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Full Length Research Paper

Reproductive mechanisms and pollen characterization in some accessions of an underutilized legume: (*Sphenostylis stenocarpa* Hochst Ex. A. Rich) harms

Popoola J. O.[1]*, Adegbite A. E.[2], Obembe O. O.[1] and Agbolade J. O.[2]

[1]Department of Biological Sciences, Covenant University, P. M. B. 1023, Ota, Ogun State, Nigeria.
[2]Department of Biological Sciences, University of Agriculture, P. M. B. 2240, Abeokuta, Ogun State, Nigeria.

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Studies on flowering, pollen, pod and seed characters, germination rate and seed set percentage were carried out on twenty five accessions of African Yam Bean (AYB). Self compatibility tests confirmed all the accessions as obligate selfers, while the reciprocal crosses were not successful. Germination rate, percentage seed set and pollen fertility were observed to be high in the accessions. Correlation analysis among the reproductive traits revealed that pod length, pod width, number of locules per pod and number of seeds per pod contributed significantly to the percentage seed set in all the accessions. Pollen fertility and seed viability were also observed to be high in all the accessions except in TSs23 where low pollen fertility, low seed viability and low percentage seed set were recorded. All the accessions produced tricolporate pollen grains. Pollen size ranged from 66.15 µm in TSs40 to 82.75 µm in TSs119, pollen fertility ranged from 53.39% in TSs23 to 95.30% in TSs119, seed set ranged from 83.32% in TSs90, 89.21% in TSs23 and 95.72% in TSs3. The germination rate ranged from 59.68% in TSs23 to 99.03% in TSs22. The percentage moisture content ranged between 4.38% in TSs22 and 11.43% in TSs119.

Key words: Pollen characters, seed set, germination rate, self compatibility.

INTRODUCTION

The knowledge of reproductive biology is essential for understanding the breeding pattern of a species, as well as its genetic improvement. The importance of floral biology, pollen grain size, structure and fertility in the characterization of plant species cannot be over-emphasized. Floral morphology, in particular, has been a major factor in determining the breeding status, cross pollination success and fertility of angiosperm families (Dafni, 1992; Faegri and Van der Pijl, 1979). The use of pollen characters as reliable indicators of ploidy level in related species has also been reported (Stebbin, 1950; Ferguson, 1990). In determining the reproductive mechanisms of a species, reproductive traits are highly correlated with reproductive success and thus influence genetic variation in a population (DeMauro, 1993).

The genus *Sphenostylis* contains highly variable species with considerable overlap in their morphological and cytological characters, even though, there is no documented evidence of natural hybridization or cross pollination (Potter, 1992). African Yam bean (AYB) *Sphenostylis stenocarpa* is the most economically important species in the genus *Sphenostylis* and most important tuberous legumes of tropical Africa (Potter and Doyle, 1992; Adewale, 2010). AYB is mainly grown for both its edible seeds and tubers and the tuberous roots serve as a source of CHO in Zaire. It is a good source of protein (19 and 29% in tuber and seed grains) and rich in minerals such as phosphorus, potassium and iron (Ajibade et al., 2005). The value of the protein in both seeds and tubers is comparatively higher than what could be obtained from other legume crops (Azeke et al., 2005). AYB is particularly useful for medicine, fodder crop, ornamental purposes and it is being explored

*Corresponding author. E-mail: pjay_gbenro2008@yahoo.com. Tel: +234 805 710 8566.

