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Research

Growth Habit and Epidermal Characteristics of Some Cultivars of African Yam Bean (*Sphenostylis stenocarpa* A. Rich Harms)

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Abstract

African yam bean (Sphenostylis stenocarpa A.Rich) Harms constitutes one of the grain legumes that could be taken as a source of dietary protein. It consists of valuable proteins and other nutrients that can compare favourably with those found in other widely consumed beans such as Vigna unguiculata Linn. (Walp). Though, African yam bean is cultivated and consumed in some parts of South Western Nigeria, yet it has not gained much recognition because its importance is yet to be determined. Major crop plants such as Soybean and Cowpea are replacing minor crops like African yam bean, hence the need for it to be studied for improvement breeding programmes. Seeds of 18 accessions were planted on four experimental plots using Randomised Complete Block Design (RCBD) and monitored from planting to seedling emergence. Vegetative characters were observed and compared for the various accessions. The growth pattern for each of the cultivars was monitored and average measurements were taken on parameters such as plant height, length of internodes, number of internodes per plant, length of leaves, width of leaves. Leaf epidermal anatomy was also studied. Results obtained showed that the cultivars are phenotypically identical as they exhibited similar growth patterns and structural habits. In spite of the morphological similarities observed in the four major colour types –Brown, Grey, Red, and Black, Leaf epidermal anatomy revealed the presence of two types of stomata which were the Diacytic and Amphipericytic stomata.

KEY WORDS: Legumes, Cultivars, Epidermal Anatomy, Accessions, Stomata

Introduction

Grain legumes constitute the main source of protein of an average home in Africa. The most significant ones are Cowpea (*Vigna unguiculata Linn*, Walp), groundnut (*Arachis hypogea Linn)*, Lima beans (*Phaseolus lunatus*Linn), soybean (*Glycine maxLinn*) to mention a few. However, there are other pulses that could help meet dietary needs but are cultivated in localized areas and used less (Amoatey, 2001). Edible legumes are excellent sources of dietary proteins and oils especially in developing countries. There are many more legumes called minor legumes because they do not enjoy wide popularity or simply because the importance of most of them is undetermined (Okpara & Omaliko,1995).These underexploited legumes include African yam bean (*Sphenostylis stenocarpa* A. Rich) Harms), Bambara groundnut (*Vigna subterranean* (Linn) Vedc.), Pigeon pea (*Cajanus cajan Linn*), Jack beans (*Canavalia ensiformis(Linn) DC*), Mexican yam bean (*Pachyrhizus erosus Linn)*, and Sword bean (*Canavalia gladiata Linn)* (Duke, *et al*.,1997).

Recent studies have shown that some of these minor legumes are highly nutritious and can be used as foods, cover crops, green manure and natural fertilizers(Duke*et al*.,1997;Assefa and Keiner,1997).The African yam bean is grown for both the edible seeds and tubers.The plant is a vigorous vine that climbs and twines to height over 3 metres and requires staking(Okpara and Omaliko,1995). Various types of molecular markers are used in evaluating DNA polymorphism and are generally classified as hybridization-based markers and Polymerase Chain Reaction (PCR)- based markers (Swati *et al*., 1999). The main objective of this study was to evaluate the morphological and epidermal variations in some accessions of African yam bean.

Materials and Methods

Collection of Samples: Seed samples of African yam bean (*Sphenostylis stenocarpa)* were collected from different Research Institutes. Nine accessions representing the four major different types of colours were collected from the International Institute of Tropical Agriculture (IITA), Ibadan. These included TSS 04, TSS 09, TSS 14, TSS 15, TSS 23, TSS 48, TSS 56, TSS 96, and TSS 139. Other nine accessions were also sourced from the Institute of Agricultural Research and Training (IAR&T), Ibadan, including: AYB 12, AYB 16, AYB 21, AYB 25, AYB 27, AYB 28, AYB 32, AYB 35, and AYB 50.These accessions were planted on four experimental plots between April and May 2006 using Randomized Complete Block Design (RCBD).

Morphological Description: After planting the seeds, the dates of planting were recorded and monitored up till seedling emergence. The plants were monitored and observed thrice in a week. Measurements were also taken on different parameters. Measurements were taken randomly from ten plants from each accession. The statistical analyses carried out on the data included the Duncan Analysis and the Analysis of Variance of various parameters studied.

Comparative Leaf Epidermal Anatomy: Leaf samples were collected from the third internode from the plant base for each of the various accessions. Fresh plant samples were used, and the leaves were washed with water in a petri dish. The epidermal characters were investigated from membrane preparations.

