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EVALUATION OF SICKLE POD (*Senna obtusifolia* L) ACCESSIONS IN THE SUDAN SAVANNA ZONE OF NIGERIA

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ABSTRACT
Field investigation was conducted at the Teaching and Research Farm of the Faculty of Agriculture, Bayero University Kano to evaluate eight accessions of Sickle pod (*Senna obtusifolia* L.) for genetic variability and plant characteristics. The accessions served as the experimental treatments and were laid in Randomized Complete Block Design (RCBD) and replicated three times. Results of the study indicated significant differences in days to emergence ($P \leq 0.05$), days to first flowering, days to 50% flowering, plant height, peduncle length and number of leaves per plant at post-flowering. The genetic and phenotypic coefficients of variations were both higher in days to flowering (31.02 and 21.46%), number of pod per plant (41.57 and 54.52%) and pod length (31.08 and 31.89%) respectively. The magnitude of estimated heritability in broad sense was equally higher indicating possible selection at first filial generation when crossed. Further research is recommended to document sufficient information on *Senna obtusifolia*.

Keywords: Genetic coefficient of variation, phenotypic coefficient of variation, heritability.

INTRODUCTION

Sickle pod (*Senna obtusifolia* L.) is an herbaceous to semi woody plant belonging to the fabaceae family. The name *Senna obtusifolia* is reported to be synonymous to *Senna tora, Cassia tora* or *Cassia obtusifolia* (Abubakar *et al*., 2018; Harr-O'kuru *et al*., 2012; Holm *et al*., 1997). The plant is erect, bushy annual to short-lived perennial herb growing up to 2.5 meters in height (Holm *et al*., 1997; Parsons and Cuthbertson, 1992). Sickle pod holds great potentials as a source of medicine, minerals and noble genes for drought tolerance. It has been used in traditional Indian and Chinese medicines for quite long (Shukla *et al*., 2013). Some parts of the plant contain substances that are used for the synthesis of useful drugs (Sofowora, 2000) and the whole plant is traditionally used for the treatment of diseases. The leaves and seeds of sickle pod are acrid, laxative, anti-helminthic, ophthalmic, liver tonic, cardio-tonic and expectorant. Others reported it to be a good source of antibiotic substances for the treatment of bacterial and fungal infections including gonorrhea, pneumonia, urinary tract and some mycotic infections (Doughari *et al*., 2008; Patil *et al*., 2004; Shukla *et al*., 2013). The plant is reported to contain substances such as chrysophenol, emodin and rhein (Duke, 2001; Wu and Yen, 2004; Yen *et al*., 1998) and also exhibit significant anti-mutagenic activity (Choi *et al*., 1997; Yen *et al*., 1998). About 80% of the world population relied on such plants for their primary health care (Owolabi *et al*., 2007).

In Nigeria, Sickle pod plant grows as a weed during rainy season in the savanna area and is used as vegetable by people living in rural areas. Smith *et al.* (1996) pointed edible wild plant to often have high mineral content particularly, zinc. The use of non-conventional wild plants for nutrients supply was emphasized due to increasing population and economic crises in most developing nations (Hassan *et al*, 2007). Recent surveys showed Senna seed becoming an export commodity from Nigeria and its leaves serves as substitute for moringa leaves due to higher cost of the latter (Anonymous, 2016). Considering the wide phenotypic diversity exhibited by *S. obtusifolia* it is likely to find ample variation in its genetic resources which could be exploited in genetic improvement. Documenting data on this versatile crop is therefore of significance for the huge potential it presents. This work was conducted to assess the available germplasm in sickle pod for genetic variability that could be exploited in breeding programs.

MATERIALS AND METHODS

Field experiment was conducted at Bayero University Kano (BUK) Teaching and Research Farm (Lat. 11.98^0N, Long. 8.43E alt. 466m above sea leve1) between July and November 2017. The experimental treatments consisted of eight accessions of sickle pod sourced from 4 locations in North East (Kirfi, Maiduguri, Gombe, Gasol and Potiskum: accessions 1, 2, 7 and 8 respectively), 2 locations in North West (Ungoggo and Jibia: accessions 4 and 5 respectively) and a location in North Central (Gurara: accession 6) representing the Sudan savanna of Nigeria. These were laid out in randomized complete block design (RCBD) and replicated three times. Replication was considered as a random effect and the accessions as fixed effect. Each plot consisted of 6 rows of 4 meter length spaced at 0.75m. The net plot was $6m^2$. Six stands were randomly tagged from each

net plot for the purpose of data collection.

