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REGIONAL VARIATION IN AGRO-MORPHOLOGICAL DESCRIPTORS OF *SESBANIA BISPINOSA* (JACQ.) W. WIGHT

Sontosh C Chanda, Md Amir Hossain[1], Md Mustafizur Rahman[1], ANM Shamsuzzaman[2] and AKM Golam Sarwar*

Laboratory of Plant Systematics, Department of Crop Botany, Bangladesh Agricultural University, Mymensingh, Bangladesh

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Abstract

The effect of regional diversity on 12 agro-morphological descriptors of *Sesbania bispinosa* (Jacq.) W. Wight was studied. The mean sum of square varied significantly for six of these traits *viz*., plant height, branch number/plant, pod number/plant, pod length, seed number/pod and seed width. Among the ten regions, plants grown from seeds of Tangail, Chuadanga and Sirajganj districts of Bangladesh performed better in terms of plant height, number of branches/plant, number of pods/plant, pod length, number of seeds/pod and seed width. In principal component analysis, first six principal components (PC1, PC2, PC3, PC4, PC5 and PC6) showed Eigen value >1 and accounted for 85.6% of the total variance. In cluster analysis based on the studied agro-morphological descriptors, the cluster 1 consists of three regions (Chuadanga, Tangail and Jhinaidah), cluster 2 of six regions (Khulna, Mymensingh, Rangpur, Sunamganj, Gaibandha and Faridpur) and cluster 3 of only one district (Sirajganj). Considering these multivariate analyses, three different morphotypes of *S. bispinosa* could be identified from different locations.

Introduction

Sesbania, belonging to Fabaceae, is one of the most important green manure crops with multiple uses *viz.*, mulch for moisture conservation, weed suppression, ground cover, firewood, fuel, fiber and bio-energy sources, providing live support fencing wood, raw materials for industrial uses, and in traditional agro-forestry systems (Ndoye *et al*. 1990, Swami *et al*. 2012, Sarkar *et al*. 2017). It also possesses medicinal importance (Gomase *et al.* 2012) and uses as animal feed and fodder (Shahjalal and Topps 2000, Kabir *et al*. 2018). Three species of the genus *Sesbania viz*., *S. sesban* (L.) Merr., *S. bispinosa* (Jacq.) W. Wight [syn. *S. aculeata* (Wild.) Poir] and *S. cannabina* (Retz.) Poir, are commonly called as *dhaincha* in Bangladesh (Ahmed *et al*. 2009, Sarwar *et al*. 2015). Among the species, S. *bispinosa* is the most common (Chanda *et al*. 2018). *Sesbania* species are found all over the Bangladesh and tolerant to saline and alkaline soils, and waterlogged condition. It grows well in char lands, roadsides as well as other marginal lands. The genus *Sesbania* can adapt up to 500 m height, annual temperature ranging from 20 to 30^0C and rainfall varying from 570 to 2210 mm. It propagates through both sexual and asexual systems.

Considering the bulky magnitude of *Sesbania* species, systematic breeding efforts are required to develop the plant type and economic characters of the crop. These characters are mainly relevant to environmental, morphological and physiological behaviours. Morphological dissimilarity is robustly influenced by different environments. Morphological differentiation occurs in the constant adaptation of the species in environment (Hussain and Mahmood 2004, Singhdoha *et al*. 2017).

*Author for correspondence: <drsarwar@bau.edu.bd>. [1]Department of Genetics & Plant Breeding, Bangladesh Agricultural University, Mymensingh, Bangladesh. [2]Deputy Director, Local Government, Sirajganj, Bangladesh.

Selection through morphological descriptors significantly influences to achieve the crop improvement programme. Dendrogram and principal component analyses (PCA) are suitable multivariate technique which helps to determine effective traits for indirect selection of superior genotypes (Lever *et al*. 2017, Mehraj and Shimasaki 2017).

