypic and environmental coefficients of variation, heritability estimates and genetic advance of African yam bean characters

In table 4, the values of the genotypic variance (δ^2g), phenotypic variance (δ^2p), broad sense heritability estimate (H_b) and Genetic advance (GA), of 14 traits studied in two planting seasons were recorded. Number of pods per plant and yield per plant recorded highest genotypic variance (94.53 and 84.04). Also, the genotypic coefficients of variation (GCV) were also high for seed yield per plant and number of filled pods (74.07 and 70.15) respectively, accounting for the high heritability estimate of 98% recorded in the performance of pod and yield traits. However, GCV for days to maturity (31.30), number of seeds per plant (218.09) and number of peduncles per plant (37.28) were moderately high, compared to their respective genotypic variance values. This is responsible for the high values of the selection parameters. The high values of heritability estimate (H) and genetic advance (GA) for these traits confer on them reliability in selecting for them, when breeding focuses on improving the seed yield of African yam bean. High values for H and GA is suggestive of genetic influence on the measured traits, rather than environmental influence.

TABLE 3: Genotypic correlation among 14 African yam bean characters in two seasons

	Number of peduncles	Pods/ plant	Filled pods/ plant	Pod length	Number of seeds/ pod	100 seed weight	Vine length	Pri. Branches	Sec. branches	Internode distance	Seeds/ plant	Days to 50% flowering	Days to maturity
Seed yield/plant	0.80**	0.88**	0.84**	0.34*	0.03	-0.32*	0.29	0.19	0.28	0.10	0.96**	-0.05	-0.13
Number of peduncles	--	0.90**	0.93**	0.30	-0.13	-0.50*	0.12	0.36*	0.45*	0.23	0.84*	-0.07	-0.15
Pods/plant	--	--	0.91**	0.30*	-0.13	-0.42*	0.20	0.13	0.17	0.18	0.88**	-0.12	-0.20
Filled pods/plant	--	--	--	0.21	-0.23	-0.58**	0.07	0.24	0.31*	0.14	0.89**	-0.24	-0.06
Pod length	--	--	--	--	-0.24	-0.09	0.33*	-0.12	0.08	-0.31*	0.29	0.21	-0.22
Number of seeds/pod	--	--	--	--	--	0.05	0.08	-0.19	-0.13	-0.05	-0.02	0.25	0.03
100 seed weight	--	--	--	--	--	--	0.44*	0.06	-0.01	-0.02	-0.55	0.08	-0.02
Vine length	--	--	--	--	--	--	--	-0.09	0.14	0.01	0.11	0.19	-0.23
Primary branches	--	--	--	--	--	--	--	--	0.79**	0.13	0.20	-0.12	-0.17
Secondary branches	--	--	--	--	--	--	--	--	--	0.32*	0.26	0.05	0.01
Internode distance	--	--	--	--	--	--	--	--	--	--	0.09	0.08	0.11
Seeds/plant	--	--	--	--	--	--	--	--	--	--	--	-0.11	-0.12
Days to 50% flowering	--	--	--	--	--	--	--	--	--	--	--	--	0.02

*, ** = significant at 0.05 and 0.01 probability levels.

TABLE 4: Genotypic, phenotypic, environmental coefficient of variation, heritability estimate and genetic advance of African yam bean characters

Characters	δ^2g	δ^2p	δ^2e	GCV (%)	PCV (%)	ECV (%)	H	GA
Number of peduncles	11.41	11.62	2.14	37.28	37.63	5.11	0.98	23.46
Pods/plant	84.04	85.65	16.18	49.66	50.14	6.89	0.98	52.91
Filled pods/plant	11.69	12.02	3.31	70.15	71.14	11.81	0.97	70.02
Pod length	10.98	13.08	2.10	13.94	15.22	6.10	0.84	22.63
Seed/pod	19.10	19.98	87.40	218.09	223.03	46.65	0.95	79.10
100 seed weight	13.63	15.23	1.6	19.07	20.16	6.53	0.42	28.24
Vine length	35.20	35.97	7.71	17.30	17.49	2.56	0.98	72.62
Pri. Branches	0.04	0.52	0.49	7.46	26.91	26.12	0.08	0.09
Sec. branches	0.76	1.66	0.90	13.11	19.38	14.27	0.46	1.57
Internode	10.25	16.89	6.64	25.88	33.22	20.83	0.61	21.22
Seed/plant	82.18	32.25	73.54	243.92	244.20	11.66	1.00	86.44
Days to 50% flowering	11.25	14.39	3.15	2.98	3.37	1.58	0.78	23.12
Days to maturity	55.84	26.86	102.01	31.30	31.91	6.22	0.96	53.12
Seed yield/plant	94.53	9.61	16.07	74.07	74.70	9.66	0.98	70.40

CONCLUSION

Performance of the African yam bean was different under the two planting seasons, with significant effects observed in the measured characters, depending on the genetic constitution of the various accession; further strengthening the observation made by Ajibade (Ajibade *et al*., 2005). Genotype by environment interaction provided the opportunity to understand the performance of African yam bean genotypes over the planting environments. The genetic advance and realized heritability estimates are equally reliable and effective in selecting accessions for effective breeding programs. Genetic advance and heritability estimate can also be considered to achieve confidence in selection procedure, leading to successful breeding research work.

Seed yield was dependent upon the number of peduncles per plant, pods per plant, number of filled pods per plant and also the total number of seeds per plant. This was due to their significant positive correlation with the seed yield, similar to the values reported by Togun and Olatunde (1998), on vegetative and reproductive characters and their effects on yield. The characters were quite variable and exhibited higher genotypic correlation relative to the phenotypic correlation; suggesting little or no environmental influence. The high values of heritability estimate (H) and genetic advance (GA) for these traits confer on them reliability in selecting for them, when breeding focuses on improving the seed yield of African yam bean. High values for H and GA is suggestive of genetic influence on the measured traits, rather than environmental influence.

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