Table 1. Seed shape and color in the accessions of *Sphenostylis stenocarpa.*

Accession number	Origin / Locality	Seed coat colour	Seed shape
TSs1	Nigeria: Obudu	Brown	Globose / rhomboid
TSs3	Nigeria	Brown	Globose
TSs4	Nigeria: Enugu	Brown	Ovoid
TSs7	Nigeria: Umuchite	Grayish brown	Ovoid / globose
TSs10	Nigeria: Obuduiogota	Dark brown (speckled)	Ovoid / globose
TSs11	Nigeria	Creamy white	Globose
TSs16	Nigeria	Grey	Ovoid
TSs22	Nigeria	Brown	Globose
TSs23	Nigeria	Brown (speckled)	Ovoid / globose
TSs40	Nigeria	Brown	Ovoid
TSs56	Nigeria	Brown	Globose
TSs60	Nigeria	Brown	Globose
TSs61	Nigeria	Brown	Ovoid
TSs63	Nigeria	Brown	Ovoid
TSs65	Zaire	Dark brown	Ovoid
TSs82	Nigeria	Brown	Ovoid / rhomboid
TSs84	Nigeria	Brown	Ovoid / globose
TSs90	Nigeria: Ikot-Ekpene	Brown black (speckled)	Ovoid / globose
TSs94	Nigeria: Ikot-Ekpene	Brown	Ovoid
TSs104A	Unknown	Dark brown (speckled)	Ovoid
TSs104B	Unknown	Greenish white	Globose
TSs111	Nigeria: Ikot-Ekpene	Brown	Globose
TSs112	Nigeria	Brown	Globose
TSs119	Unknown	Brown	Globose
TSs130	Unknown	Brown (speckled)	Ovoid / rhomboid

recently for genetic transformation of cowpea (*V. unguiculata*) (Omitogun et al., 1999; Okeola and Machuka, 2001; NRC, 2007). Traditional and socio-cultural uses have been reported from Togo, Ghana and Nigeria (Klu et al., 2001).

The seeds are used during celebration of puberty rites for girls in Ghana while the pastes made from the seeds are used as a cure for stomach aches and as remedy for acute drunkenness especially when mixed with water (Asuzu, 1986; Klu et al., 2001). Special meal from AYB features during the traditional marriage ceremony among the Ekitis of Western Nigeria and it is considered an important source of income to women and children in Anambra State of Nigeria (Okigbo, 1973; Potter, 1992). Few years back, a yougurt-like product has been extracted and 'moimoi'-like dish that is similar to the steamed cowpea dish was produced from AYB (Frank-Peterside et al., 2002). It is also fertile even in poor soils and reasonable good yield have been reported both from trials and experimental field results (Adewale and Dumet, 2010).

In spite of these economic importance, African Yam Bean (AYB) is fast becoming grossly underutilized and neglected food crop in many areas of the tropics (Moyib et al., 2008; NRC, 2007; Bioversity International, 2009). The crop is facing serious genetic erosion threats and the germplasm is substantially narrow in diversity when compared to other popular legume crops of Africa origin. This is coupled with the dearth of information on many aspects of the crop. Hence, it is imperative to provide baseline information on the biology of the plant, especially with respect to its reproductive characters and pollen characteristics. This present study provides information on floral biology, reproductive system and pollen characters, which are crucial for genetic improvement of this endangered tropical crop.

MATERIALS AND METHODS

Seeds of twenty five accessions of *S. stenocarpa* were collected from the Genetic Resources Centre of the International Institute of Tropical Agriculture (IITA), Ibadan. The origin and characters of the seeds are shown in Table 1.

Land preparation and cultivation

Cultivation was carried out on experimental field at IITA, Ibadan. The experimental plot was ploughed, harrowed and ridged before planting. Three seeds of each accession were initially planted per hill but later thinned to one plant per hill after germination and

seedling establishment. The sowing was 1 by 1 m on a 10 m ridge. Ten plants for each accession were planted per plot. The experiment was laid out in a randomized complete block (RCB) design with three replicates. Poles of 3 m length were used as stakes to provide support three weeks from planting. The field was maintained by regular hand weeding with hoes. The plants were protected from insect attacks by regular spraying with 0.5% karate at 10 days interval from the period of flower bud initiation to pod maturity.

Morphological studies

Morphological studies were carried out on the reproductive characters of the twenty five accessions of *S. stenocarpa*. The qualitative characters were scored based on visual evaluation while the quantitative traits were measured and weighed using metric rulers, weighing balance and venial calipers. Ten measurements were taken for each of the quantitative characters measured or weighed. The plants were characterized using International Plant Genetic Resources Institute (IPGRI) descriptors for legumes while Methuen handbook of colours was used to determine the flower colour of the accessions (Kornerup and Wanscher, 1978).