Seeds of each accession were separately soaked in cold water for 12 hours to soften the seed coat and dried before sowing. Three seeds were sown at 15cm spacing and 2cm deep. These were thinned to two plants per hill after establishment at 2 weeks after sowing (WAS). Weeding was carried out twice at 4 and 8 WAS. Harvesting was done manually after the crop reached physiological maturity. Sickle pod is considered matured when the capsules turned brown-yellow and leaves starts to senesce.

Data were recorded from the tagged plants in each net plot during pre- and post-flowering stages at 4 and 8 weeks after emergence on plant height, number of leaves per plant and peduncle length. Days to emergence and flowering were recorded when germination and flowering were first observed. Number of pods per plant, pod length and number of seeds per pod were recorded at maturity. The data collected were subjected to analysis of variance using GenStat (VSN International. 2014). Significant treatment means were ranked using Student Newman's Keuls (SNK).

The mean sums of square of error, genotypic and phenotypic variances were estimated as reported by Shaibu *et al*. (2015) following the method of Johnson *et al*. (1955). The error mean square was taken as error variance. Genotypic variances (δ^2g) were obtained by subtracting error variance (δ^2e) from the accessions mean square (GMS) divided by number of replications (r).

$$\delta^2 g = \frac{GMS - EMS}{r}$$

The phenotypic variances (δ^2p) were derived by adding genotypic variances with the error variances.

$$\delta^2 p = \delta^2 g + \delta^2 e$$

Genotypic and phenotypic coefficients of variations (GCV and PCV) were computed as also reported by Shaibu *et al*., 2015 using the formula suggested by Burton (1952). GCV was obtained by dividing genotypic standard deviation (δg) with the population mean (m) and PCV by dividing phenotypic standard deviation (δp) with the population mean and both expressed in percentage. Standard deviations in both cases were the square roots of genotypic and phenotypic variances respectively.

$$GCV = \frac{\delta g}{m} \times 100$$

$$PCV = \frac{\delta p}{m} \times 100$$

Broad sense heritability (H^2) was estimated following the definition given by Lush (1940) and using the formula suggested by Johnson *et al.* (1955) and Hanson *et al*. (1956).

$$H^2 = \frac{\delta^2 g}{\delta^2 p} \times 100$$

where, δ^2g = Genotypic variance and δ^2p = Phenotypic variance as obtained above.

RESULTS AND DISCUSSION

The mean square values from the analysis of variance for the pre- and post-flowering characters of *Senna obtusifolia* evaluated under the current study are presented in Tables 1 and 2. There was significant difference ($P \leq 0.05$) in days to first emergence (FDE) among the accessions. All the characters evaluated at pre-flowering stages: plant height (PRFPH), peduncle length (PRFPL) and number of leaf per plant (PRFLPP) showed no significant differences ($P \geq 0.05$) across the accessions. Significant differences ($P \leq 0.01$) were however obtained days to first flowering (FDF), days to 50% flowering (DFF), post flowering plant height (PSFPH), peduncle length (PSFPL) number of leaf per plant (PSFLPP), number of pod per plant (NPP), pod length (PL) and number of seed per pod (NSPP).

The treatment means for the characters evaluated is presented in Table 3 and 4. Accessions 5 and 2 were similar ($P \geq 0.05$) and germinated earlier than all other accessions. They recorded mean days to germination of 5.33 and 5.68 days after sowing. Accession 6 was late to germinate with a mean value of 8.67 days after sowing. Accession 2 was the first to attain flowering (48.33 days after sowing), it reached 50% flowering at 56.67 days after sowing and was at par ($P \leq 0.01$) with all other accessions. Accession 8 recorded the highest mean value in days to first flowering and days to 50% flowering of 65.33 in both indicating higher flowering uniformity. Accession 6 failed to flower throughout the study period. This might not be unconnected with the environment. The mean value for post-flowering plant height was highest in accession 5 (104.89cm) though was similar to all others with the exception of accession 6 ($P \leq 0.01$) which recorded the least mean value (73.17cm). In addition, accession 5 recorded the least mean value in post-flowering peduncle length (2.79 cm) and these were highest ($P \leq 0.01$) in accession 1 and 6 with a mean value of 3.49 and 3.43cm respectively. The result of post-flowering number of leaf per plant revealed highest mean value in accession 8 (1520) which was at par with accession 6 which recorded the least mean value (426). The low value obtained in the number of leaf for accession 6 may be linked with the inability of the accession to flower. As there were no flowers recorded in the accession, there were also no values obtained for number of pod per plant, pod length and number of seed per pod. This is possible because productions of pods and seeds are tight to sexual reproduction. Accession 8 was significantly different from all other accessions ($P \leq 0.01$) and recorded the highest mean values in number of pod per plant of 37.30. The highest number of pod obtained in accession 8 is proportional to number of leaves per plant in the accession which may have been possible from higher photosynthates production and can be correlated to its late emergence and flowering. Accession 7 recorded the least mean value in number of pod per plant (10.33). Pod length was highest in accession 1 (16.15cm) and least in accession 7 (13.65cm). With the exception of accession 6 which did not bear any seeds, all other accessions were statistically similar with number of seeds per plant ranged from 26.01 in accession 4 to 25.00 in accession 1. Days to emergence in *Senna obtusifolia* as obtained in this study in the range of 4-9 days after sowing is within the reported days of 3-9 (Teem *et al*., 1980; Parson and Cuthberson, 1992). Days to flowering as obtained of 56-65 days after sowing in this study were also within the range of