Morphological descriptors *viz*., plant height, number of primary branches, seeds/pod, seed length and width, 1000-seed weight and its potential yield capacity, fluctuate due to geographical effect (Dumbre and Deshmukh 1984). The crop *Sesbania* has wide ecological adaptation, as a result, it is found in different types of soil, easily grow and survive in minimum practice (Heering 1995). Apart from taxonomic (/identification) research, a few studies have been carried out on the morphological variations of *Sesbania* species from Bangladesh (Sarwar *et al*. 2015, Chanda *et al*. 2017a, b, 2018). Morphological descriptors are strongly influenced by various environmental factors and the environment varied due to different locations (/regions). This study, therefore, was undertaken to assess the regional effect on agro-morphological descriptors of *S. bispinosa*.

Materials and Methods

The experiment was conducted at Field Laboratory of the Department of Crop Botany, Bangladesh Agricultural University, Mymensingh, during the year of 2016. Seeds were collected from ten different locations (districts) of Bangladesh *viz*., Rangpur, Gaibandha, Sirajganj, Khulna, Jhinaidah, Chuadanga, Tangail, Mymensingh, Sunamganj and Faridpur. Seeds were sown in 2.5 × 2.0 m^2 plot with 50 cm (line-line) × 15 cm (plant-plant) spacing following complete randomized design with three replications.

Twelve agro-morphological descriptors *viz*., plant height, number of branches/plant, inflorescence length, number of flowers/inflorescence, number of pods/inflorescence, number of pods/plant, pod length and width, number of seeds/pod, seed length and width and 1000-seed weight, were studied. Based on above mentioned agro-morphological descriptors (traits), analysis of variance (ANOVA) and cluster analysis were conducted, and a dendrogram, based on complete linkage between clusters and Euclidean distance, was built using the GenStat-10 statistical programme (http://www.biosci.global/softwar-en/genstat/). The principal component analysis (Robitzsch *et al*. 2018), which was computed from the eigen values of the covariance matrix, was also conducted using the “R” software package (https://cran.r-project.org/bin/windows/).

Results and Discussion

The ANOVA of *Sesbania* accessions collected from ten different locations for 12 agro-morphological descriptors and genotypes has been presented in Table 1. The differences among genotypes for most of studied characters were highly significant for genotype, treatment and genotype-treatment interaction. Among twelve agro-morphological descriptors, the mean sum of square due to accessions of different locations showed a significant variation for six descriptors *viz*., plant height, number of branches/plant, number of pods/plant, pod length, number of seeds/pod and seed width (Table 1). It indicates the presence of high genetic variability in seeds collected from different districts. The significant differences among the districts (locations) studied suggested that this variability can be further utilized in crop improvement programmes. Rani *et al*. (2006) obtained similar results in *Sesbania* species. They have suggested that a huge scope in maintaining and utilizing genetic resources and initiating a sound breeding programme of this important genus. Rest of six descriptors *viz*., inflorescence length, number of flowers and pods/inflorescence, pod width, seed length and 1000-seed weight, showed insignificant variations (Table 1). It indicates that these descriptors might mainly be genetically controlled, and there is no or little effect of environments or locations on these descriptors.

Plant height and number of flowers/inflorescence were the highest in plants grown from seeds of Tangail district (Fig. 1). On the other hand, number of pods/inflorescence and seed width were the highest from Chuadanga district. Moreover, inflorescence length, pod width, and seed length of the plant were the highest from Sunamganj district. Plant height and seed length were the smallest from Faridpur district (Fig. 1). This may indicate to the presence of huge variations in the genetic make-up of *S. bispinosa*. Plants from seeds of Gaibandha district produced the smaller inflorescence and number of flowers/inflorescence. The number of pods/inflorescence was lower from Rangpur district. Pod and seed widths were the lowest in Sirajganj district (Fig. 1). These variations in different morphological descriptors were random among the sources, might be due to the facts that genotypes initially grew under different environmental conditions (Singhdoha *et al.* 2017).