Data analysis

Means and standard deviations were calculated for all the characters measured. The mean values of all the quantitative characters measured were subjected to the version 9.1 SAS / PC software package to compute Pearson Correlation Coefficient.

Reproductive studies

Pollen studies

Pollen grains were obtained from opened flowers collected at (0630 to 0930 GMT). Slides were prepared by dusting pollen grains from the opened flowers in a drop of cotton blue in lactophenol on a clean slide and applying a cover slip or by squashing mature anthers from unopened flowers in the stain. Five slides from five different flowers were prepared for each of the accession.

Pollen fertility was estimated by counting pollen grains from at least ten fields on each of the five slides prepared for each accession at X 100 magnification. Pollen grains with full cytoplasm were considered fertile while those with half or shrink cytoplasms were considered sterile based on the protocols of Jackson (1962) and Olorode and Baquar (1976). The percentage pollen fertility was estimated by expressing the number of fertile pollen grains as a percentage of the total pollen grains counted. Pollen size was determined by measuring the diameter of forty full and deeply stained randomly selected pollen grains on the five slides prepared for each accession at X 400 magnification using ocular micrometer. The ocular measurements were later converted to microns using the stage micrometer. Means and standard deviations were calculated for the measurements. Photomicrographs of pollen grains stained with FLP – orcein were taken at X 400 to show the pollen structure and texture.

Self compatibility test

Self compatibility test was carried out on all the accessions to determine their selfing capability. This was carried out by bagging some fully developed flower buds on the plants before opening, using shoot cover to protect the flowers from pollinators. The flower buds were left covered until they opened and the flowers self pollinated.

Out crossing test

Rapid methods of hand crossing described by Rachie et al. (1975) were used in the emasculation and crossing of the AYB accessions. Mature flower buds were emasculated in the evening between (5:30 and 7:00 pm) by removing the free and exposed anthers carefully with a pair of forceps. The flowers were hand pollinated the following morning by rubbing pollen grains from male parents on the stigma of the emasculated female parents.

Germination and moisture content tests

Germination test was carried out in the laboratory at room temperature. Twenty seeds of each accession were coated with benlate before planting in sterilized germination plastics lined with moistened germination paper in four replications. The experiment was left on the germination stand for seven days after which the sprouted seeds were counted and recorded. The sprouted seeds were expressed as a percentage of total seeds plated for each accession.

$$\% \text{ Germination} = \frac{\text{Sprouted seeds counted}}{\text{Total seeds plated}} \times 100$$

Moisture content test

3 g of the seeds from each accession were weighed into pre-weighed clean dry dishes without their lids and were arranged in a well ventilated oven at 105 ± 2°C. After 16 h, the dishes were covered and transferred to a dessicator at room temperature to cool down for 30 min before reweighing the dishes with the dried seeds. The drying process was repeated for 2 h for all the accessions until constant weights were obtained for each accession. The percentage moisture content was determined by loss in weight after drying.

$$\% \text{ Moisture content} = \frac{M_1 - M_2}{M_1 - M_0} \times 100$$

Where: Mo = Weight in g of dish and lid
M_1 = Weight in g of dish, lid and sample before drying
M_2 = Weight in g of dish, lid and sample after drying

Estimation of seed set percentages

Seed set percentages were estimated for all the accessions using twenty randomly selected pods from each accession. The percentage seed set was calculated by expressing the total number of seeds per pod as a percentage of the total number of locules per pod.

$$\% \text{ Seed set} = \frac{\text{Total number of seeds per pod}}{\text{Total number of locules per pod}} \times 100$$