43-84 days reported by Mackey *et al*. (1997). All the accessions' plant heights fall within the range of 73.13 to 104.19cm. Similar result was reported by Hall and Vandiver (1996) in which *Senna obtusifolia* grows up to the range of 50 to 200cm in height. The post-flowering peduncle length also falls within the range of 2.79 to 3.49cm. This is in agreement with the findings of Randell (1988) who reported plant heights in *Senna obtusifolia* in the range of 2.0 to 4.5cm. The results of the present investigation corroborates with what was reported by Irwin and Barneby (1982) in which 25-30 seeds per pod and 10 to 25 cm long pods were recorded in *Senna obtusifolia*, respectively.

The genetic and phenotypic coefficients of variations obtained (Table 5) were both higher in days to flowering (31.02 and 21.46%), post-flowering number of leaf per plant (26.10 and 28.16%), number of pod per plant (41.57 and 54.52%) and pod length (31.08 and 31.89%) respectively as indicated by Subramanian and Menon (1973). The magnitude of estimated heritability in broad sense revealed post-flowering peduncle length and number of pod per plant as having moderate heritability of 50.13 and 58.13% as indicated by Robinson *et al.* (1949). Days to flowering, post-flowering leaf per plant, pod length and number of seeds per pod were highly heritable with values of 95.14, 85.92, 95.00 and 95.40%) as such selection for such could be made at first filial generation when crossed. This also indicated less influence of environment and higher scope for improvement of such traits.

CONCLUSION

Genetic variability was observed in *Senna obtusifolia* in this study. Even though it used to grow as weed in crops field, however it presents great potentials due to its drought tolerance nature and possible uses as a source of minerals and/or vitamins coupled with its medicinal uses recognized. As there were no available data on the plant from these agro-ecological zones, the present investigation provides baseline information that can be used for breeding purposes in harnessing its huge potential benefits in the study areas.

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Table 1: Mean square values for the analysis of variance of the pre- and flowering characters evaluated

S/V	df	FDE	PRFPH	PRFPL	PRFLPP	FDF	DFF
Accession	7	3.47*	10.97	1.10	176.10	1050.1**	1455.52**
Replication	2						
Error	14						
Total	23						

* and ** : significant and highly significant at 5 % and 1% probability levels, respectively.

Key: S/V: Source of variation, df: Degree of freedom, FDE: Days to first emergence, PRFPH: Pre-flowering plant height, PREPL: Pre-flowering peduncle length, PRFLPP: Pre-flowering number of leaves per plant, FDF: Days to first flowering, DFF: Days to 50% flowering.

Table 2: Mean square values for the analysis of variance for the post-flowering and yield characters evaluated

S/Variation	df	PSFPH	PSFPL	PSFLPP	NPPP	PL	NSPP
Accessions	7	248.77*	0.37*	318021**	326.86**	88.77**	246.45**
Replication	2						
Error	14						
Total	23						

* and ** : significant and highly significant at 5 % and 1% probability levels, respectively.

Key: S/V: Source of variation, df: Degree of freedom, PSFPH: Post-flowering plant height, PSFPL: Post-flowering peduncle length, PSFLPP: Post-flowering number of leaves per plant, NPP: Number of pod per plant, PL: Pod length and NSPP: Number of seed per pod.