Table 1. ANOVA of agro-morphological descriptors of *S. bispinosa.*

Descriptors	df	Treatments	Error	CV (%)	SE	P value (%)
Plant height (m)	9	2.7522**	0.9192	24.38	0.183	1.1
Number of branches/plant	9	374.23***	16.26	30.99	1.57	<0.1
Inflorescence length (cm)	9	2.207^{NS}	1.159	20.32	0.187	9
Number of flowers/inflorescence	9	4.191^{NS}	1.923	26.33	0.247	5.3
Number of pods/inflorescence	9	10.117^{NS}	8.012	103.59	0.461	29.7
Number of pods/plant	9	834.77***	29.33	38.09	2.32	<0.1
Pod length (cm)	9	8.57*	3.513	11.12	0.342	3.2
Pod width (mm)	9	0.2032^{NS}	0.7679	25.73	0.126	97.9
Number of seeds/pod	9	26.84***	2.974	10.01	0.46	<0.1
Seed length (mm)	9	0.03736^{NS}	0.0472	5.46	0.0335	62.6
Seed width (mm)	9	0.073885***	0.0035	6.14	0.0222	<0.1
1000-seed weight (g)	9	2.739^{NS}	2.683	9.71	0.26	44.6

df degree of freedom, *** indicates significant at 0.001 probability level, ** indicates significant at 0.01 probability level, * indicates significant at 0.05 probability level and NS = Not significant.

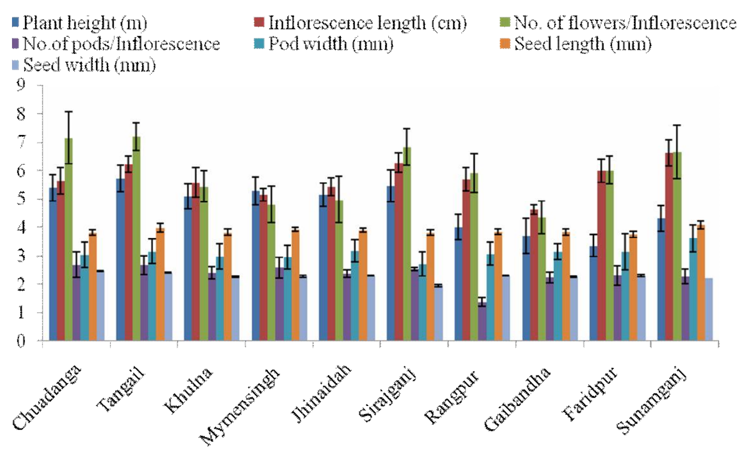

Fig. 1. Variation (in mean values) of seven agro-morphological descriptors of *S. bispinosa.* Bar indicates standard error, n = 10.

Number of branches/plant, number of seeds/pod, number of pods/plant, pod length and 1000-seed weight are presented in Fig. 2. Number of branches/plant and number of seeds/pod were the highest from Tangail district. However, number of seeds/pod was the lowest from Rangpur district. Pod length was the longest from Sunamganj district. Number of pods/plant was the largest from Sirajganj district (Fig. 2). The heaviest 1000-seed was recorded from plants grown from seeds of Tangail and Chuadanga districts. Pod length and 1000-seed weight were the lowest in Sirajganj district (Fig. 2). Plant height, branch number/plant, seed number/pod, seed length and width, and 1000-seed weight were found to be important descriptors for selecting better yield contributing parameters (Prakash *et al*. 2001).