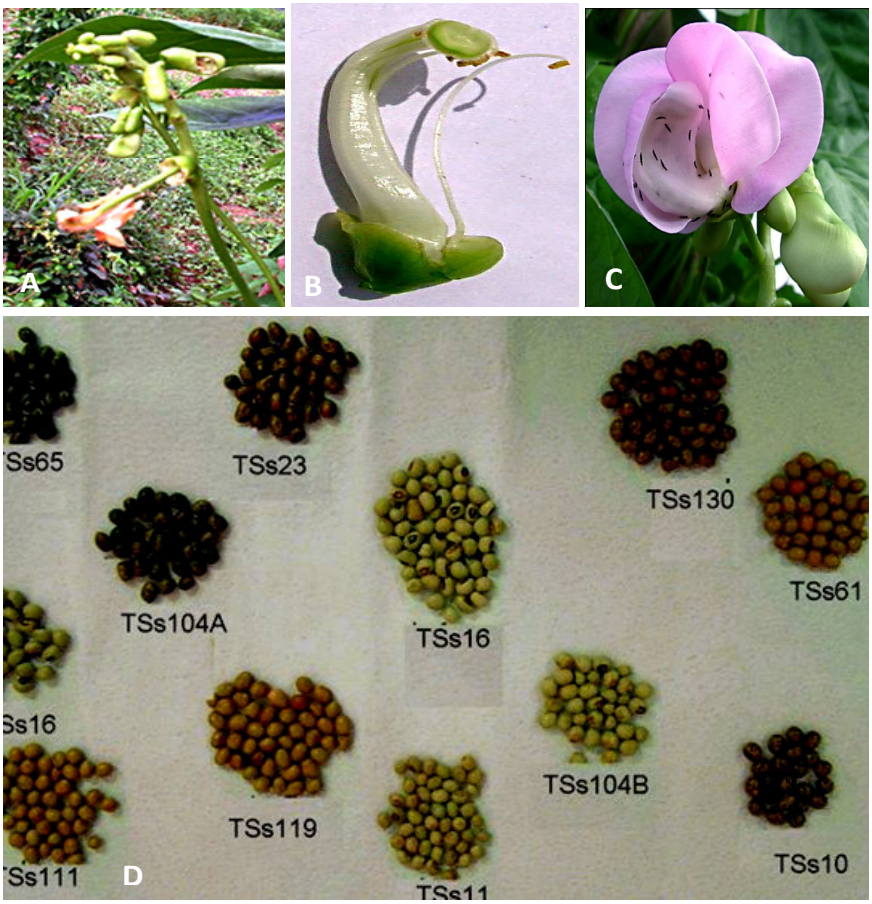

Figure 1. Floral parts and seed types. A: Raceme inflorescence, B: Diadelphous stamen, C: Purplish pink flower colour , D: Seed colour variation. Scale 3.00 mm

RESULTS

Correlation coefficient analysis

The Pearson correlation coefficient vividly revealed that pod length (PODL) was significantly correlated with pod width (PODW) r = 0.88, number of locules per pod r = 0.89, number of seeds per pod r = 0.89, %seed set r = 0.77 and seed length r = 0.55 at P≤0.001. Seed length (SL) and seed weight were also significantly correlated (Table 4). However, there was negative correlation between days to pod maturity (DPM) and pod length, pod width, number of locules per pod, number of seeds per pod and % seed set.

Floral biology

The flowers were cleistogamous which opened late in the evening or early in the morning and closed before noon. The flowers were irregular or zygomorphic, the stamens were diadelphous with nine bounded together to form a tube round the style, while the tenth stamen was free. The gynoecium was composed of a single carpel which develops to form the pod. The inflorescence was a raceme having the older flowers at the base opening before the younger flowers at the tip. The accessions studied were prolific in flower production, though a large number of the flowers produced aborted and later dropped before pods were formed (Figure 1).

