Growth Pattern and Classification of Soybean Under Semi-sodic Soils

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Wide range of variation was observed in sixty genotypes of soybean evaluated under semi-sodic soil condition. Euclidian Non Hierarchical cluster analysis resulted in formation of four clusters. Cluster I exhibited the determinate habit, while cluster IV comprised indeterminate types. Cluster II and III both were found to be semi-determinate type. The semi-determinate growth habit recorded less biological yield in comparison to both determinate and indeterminate types but produced more seed yield and recorded the highest harvest index. The study demonstrated that selection of genotypes with semi-determinate growth habit would result in development of high yielding soybean lines under semi-sodic soils.

Key Words: Cluster analysis, Growth pattern, Semi-sodic soil, Soybean

Soybean [*Glycine maxI* (L.) Merr.] is one of the most important oilseed crop in India. Besides being a rich source of oil, it also constitutes an important part of human and animal feed.

There have been contradictory reports claiming superiority of determinate and indeterminate growth habit over one another (Ablett, 1988; Lampang *et al.*, 1988; Chinchilla *et al.*, 1988; Parvez *et al.*, 1989). The present investigation was undertaken study the effect of seed yield under semi sodic-soil condition.

Cluster analysis based on Principal Component Analysis (PCA) is a useful tool for categorizing a large number of germplasm accessions into morphologically similar groups. The present investigation was aimed at using this technique to study the pattern of variability in growth habit as well as other economic traits.

Materials and Methods

Sixty genotypes of soybean collected from various sources were evaluated in a Randomized Block Design with three replications in two successive seasons i.e. summer and *kharif* under semi-sodic soil condition at Banthra Research Station of National Botanical Research Institute (NBRI), Lucknow, Uttar Pradesh, situated between $80^0$45'–$80^0$53' longitude and 26° 40'–26^0 45' N latitude and at an altitude of 129m above the mean sea level. The area falls into a subtropical zone, characterized by hot, dry summers and cold winters. It receives an annual rainfall of 80-100 cm. Each genotype was grown in 5 rows of 2m length with row-in-row and plant-to-plant spacing of 50 and 20 cm, respectively. The observations were recorded on five randomly selected plants from each genotype for seven characters, namely, plant height at anthesis, plant height at harvest, plant height between flowering to harvest, degree of determination, plant biological yield, seed yield and harvest index. Degree of indetermination was calculated as per the formula given by AVRDC (1976).

The data were analyzed using Euclidian Non Hierarchical Cluster Analysis as described by Beale (1969) and elaborated by Spark (1973).

Results and Discussion

A wide range of variation was observed among the genotypes for the traits namely, growth in reproductive phase (H2-H1) and degree of indetermination (DDh), while the other attributes namely, plant height at anthesis (H1), plant height at harvest (H2), biological yield (BY), and harvest index (HI) exhibited medium range of variation. The lowest variation was recorded for seed yield (Table 1).

The Euclidian non hierarchical cluster analysis resulted in formation of four clusters based on the similarity among the constituent parameters. Cluster III was found to be biggest containing 28 morphological accessions

Table 1. Cluster mean, standard deviation and coefficient of variation (%) for seven characters in soybean

Characters	Mean	SD	CV (%)
Plant height (H1)	27.34	3.61	14.83
Plant height (H2)	31.14	3.85	12.36
Plant height (H2-H1)	3.73	1.86	49.86
Degree of indet. (DDh)	11.73	5.61	47.82
Biological yield (BY)	63.13	9.26	14.67
Seed yield (SY)	37.91	2.11	5.56
Harvest index (HI)	23.86	3.30	13.83

(Table 2). Cluster IV, which contained 13 accessions, was found to be comprising most promising accessions as demonstrated by high average degree of indetermination (16.08), biological yield (75.54) and harvest index (27.71). In cluster IV, highest variability among the genotypes was also recorded indicating further scope of selection within the said cluster (Table 3). Clusters I and II containing 12 and 7 accessions, respectively, differed mainly for average degree of indetermination, growth during reproductive phase and biological yield. Clusters II and III with semi-determinate growth pattern recorded the low biological yield in comparison to cluster I and IV, but produced high seed yield resulting in high harvest index. These results supported by studies of Ablett (1988) and Ablett *et al.* (1989) demonstrated that selection of genotypes with semi-determinate growth habit could result in development of high yielding soybean lines under semi-sodic soil conditions.