Results and Discussion

Morphology: Morphological characters of the accessions observed revealed that they are members of the same family. Several parameters such as leaf shape, leaf arrangement, plant height and number of internodes showed a high degree of similarities which justify their grouping together as members of the same species (Tables 1-5). Apart from variations in seed colour, all other morphological characters of the cultivars showed a very high degree of resemblances to one another. Statistical analyses of the data collected on the descriptive characters of the different accessions revealed that each of the different accessions collected from the different Research Institutes are related to one another.

Leaf Epidermal Anatomy: Examination of the leaf epidermal layers of the various samples revealed a number of similarities and differences among the different colour types. It was observed that the cell outlines were obviously different from one another. The type of undulation of the cell walls varies from one seed type to the other. The brown seed type has serrated type of cell outline. The cells on the abaxial surface are more irregular and undulated than cells on the adaxial surface that appeared more regular, more identical, and almost of equal sizes. The epidermal cells of the Black and Red seeds are more regular, less undulated and strikingly different from those of the Brown and Grey seeds.

Stomata: Two types of stomata were found on the epidermal layers of the various seed types, these are the diacytic type of stomata which was common to all the seed types and found on the abaxial leaf surfaces. The second type of stomata is the amphipericytic type of stomata which was found on the adaxial surface of all the seed types except in the Black seed type which contain only very few diacytic stomata on the adaxial

leaf surface. There are some stomata with specialized subsidiary cells. The cell outlines were different from one another

Morphological characters which are direct expressions of the genome are used in identifying and classifying different groups of living organisms. The growth pattern and other characters of the plant morphology such as plant size, leaf size, and fruit size have been extensively considered in plant taxonomy. Plant morphology is the study of the physical form and external structure of plants. Plant biologists use morphological characters which can be compared, measured, counted and described to assess the differences or similarities in plant taxa and use these characters for plant identification, classification and description (Raven, *et al*. 2005).

The phenotypic relationship among the different seed types revealed by the data obtained from the morphological descriptions justified their inclusion in the same species. The use of anatomical characters in taxonomy has been highlighted since high powered microscopes became commonly available (Stace, 1980). The use of epidermal morphology has been well documented in botanical literature. Nurit- Silva and De Fatima (2011) used comparative anatomical study of the leaf epidermis of five Brazilian species of *Solanum sect.polytrichum* to evaluate their taxonomic significance to be used for separation and delimitation of the species of the section.

There were variations in the types of stomata on the epidermal layers and the types of cells on the epidermal surfaces. However, it was observed that two types of stomata – diacytic and amphipericytic were found on the upper epidermal layer of the Grey and Brown seed varieties. This could be an important factor in delimiting the seed types, however, more anatomical evidences would also be required to complement this evidence.

Moreover, the shapes, sizes, and arrangements of leaf epidermal cells differ among the seed colour types. It was observed that the structure and shapes of epidermal cells were similar in the lower epidermal layers of the Brown and Grey colour seeds. A distinctively different shape and structure was observed in the Black and Red seed types. These anatomical similarities suggest that the Brown and Grey coloured seed types are more closely related to one another than the Black and Red seed types. This observation correlated with the works of Sonibare *et al.* (2005), in which epidermal morphology was used in the justification of the classification and taxonomy of *Ficus L*. Irena Gie *et al*. (2005) also considered the anatomical features and ultrastructure of *Deschampsia antarctica* (Poaceae) leaves from different growing habitats in confirming their level of relatedness.

Conclusion

Results of this work showed that the plants are very similar in their growth habits; as they displayed identical phenotypes. The shapes of the epidermal cells and their sizes did not suggest any reason for separating the seed types from the Genus. Apart from the two types of stomata observed on the epidermal layers of the leaves, epidermal characters cannot be used for separating the species. Further analyses of the anatomical structure of other parts such as the petiole, the stem and leaf transverse sections could perhaps provide more anatomical evidences to separate them. The growth habit and epidermal observations revealed that the Brown seed and the Grey seed types are closely related while the Black seed and the Red seed types are also more related to each other.