The TSs1 began flowering 74 days from planting while it was 86 days in TSs61. TSs112 produced the highest number (16) of flowers per peduncle while TSs23 had the least (8). Standard petal length ranged from 3.11 cm in TSs82 to 2.64 cm in TSs1 while standard petal width ranged from 3.03 cm in TSs11 to 4.12 cm in TSs61. Nine accessions produced purplish white flowers, eleven produced purplish pink flowers while two produced violet flowers (Table 2 and Figure 1). Pod length ranged from 12.58 cm in TSs61 to 30.75 cm in TSs130. The lowest number of locules per pod and seeds per pod (8.03 and 6.72) were recorded in TSs61 while TSs130 produced the highest (21.44 and 20.08) respectively. The % seed set ranged from 83.32 in TSs61 to 95.72 in TSs130 and weight of seeds ranged from 22.33 g in TSs11 to 39.50 g in TSs40.

Table 2. Dimensions of the different floral features.

Acc No.	SPL	SPW	DF	DFF	PDL	CLL	NFP
TSs1	2.64	3.16	74	48	16.40	0.79	10.00
TSs3	2.90	3.83	76	53	20.25	0.87	10.00
TSs4	2.83	3.64	77	69	19.14	0.85	9.67
TSs7	3.07	3.77	79	63	22.61	0.86	9.67
TSs10	3.04	3.69	82	51	20.97	0.86	8.67
TSs11	2.75	3.03	84	58	22.07	0.71	9.00
TSs16	2.93	4.09	85	56	23.54	0.72	9.33
TSs22	2.92	3.72	80	53	17.90	0.88	10.33
TSs23	2.97	3.89	84	49	20.74	0.87	8.00
TSs40	3.03	3.85	87	51	19.97	0.72	9.67
TSs56	2.92	3.78	86	48	14.83	0.79	11.33
TSs60	2.87	3.61	85	60	13.36	0.76	12.67
TSs61	2.88	4.12	86	58	16.38	0.69	10.00
TSs63	2.87	3.64	84	65	17.61	0.65	10.00
TSs65	2.88	3.92	89	62	15.76	0.81	10.33
TSs82	3.11	3.92	91	70	13.93	0.79	9.33
TSs84	2.88	3.66	93	62	11.57	0.89	9.67
TSs90	3.02	4.03	92	**72**	11.56	0.82	9.67
TSs94	2.98	3.88	**99**	69	12.62	0.85	10.00
TSs104A	2.93	3.67	90	67	19.23	0.72	13.33
TSs104B	2.79	3.77	92	57	20.42	0.73	15.00
TSs111	2.70	3.47	95	48	15.82	0.83	14.00
TSs112	2.88	3.50	94	59	19.71	0.76	**15.67**
TSs119	2.88	3.64	80	70	17.67	0.80	15.33
TSs130	2.97	4.02	84	71	21.99	0.84	15.33
Mean	2.90	3.73	85.92	59.56	17.84	0.84	11.04
±SE	0.01	0.03	0.72	0.92	0.46	0.02	0.32
Co. Var	4.28	7.86	7.28	13.35	22.12	25.34	25.29
P values	0***	0***	0***	0***	0***	NS	0***

Significance *P<0.05, ***P<0.001, NS-Non significant, SPL – Standard petal length (cm), SPW – Standard petal width (cm), DF – Days to 50% flowering, DFF – Days from flower opening to pod maturity, PDL – Peduncle length (cm), CLL – Calyx lobe length (mm), NFP – Number of flowers per peduncle.

Reproductive studies

Pollen studies

Table 3 shows pollen characters while Figure 2 reveals the ratio of fertile and sterile pollen grains, pollen structure and texture. All the accessions possessed tricolporate and fenestrate pollen grains with scabrate exine. The mean pollen size ranged from 66.15 µm in TSs40 to 82.75 µm in TSs119 and pollen fertility ranged from 53.39% in TSs23 to 95.30% in TSs119.

Compatibility test

The essential floral parts (stamens and pistils) were arranged in the flowers to ensure self pollination and fertilization of the ovules by pollen grains from the same flower. This arrangement which always ensured self fertilization resulted in high fruit set and high % seed set. The % seed set was generally high for all the accessions which ranged from 82.92 in TSs94 to 95.75 in TSs130. A total of one hundred and twenty six (126) reciprocal crosses were carried out and all the flowers outcrossed dropped two or three days after.