The average distance between cluster centroids represent the extent of diversity between the two clusters. In this study, clusters I and II were found to be most divergent (3.554) that could easily be traced to the difference in their average degree of indetermination. The other notable distances between cluster centroids were observed for clusters I and IV (3.526) and clusters II and III (3.467) which could readily by identified due to differences in average degree of indetermination and growth during reproductive phase, respectively (Table 4).

Average distance of cluster numbers from cluster centroid was recorded to be maximum in cluster II (2.168), indicating the within cluster diversity for future exploitation in selection programmes (Table 4). All the other clusters viz. I, III and IV exhibited the same degree of distance of cluster members from cluster centroids. Cluster II which comprised accessions having desired semi-determinate growth habit and maximum within cluster diversity, should be utilized in future breeding programme for developing high yielding soybean lines for semi-sodic soil conditions.

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Table 2. Clustering pattern based on Euclidian cluster analysis over growth pattern

Clusters	Growth habit	No. of genotypes	Populations
I	Determinate	12	UPSL254, 343ch, 425, 443, 555, 601,UPSM593, JS79-20 71-05, 87-59, L-1596, UPSE2048
II	Semi-determinate	7	UPSE2683, 2703, UPSL216, 326, 785, 796, UPSM651
III	Semi-determinate	28	UPSL29, 62, 92, 117B, 152, 272, 284, 298, 319, 365, 788, 858, UPSM20, 42, 68, 164, 657, 802, 853, 889, 1030A, 1034, UPSV 65A, 37, UPSM1090A, AGS99, UPSL181
IV	Indeterminate	13	UPSL1171, UPSM181, 858, 1099, 1115, PK308, 317, UPSL160, UPSM1705, 1094A, SL-3UGM-34, UPSL470

Table 3. Mean and standard deviation of four clusters for seven characters

Cluster No.	Plant height (HI) (cm)	Plant height (H2) (cm)	Plant height (H2-H1) (cm)	Degree of indetemination	Biological yield	Seed yield	Harvest index
I	30.30 (1.78)	31.52 (1.83)	1.22 (0.69)	3.85 (2.120)	65.88 (7.63)	37.21 (2.27)	24.43 (2.42)
II	32.85 (2.10)	38.19 (3.37)	5.33 (1.80)	13.78 (3.57)	6.147 (9.12)	39.23 (1.73)	24.15 (3.94)
III	25.16 (2.40)	28.93 (2.79)	3.77 (1.19)	12.56 (4.15)	56.53 (3.92)	38.44 (2.04)	21.76 (2.09)
IV	26.33 (2.72)	31.74 (2.37)	5.10 (1.40)	16.08 (4.38)	75.54 (3.78)	36.70 (1.64)	27.71 (1.99)

Table 4. Average distance of cluster members from cluster centroid and distances between cluster centroids

Clusters	I	II	III	IV
I	1.687			
II	3.554	2.168		
III	2.959	3.467	1.802	
IV	3.526	3.340	3.112	1.720

Diagonal values are average distances of cluster members from cluster centroids.

References

Ablett GR (1988) Agronomic performance in indeterminate, semi-determinate and determinate soybeans [*Glycine max* (L.) Merr.] [Abstract]. Dissertation Abstracts International, B (Sciences and Engineering), 48 (8), 2165B (En.) University of Guelph, Ontario NIG 2WI, Canada.

Ablett GR, WD Beversdorf and VA Dirks (1989) Performance and stability of indeterminate and determinate soybean in short-season environments. *Crop Sci.* **29:** 1428-1433.

AVRDC (1976) Mungbean report for 1975, Shanhua, Taiwan, 72p.

Beale EML (1969) Euclidian cluster analysis. Paper presented at the 37th session of the International Statistical Institute, UK.

Chinchilla RG, SP Carrilo, DO Agudelo and H Rojas (1988) Evaluation of soybean [*Glycine max* (L.) Merr.] cultivars with different growth habits according to irrigation level. *Acta Agronomica* **38:** 7-22.

Lampang AN, S Pichitporn, S Sirisingh and N Vanakijmongkol (1988) Mungbean growth pattern in relation to yield. In: Mungbean Proceedings of the Second Int. Symp. at Bangkok, Thailand. AVRDC Pub. No., **88:** 164-168.

Parvez AQ, FP Gardner and KJ Boote (1989) Determinate-and indeterminate -type soybean cultivar prepossess to pattern, density and planting date. *Crop Sci.* **29:** 150-157.

Spark DN (1973) Euclidian cluster analysis algorithm. *Appl. Stat.* **22:** 126-130.