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Table 1. Average Measurement of Plant Height (cm)

CULTIVARS	1	2	3	4	5	TOTAL	MEAN	S.E
TSS 04	138.2	135.6	140.4	136.8	137.6	688.6	137.7	±3.25
TSS 09	125.6	125.1	127.3	124.8	126	628.8	125.8	±3.17
TSS 14	103	96.5	132.1	100.4	121.6	553.9	110.8	±2.15
TSS 15	129.8	128.4	128.1	120.4	126.5	633.2	126.6	±2.48
TSS 23	104.2	107.3	110.4	96.2	121	530.1	106	±1.75
TSS 46	150	147.1	152.5	148.2	146.2	744	148.8	±1.80
TSS 56	139.4	135.6	132	140.4	145.7	693.1	138.6	±2.05
TSS 96	114.3	113.2	121.4	103.6	110.2	562.7	112.5	±1.85
TSS 139	153.4	144.7	150.2	146.8	154.4	749.5	149.9	±1.75
AYB 12	127.4	131.1	142.3	126.3	121.2	648.3	129.7	±2.05
AYB 16	132.7	127.8	157.3	140.1	130.1	688	137.6	±1.89
AYB 21	110	108.2	122.4	109.3	104.3	554.2	110.8	±2.35
AYB 25	123.6	144.1	112.5	133.3	121.4	634.9	127	±2.15
AYB 27	145.6	157.2	148.3	135.4	141.3	727.8	145.6	±1.76
AYB 28	147.6	148.6	145.3	150.1	146.3	737.9	147.6	±1.76
AYB 32	130	133.1	128.5	127.2	132.6	651.4	130.3	±1.15
AYB 35	128.9	129.1	125.2	132.1	128.1	643.4	102.5	±1.21
AYB 50	102.4	106.4	110.2	98.6	94.8	512.4	102.5	±1.09

Table 2. Average Measurement of Internode Length (cm)

CULTIVARS	1	2	3	4	5	TOTAL	MEAN	S.E
TSS 04	12.8	13.1	12.5	11.4	12.5	62.3	12.5	±0.75
TSS 09	12.2	12.6	11.6	10.7	13.2	60.3	12.1	±0.62
TSS 14	9.3	10.2	11.4	8.5	9	48.4	9.7	±0.07
TSS 15	12.3	12.3	13.1	10.4	13.2	61.3	12.3	±0.15
TSS 23	13.1	12.8	11.5	13.2	12.8	63.4	12.7	±0.32
TSS 46	15.4	16.2	14.7	13.2	16.7	76.2	15.3	±1.02
TSS 56	14.2	13.1	15.4	14.2	13.1	70	14	±0.89
TSS 96	13.1	13.4	12.9	11.4	13.3	64.1	12.8	±1.02
TSS 139	14.2	12.4	13.6	15.5	14.7	70.4	14.1	±1.10
AYB 12	19.4	17.5	19.6	20.2	18.4	95.1	19	±1.00
AYB16	32.2	21.6	22.8	24.6	24.4	116.6	23.3	±1.85
AYB 21	11	10.8	12.6	12.4	10.6	57.4	11.5	±0.75
AYB25	16.6	15.5	17.6	17.4	14.5	81.6	16.3	±1.25
AYB27	13.4	12.7	13.2	14.2	12.8	66.4	13.3	±0.95
AYB 28	20.5	22.2	21.3	19.8	20.4	104.2	20.8	±1.01
AYB 32	19	18.6	19	20.1	17.5	94.2	18.8	±1.07
AYB 35	16.2	14.2	17.8	18.2	15.5	81.9	16.4	±0.85
AYB 50	10	9.1	12.3	11.4	10.2	53	10.6	±0.75

Table 3. Average Number of Internodes Per Plant

CULTIVARS	1	2	3	4	5	TOTAL	MEAN	S.E.
TSS 04	11.5	12.7	11.6	10.8	12.1	58.7	11.7	±0.90
TSS 09	12.3	13.4	11.7	11.7	12.6	60.5	12.1	±0.75
TSS 14	14	14.7	13.6	13.6	13.1	69.5	13.9	±0.62
TSS 15	13.2	12.8	11.7	11.7	13.4	64.7	12.9	±0.73
TSS 23	11.1	10.9	11.8	11.8	12.2	55.8	11.2	±0.43
TSS 46	12.3	13.4	11.5	11.5	12.3	62.1	12.4	±0.28
TSS 56	10	11.5	9.6	9.6	11.4	54.6	10.9	±0.17
TSS 96	9.2	12.7	10.1	10.1	8.4	49.6	9.9	±0.35
TSS 139	10.6	11.5	10.5	10.5	9.2	50.9	10.2	±0.83
AYB 12	6.1	7.2	8.4	8.5	9.2	39.4	7.9	±0.06
AYB 16	8.1	6.5	7.2	6.3	6.4	34.5	6.9	±0.56
AYB 21	10.2	10.2	8.5	9.6	8.7	47.2	9.4	±0.83
AYB 25	8.4	9.2	7.8	8.1	7.1	40.6	8.1	±0.75
AYB 27	10.2	11.1	9.5	10.2	10.3	51.3	10.3	±0.83
AYB 28	8.2	10.1	7.2	8.5	9	43	8.6	±0.78
AYB 32	6.5	7.8	8.1	8.2	7.7	38.3	7.7	±0.66
AYB 35	9.2	10.1	8.7	9.1	10	47.1	9.4	±0.55
AYB50	10.2	11.4	9.8	10.6	11	53	10.6	±0.45