Germination test and percentage moisture content

The accessions showed very high germination rate except for 59.68% in TSs23. The low germination rate observed in TSs23 correlated with low pollen fertility. Moisture content was found to range from 4.38% in TSs22 to 11.43% in TSs119.

DISCUSSION

The reproductive biology of accessions revealed that

Table 3. Percentages of seed set, germination and pollen fertility.

Acc no.	NPF	PF (%)	PS	PODL	PODW	NLP	NSPP	SS (%)	100 WT	SG (%)	% MC
TSs1	2031	83.70	79.75	25.54	1.50	19.83	18.25	93.01	28.83	91.73	10.70
TSs3	2655	75.33	77.50	25.97	1.42	20.47	19.72	95.04	26.47	95.62	8.90
TSs4	1954	66.43	74.00	28.28	1.50	19.36	17.50	91.28	30.47	70.15	9.86
TSs7	2158	87.58	68.13	27.33	1.45	19.11	17.36	91.56	27.10	65.60	9.23
TSs10	2754	73.17	74.50	27.44	1.75	20.53	19.17	95.33	31.60	89.18	11.11
TSs11	2349	79.61	71.00	18.79	1.06	16.81	13.94	84.67	22.33	83.50	8.62
TSs16	1972	83.87	73.46	28.48	1.52	20.94	18.94	91.11	31.10	79.80	8.20
TSs22	2345	83.97	73.25	25.05	1.64	19.53	17.56	89.14	30.70	99.03	4.38
TSs23	1873	53.39	67.00	23.24	1.49	18.20	16.39	89.21	31.77	59.68	8.33
TSs40	1989	60.58	66.15	25.10	1.41	18.08	16.28	89.08	**39.50**	95.00	7.52
TSs56	1878	71.88	67.75	27.07	1.49	20.39	18.14	90.26	32.87	71.63	9.84
TSs60	1997	71.26	67.00	19.41	1.50	15.17	13.25	86.64	25.80	94.20	10.20
TSs61	2011	61.46	70.25	12.58	1.01	8.03	6.72	83.32	30.57	68.30	11.11
TSs63	2107	68.91	70.00	23.31	1.46	16.69	15.39	89.37	32.27	89.30	10.91
TSs65	1921	81.62	71.73	19.40	1.28	15.58	14.03	89.20	26.30	84.50	10.17
TSs82	2120	68.82	67.25	22.28	1.28	15.67	13.45	85.98	29.43	83.63	9.84
TSs84	2349	79.77	67.13	19.97	1.28	12.28	10.36	84.19	28.73	70.63	10.91
TSs90	2804	60.77	76.50	19.36	1.33	16.31	13.97	85.11	31.57	75.30	8.16
TSs94	2561	82.50	69.50	18.09	1.27	13.69	11.17	82.92	30.40	83.93	9.52
TSs104A	2347	89.48	71.25	27.02	1.61	16.72	14.78	85.96	30.20	80.25	9.80
TSs104B	2321	85.48	70.25	26.23	1.46	20.70	18.08	91.23	26.23	74.00	10.17
TSs111	2049	75.16	71.89	24.08	1.44	18.50	16.42	90.44	27.20	89.30	5.80
TSs112	2824	74.40	75.25	22.19	1.45	18.89	17.36	92.82	29.33	82.53	8.77
TSs119	2785	95.3	82.75	24.82	1.53	19.11	17.33	88.81	33.13	90.15	11.43
TSs130	2849	90.17	80.50	30.75	1.57	21.44	20.08	95.72	30.80	92.83	10.83

NP – Pollen counted, PF – Pollen fertility, PS – Pollen size, PODL – Pod length, PODW – Pod width, NLP – Number of locules per pod, NSPP – Number of seeds per pod, SS% - Seed set percentage, 100 WT – 100 seed weight, SG% - Seed germination percentage, %MC – Percentage moisture content.