Table 3: Mean values for the growth characters evaluated

Accessions	FDE	PRFPH	PRFPL	PRFLPP	FDF	DFF	PSFPH	PSFPL	PSFLPP
1	6.00^{a}	18.22	1.78	50.30	54.67^{b}	63.33^{cd}	94.66^{b}	3.49^{b}	1142^{bc}
2	5.67^{a}	20.11	2.15	54.70	48.33^{b}	56.67^{b}	91.72^{b}	3.20^{ab}	1172^{bc}
3	6.00^{a}	19.05	2.20	65.00	52.33^{bc}	62.33^{cd}	93.77^{b}	3.10^{ab}	1338^{c}
4	7.00^{ab}	24.05	2.20	47.00	52.67^{bc}	63.00^{cd}	93.61^{b}	3.22^{ab}	1215^{c}
5	5.33^{a}	19.55	1.85	67.00	59.67^{cd}	59.67^{bc}	104.89^{b}	2.79^{a}	1251^{c}
6	8.67^{b}	18.39	1.77	30.30	0.00^{a}	0.00^{a}	73.17^{a}	3.43^{b}	426^{a}
7	6.00^{a}	18.99	1.97	47.00	62.67^{d}	62.77^{cd}	92.33^{b}	3.31^{ab}	964^{b}
8	5.67^{a}	18.38	2.13	48.30	65.33^{d}	65.33^{d}	99.33^{b}	3.01^{ab}	1520^{d}
Mean	6.29	19.59	2.01	51.20	45.83	54.12	92.90	3.30	1129
S.E.D	0.69	2.85	0.25	10.84	2.60	2.45	7.02	0.25	144.2

Means with different superscripts within the same column are significantly different ($p<0.05$ or $p<0.01$)

Key: FDE: First day to emergence, PRFPH: Pre-flowering plant height, PRFPL: Pre-flowering peduncle length, PRFLPP: Pre flowering number of leaves per plant, FDF: First days to flowering, DFF: Days to 50% flowering, PSFPH: Post flowering plant height, PSFPL: Post flowering peduncle length, PSFLPP: Post-flowering number of leaves per plant.

Table 4: Mean for the yield characters evaluated

Accession	NPPP	PL	NSPP
1	25.33^{c}	16.15^{d}	25.00^{b}
2	16.00^{bc}	14.45^{bc}	25.33^{b}
3	19.30^{bc}	16.00^{cd}	26.00^{b}
4	18.13^{bc}	15.18^{bcd}	26.01^{b}
5	24.00^{c}	15.72^{cd}	25.67^{b}
6	0.00^{a}	0.00^{a}	0.00^{a}
7	10.33^{b}	13.65^{b}	25.67^{b}
8	37.30^{d}	15.30^{bcd}	25.60^{b}
Mean	18.80	13.31	22.42
S.E.D	5.41	0.70	1.47

Means with different superscripts within the same column are significantly different ($p<0.05$or $p<0.01$)
Key: PPP: Number of pods per plant, PL: Pod length NSPP: Number of seeds per pod.

Table 5: Estimate of genetic coefficient of variability, phenotypic coefficient of variability and heritability

CHARACTERS	VE	VG	VP	GCV (%)	PCV (%)	H^2 (%)
FDE	0.892	0.401	1.293	10.07	18.07	31.03
FDF	10.315	202.114	212.429	31.02	31.80	95.14
FF	8.179	281.848	290.026	31.02	31.46	97.18
PRFPH	11.675	0.266	11.941	2.63	17.64	2.22
PSFPH	76.097	32.094	108.191	6.10	11.19	29.66
PRFLPP	190.550	55.481	246.031	14.55	30.63	22.55
PSFLPP	14222.552	86771.257	100993.809	26.10	28.16	85.92
PRFPL	0.098	0.003	0.101	2.81	15.81	3.15
PSFPL	0.092	0.093	0.185	9.23	13.03	50.13
NPPP	44.135	61.284	105.419	41.57	54.52	58.13
PL	0.900	17.106	18.006	31.08	31.89	95.00
NSPP	2.331	48.395	50.726	31.03	31.77	95.40

Key: FDE: First day to emergence, FDF: First days to flowering, DFF: Days to 50% flowering, PRFPH: Pre-flowering plant height, PSFPH: Post flowering plant height, PRFPL: Pre-flowering peduncle length, PSFPL: Post flowering peduncle length, PRFLPP: Pre flowering number of leaves per plant, PSFLPP: Post-flowering number of leaves per plant, , NPPP: Number of pods per plant, PL: Pod length NSPP: Number of seeds per pod, VE: Environmental variance, VG: Genotypic variance, VP: Phenotypic variance, GCV: Genotypic coefficient of variability, PCV: Phenotypic coefficient of variability, H^2: Heritability in broad sense.