Table 4. Average Measurement of Leaf Length (cm)

CULTIVARS	1	2	3	4	5	TOTAL	MEAN	S.E.
TSS 04	9.2	10.5	11.2	8.4	8.6	47.9	9.58	±0.75
TSS 09	10.2	9.4	11.5	10.6	9.7	51.5	10.3	±1.15
TSS 14	8.5	7.5	10.6	8.5	8.4	43.5	8.7	±0.72
TSS 15	9.8	11.4	9.1	10.2	8.5	49	9.8	±0.62
TSS 23	10.2	10.5	11.4	9.2	10.5	51.8	10.4	±0.55
TSS 46	8.6	7.8	9.7	10.2	8.1	44.4	8.9	±0.51
TSS 56	9.7	11.4	8.1	8.1	9	46.3	9.3	±0.35
TSS 96	11.4	11.7	10.2	9.4	12.1	54.8	10.9	±0.85
TSS 139	10.4	10.6	12.1	8.6	9.4	51.1	10.2	±0.05
AYB 12	8.7	7.5	8.4	10.2	11.2	46	9.2	±0.82
AYB 16	7.5	10.2	11.4	10.5	9.1	48.7	9.7	±0.77
AYB 21	9.2	10.2	9.6	11.1	10.2	50.3	10.1	±0.89
AYB 25	10.1	11.2	9.4	10.2	9.3	50.2	10	±0.80
AYB 27	8.7	9.2	10.1	8.4	7.8	44.2	8.8	±0.75
AYB 28	8.5	9.1	10.3	9	8.1	45	9	±0.82
AYB 32	8.1	7.2	10.2	10.1	9.2	44.8	8.9	±0.66
AYB 35	9.1	8.7	7.8	8.1	8.4	42.1	8.4	±0.69
AYB 50	10.1	9.6	8.7	8.2	8.1	45.7	9.1	±0.72

Table 5. Average Leaf Width
(cm)

CULTIVARS	1	2	3	4	5	TOTAL	MEAN	S.E.
TSS 04	4.2	4.6	5	4.6	3.8	22.2	4.4	±0.02
TSS 09	5.3	4.8	4.1	5.4	5.2	24.8	5	±0.15
TSS 14	3.6	4.1	5.1	3.2	3.1	19.1	3.8	±0.21
TSS 15	4.1	5.2	4.6	4.2	4	22.1	4.4	±0.33
TSS 23	4.5	5	5.1	4	4.1	22.7	4.5	±0.25
TSS 46	4.4	4.7	3.8	4.1	4	21	4.2	±0.11
TSS 56	4.1	5.1	5.1	3.8	3.7	21.8	4.3	±0.45
TSS 96	5.1	6.1	4.2	4.5	5.7	25.6	5.1	±0.35
TSS 139	4.6	4.5	5.1	4.2	4.3	22.7	4.5	±0.25
AYB 12	5.4	4.5	5	4.7	4.8	24.4	4.8	±0.35
AYB 16	4.8	4.6	5.2	5.1	4.7	24.4	4.8	±0.15
AYB 21	4.8	4.9	4.8	5.2	4.7	24.4	4.8	±0.81
AYB 25	5	5.1	4.6	4.5	4.8	24	4.8	±0.32
AYB 27	4.6	4.4	4.3	5	5.1	23.4	4.7	±0.21
AYB 28	4.8	5	5.1	4.2	4.4	23.5	4.7	±0.32
AYB 32	4.9	4.7	4.6	5.1	5.2	24.5	4.9	±0.15
AYB 35	4.7	4.4	4.6	5.4	4.6	23.7	4.7	±0.25
AYB 50	5.1	5.2	4.7	4.6	4.7	24.3	4.9	±0.30