Table 4. Correlation analysis of some reproductive characters.

	DPM	NPP	PPP	PODL	PODW	NLP	NSPP	SS	SL	SW	ST	SDW
DPM	1.00	0.03	-0.09	-0.52*	-0.50*	-0.65***	-0.66***	-0.56*	0.13	-0.20	-0.39	-0.02
NPP		1.00	0.59**	0.07	-0.07	0.12	0.11	0.13	-0.25	0.00	0.13	-0.19
PPP			1.00	0.15	0.20	0.26	0.27	0.19	0.05	0.21	0.26	0.25
PODL				1.00	0.88***	0.89***	0.89***	0.77***	0.26	0.15	0.55*	0.23
PODW					1.00	0.73***	0.76***	0.66***	0.15	0.14	0.50**	0.31
NLP						1.00	0.99***	0.83***	0.09	0.09	0.40	0.08
NSPP							1.00	0.89***	0.09	0.09	0.42	0.10
SS								1.00	-0.00	0.04	0.37	0.05
SL									1.00	0.09	0.22	0.66***
SW										1.00	0.56	0.27
ST											1.00	0.43
SDW												1.00

Significance * = P<0.05, ** = P<0.01and *** = P<0.001, DPM- Days to pod maturity, NPP – Number of pods per peduncle, PPP – Pods Per plant, PODL – Pod length (cm), PODW – Pod width (cm), NLPP – Number of locules per pod, NSPP – Number of seeds per pod, SS – Seed set %, SDL – Seed length (mm), SDW – Seed width (mm), SDT – Seed thickness (mm), SDW – Seed weight (g).

AYB is highly prolific and fertile. Flower production, pollen fertility, duration of flowering and pod and seed set potentials are important indices of the reproductive capacity of plant species (Togun and Egunjobi, 1997).

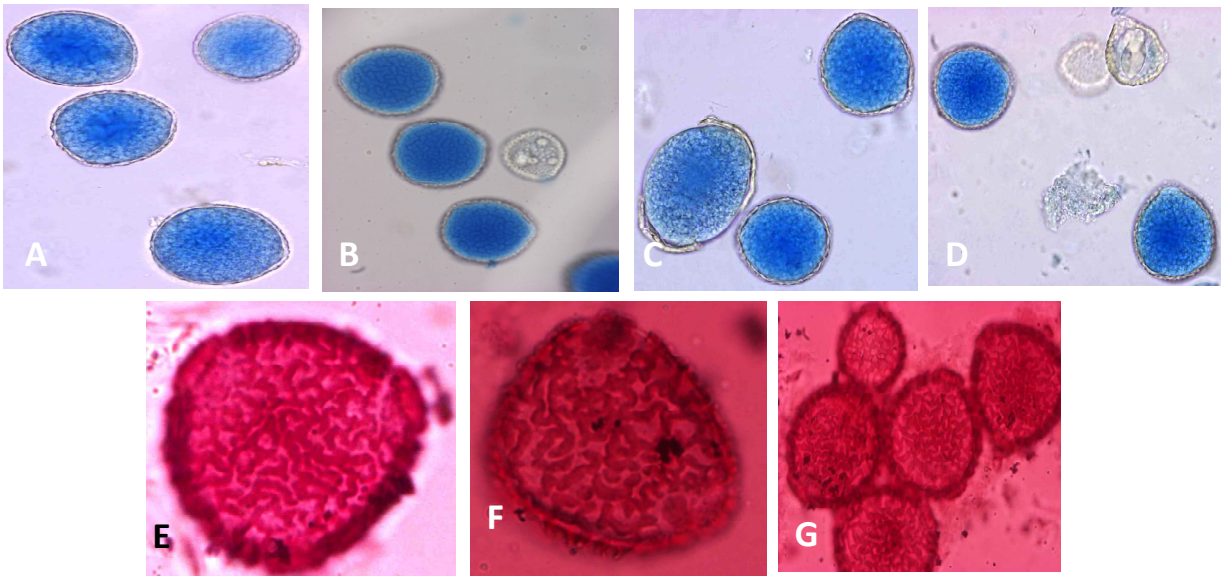

Figure 2. Pollen types. A: Fertile and sterile pollen grains in TSs10, B: Fertile and sterile pollen grains in TSs23 C: Fertile and sterile pollen grains in TSs65, D: Fertile and sterile pollen grains in TSs104A, E: Pollen structure and shape in TSs10, F: Pollen structure and shape in TSs56, G: Pollen structure and shape in TSs119.