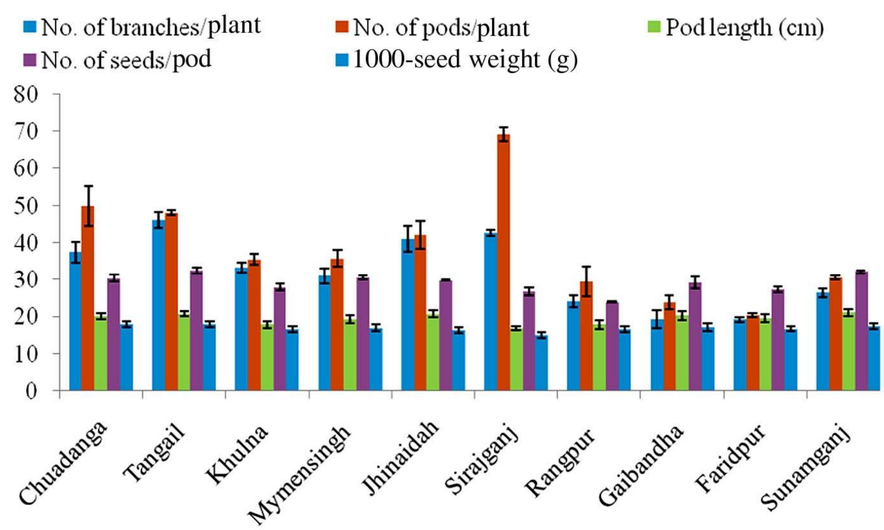

Fig. 2. Variation (in mean values) of five agro-morphological descriptors of *S. bispinosa*. Bar indicates standard error, n=10.

The principal component analysis (PCA) is a helpful statistical system for providing an improved understanding of the relations among variables. It shows the structure of collection by identifying the most relevant variables, associations among germplasms, and probable outliers (Martinez-Colvo *et al*. 2013, Yilmaz *et al*. 2017). The first six principal components (PCs) possess Eigen value more than 1 and explained up to 85.6% of the total variance (Table 2). Based on the Eigen value criterion, only the PCs with Eigen value larger than 1 are considered important (Halim *et al*. 2013); and the coefficient value more than 0.30 was considered important for the descriptors selection (Khan *et al*. 2015). The first PC accounted for more than 22.8% of the total variations (Table 2). In first PC, the number of pods/plant (0.324) contributed more than other descriptors. The second PC accounted for more than 21.6% of the total variations which identified yield component *viz*., plant height (0.490), number of branches/plant (0.473) and number of pods/plant (0.401) were exhibited more than 0.30 values and the main characters responsible for classification (Table 2). The third PC accounted for 15.6% of total variations. All components negatively associated with yield contributing characters except inflorescence length. The fourth PC accounted 9.7% of total variations and positively associated with number of pods/inflorescence (0.457). The fifth PC accounted 8.5% of total variations and associated with inflorescence length (0.337), number of pods/inflorescence (0.492) and pod width (0.616) of *S. bispinosa* (Table 2). The sixth PC accounted 7.4% of total variations and positively associated with pod length (0.519) and number of seeds/pod (0.484). The second PC is emerged as the most important component in terms of biomass (plant height and number of branches/plant) and seed yield producing descriptors (number of pods/plant) is higher than other components. This result matched with the results of Zhou *et al*. (2015) in tomato crop.

Table 2. Factor loading of the first six principal components with Eigen vector values.

Variable	PC1	PC2	PC3	PC4	PC5	PC6
Plant height (m)	0.015	0.490	–0.013	0.236	–0.087	–0.045
Number of branches/plant	0.186	0.473	–0.149	0.141	–0.189	–0.133
Inflorescence length (cm)	0.294	0.205	0.077	-0.461	0.337	0.148
Number of flowers/inflorescence	0.234	0.207	–0.149	-0.538	0.137	–0.324
Number of pods/inflorescence	–0.112	0.120	–0.030	0.457	0.492	–0.081
Number of pods/plant	0.324	0.401	–0.007	0.142	–0.122	–0.166
Pod length (cm)	–0.299	0.164	–0.269	–0.212	0.062	0.519
Pod width (mm)	–0.174	-0.008	–0.101	–0.098	0.616	–0.296
Number of seeds/pod	–0.110	0.283	–0.408	0.041	0.093	0.484
Seed length (mm)	0.257	–0.262	–0.505	0.061	–0.064	–0.056
Seed width (mm)	–0.366	0.029	–0.312	–0.229	–0.319	–0.298
1000-seed weight (g)	–0.292	0.045	–0.286	0.180	0.160	–0.313
Eigen value	3.1904	3.0246	2.1818	1.3544	1.1968	1.04
Proportion	0.228	0.216	0.156	0.097	0.085	0.074
Cumulative variation (%)	22.8	44.4	60.0	69.7	78.2	85.6