The accessions with long duration of flowering (TSs119, TSs112, and TSs130) produced higher number of pods per plant than those with short duration of flowering such as TSs1 and TSs3. Consequently, the long vine length and luxuriant growth habit of the accessions encouraged production of large number of flowers that matured into pods and seeds. However, it was observed that a large number of the flowers dropped before or after fertilization. The arrangement of the floral parts considerably ensured self pollination and pollen economy which enhanced seed set and viability. The flower morphology such as arrangement of the floral parts coupled with the simultaneous time of maturity of both the stamens and the pistil also encouraged self-fertility in the species, resulting in high pod production with above 80% seed set, for most of the accessions. Pollen fertility, percentage seed set and percentage germination were observed to be very high in most of the accessions. These observations were largely due to the fact that the species is an obligate selfer having regular gametes. Pollen fertility percentage was highest in TSs119 (95.3%), which also recorded highest number of pods per plant, 90% seed set and 90% germination while TSs23 which recorded lowest pollen fertility of 53.39% had the lowest germination percentage of 60%, though with a relatively high 89.1% seed set. The percentage seed set ranged from 81.62% in TSs94 to 96.08% in TSs3. The results of the germination and moisture content tests indicated that the seeds produced were viable.

The pollen grains are tricolporate, fenestrate with scabrate exine in all the accessions. The three colpus are characterized by large, window-like spaces lacking a tectum. The pollen grains are also single reticulate, gently rounded without sharp corners with spinous cover that are interrupted by three protuberances (germpores) in a fixed geometrical pattern (De Leonardis et al., 1993). This description of pollen is in agreement with findings of Ferguson (1990), Perveen and Qaiser (2009) and Banks et al. (2010) on majority of Moringaceae and Fabaceae having tricolporate pollen grains. Since all the accessions belong to the same species, it is speculated that the same gene(s) are responsible for pollen type and structure in the different accessions of the species. The variations observed in pollen size and fertility could be due to differences in chromosome size and gametogenesis in different accessions of the species. This implies that accessions with relatively large chromosomes and normal gametogenesis will possess relatively large pollen grains with high pollen fertility, and consequently, high plant fertility and high seed viability.

Correlation analysis involving seed set and certain characters indicated that pod length, pod width, number of locules per pod and number of seeds per pod significantly contributed to the high percentage seed set in the accessions. Therefore, selections based on these characters could enhance seed productivity considerably. Significant differences ($P<0.001$) observed in some of the characters indicate phenotypic and genetic differences among them, hence they could be utilized as raw materials for genetic improvement of the species.

In this study, we have provided important basic information that can help in breeding programme and genetic manipulation of the species. Genetic and phenotypic variability with relatively high co-heritability as identified by Adewale et al. (2010), among seed characters can help in possible hybridization. Being o bligate selfer with

high pollen fertility and seed viability, high seed yield and productivity is assuredly guaranteed. The palynologic characters of the species are narrow just like its germplasm diversity, and one contribution this paper has highlighted, is the identification of AYB pollen grains and its use to measure productivity. An expanded knowledge and future research into the pollen structure portend greater potentials for its morphological and cytological characterization which can result in better genetic improvement. Though the rate of outcrossing is low (Adewale, 2010), future research focus can be directed towards using molecular approach to overcome some of the constraints to its utilization. Further germplasms collection, characterization and conservation of the species will enhance knowledge about its diversity and genetic manipulation.

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