PC1- first principal component, PC2 - second principal component, PC3 - third principal component, PC4 - fourth principal component, PC5 - fifth principal component and PC6 - sixth principal component.

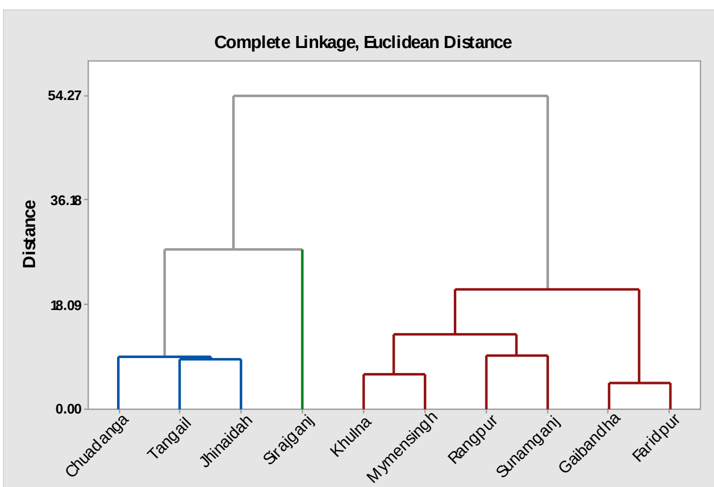

Fig. 3. Dendrogram built based on twelve agro-morphological descriptors of *S. bispinosa*.

In cluster analysis based on 12 agro-morphological descriptors, complete linkage between clusters and Euclidean distance, the collected *S. bispinosa* accessions were grouped into three clusters (Fig. 3). The main clusters were further divided into sub-clusters. The cluster 1 consisted of three districts (Chuadanga, Tangail and Jhinaidah), cluster 2 of six districts (Khulna, Mymensingh, Rangpur, Sunamganj, Gaibandha and Faridpur) and cluster 3 of only one district (Sirajganj). The cluster analysis shows a high homogeneity within a cluster and high heterogeneity between clusters (Jain and Patel 2016). Shim *et al*. (2016) stated that the germplasms can be classified based on the variation of morphological descriptors using principal component and clustering analyses. Based on agro-morphological descriptors, accessions collected from Chuadanga, Tangail and Jhinaidah districts may belong to one morphotype, accessions of Khulna, Mymensingh, Rangpur, Sunamganj, Gaibandha and Faridpur districts to another morphotype and lastly the accession of Sirajganj district to another morphotype of *S. bispinosa* (Fig. 3).

Among 12 agro-morphological descriptors of *S. bispinosa*, six descriptors *viz*., plant height, number of branches/plant, number of pods/plant, pod length, number of seeds/pod and seed width, from different districts showed significant variation for mean sum of square. The Eigen value more than 1 was observed in first six PCs which cumulatively explained 85.6% of the total variations. Plant height, number of branches/plant and number of pods/plant are contained highest loading value in second component. In cluster analysis based on 12 agro-morphological descriptors, collected *S. bispinosa* accessions were grouped into 3 clusters/morphotypes. Among ten locations, the seeds (/plants) from Tangail, Chuadanga and Sirajganj districts may be emerged as better resources than seeds from other districts in terms of above mentioned six agro-morphological descriptors of *S. bispinosa.*

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