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Genetic Variability Analysis in Different Genotypes of Soybean (*Glycine max* (L.) Merrill)

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Abstract: Twenty eight soybean genotypes were evaluated for eleven morphological characters during December, 2011 at Sher-e-Bangla Agricultural University, Dhaka, Bangladesh. The experiment was conducted to estimate the genetic variability in different soybean genotypes. The results of analysis revealed that all the characters like days to first flowering, days to 50% flowering, days to maturity, plant height (cm), number of branches per plant, number of pods per plant, pod length (cm), number of seeds per pod, seeds per plant, hundred seed weight (g) and seed yield per plant (g) were significantly affected due to various soybean genotypes. The days to first flowering ranged from 51.67 to 76.33, days to 50% flowering from 55.33 to 79.00, days to maturity from 105.33 to 132.00, plant height from 21.90 to 79.87 cm, number of branches per plant from 1.80 to 5.87, number of pods per plant from 24.62 to 59.57, pod length from 2.53 to 4.19 cm, number of seeds per pod from 2.37 to 2.66, seeds per plant 60.70 to 158.37, hundred seed weight from 6.27 to 16.57 g and seed yield per plant from 5.73 to 17.40 g. The genotypes F-85-11347, MTD-451, CHINA-1, PI-4174-75 and YESOY-4 remained the best among twenty eight genotypes studied in terms of studied traits. It was suggested that these superior lines may be focused and involved in future breeding programme for developing new high yielding soybean variety.

Key words: Agronomic Characters · Genetic Variation · Soybean · Yield

INTRODUCTION

Soybean (*Glycine max* (L.) Merrill) is a wonderful crop gifted by the nature to mankind which is one of the richest sources of oil as well as protein. It grows well in different regions of the world, especially in the tropical to the mid temperate zones. About 71 thousand hectares of land in the Bangladesh is under cultivation of soybean and annual production is approximately 135 thousand tons [1]. It is belongs to the family Leguminosae and is a self-pollinated crop having chromosome number 2n=40. It contains about 40 to 42% protein and 18 to 22% oil [2]. The present nutritional situation of third world and some developing countries like Bangladesh is a matter of great concern since the most of the people are suffering from malnutrition. Soybean plays an important role in this case and can help to meet up the nutritional deficiency problem. Soybean could be regarded as an ideal food for the people of poor and developing countries as it contains high quality of protein and reasonable quantity of oil as a source of energy [3]. Because of a good source of protein, unsaturated fatty acids, minerals like Ca and P including vitamin A, B, C and D, soybean can meet up different nutritional needs [4]. Soy protein products can be good substitutes for animal products because, soybean offers a 'complete' protein profile and can effectively replace animal-based health hazardous foods [5]. Moreover, soybean also contain numerous compounds that act as antioxidant and are beneficial to human health as they diminish the risk of cardiovascular diseases, breast cancer, osteoporosis, diabetes and neurodegenerative diseases such as Alzheimer's and Parkinson's and reduce the menopausal symptoms [6]. Being a leguminous crop it improves the soil by fixing the

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atmospheric nitrogen through Rhizobium bacteria that lives in root nodules [7, 8]. In addition, soybean is a very suitable crop to fit into the cropping systems of Bangladesh.

Considering the potentiality of this crop, there is a need for improving and developing varieties suited to specific agro-ecological conditions and also for specific end use. The low yield of soybean in Bangladesh and developing countries is the main constrain for growing of soybean. Therefore, breeders should emphasize on yield improvement of soybean. In order to increase yield, genetic variability is the prerequisites since it is the source of variation and raw material for yield improvement work [9]. Assessment of genetic variability is also needed for efficient parent selection in breeding program, long term selection gain and exploitation of heterosis [9].

Therefore, the study was undertaken to assess the genetic variability and evaluate the performance of different genotypes of soybean.

MATERIALS AND METHODS

The study was conducted to assess the morphogenetic divergence among twenty eight soybean genotypes. The experiment was carried out during December, 2011 to April, 2012 at the field laboratory of Sher-e-Bangla Agricultural University, located at 23° 77′ N latitude, 90° 33' E longitude at an altitude of 8.6 m above sea level in Dhaka, Bangladesh. Experimental material consisting of twenty eight genotypes were sown in randomized complete block design with three replications; each plot consisted of a single row of 3m long with row to row distance of 50cm maintaining 10 plants per meter. Sowing was done with the help of hand drill. Ten random plants were used to take the data on days to first flowering, days to 50% flowering, days to maturity, plant height, number of branches per plant, number of pods per plant, pod length, number of seeds per pod, seeds per plant, hundred seed weight and seed yield per plant from each plot of each replication. All intercultural operations were carried out following standard procedures as described by Mondal *et al.,* [10]. The data were analyzed by Mahalanobi's D^2 statistics, principle component analysis, principle coordinate analysis and canonical variate analysis.

The data were subjected to statistical manipulation for the analysis of variance through computer's software M-Stat-C using the formula of Steel and Torrie [11]. The significant data were further analyzed statistically using Least Significant Difference (LSD) test at 5% probability level to compare the differences among the genotype means.

RESULTS AND DISCUSSION

The results of analysis of variance regarding various plant traits are given in Table 1. From this table it was found that in replication only days to first flowering and number of pods per plant showed significant differences, but varieties showed significant variation for all eleven characters studied.

Means regarding different plant traits and their comparison are given in Table 2. The days to flowering ranged from 51.67 to 76.33. The line Australia was found early as it completed flowering in 51.67 days and genotype F-85-11347 was late and took 76.33 days to first flowering. Similar results were found in case of line Australia for days to 50% flowering and days to maturity required minimum 55.33 days and 105.33 days, respectively and in case of line F-85-11347 for days to 50% flowering maximum 79 days and maturity required maximum 132 days. Also other lines BS-13, JOYAWAZA, BOAS-5, LG-92P-12-18 and PI-4174-75 required maximum 132 days to maturity.

Plant height is an important trait in erect type soybean and usually positively correlated with yield [12]. The present results revealed that plant height was highly significant affected among soybean genotypes. The plant height ranged from 21.90 to 79.87 cm. The tallest plant was observed with line MTD-451 (79.87 cm) followed by BOAS-5 (79.43 cm) and BARI soybean5 (79.17 cm). The lowest plant height was observed with AUSTRALIA (21.90 cm) followed by SHOHAG (34.60 cm). Similar results were reported by Baranek *et al.* [13], Salimi *et al.* [14] and Youseif *et al.* [15] also showed highly significant variability in plant height in various soybean genotypes.

The number of branches is the most important yield component in soybean. The effective and fruit bearing branches are plays an important role in enhancing the final yield. The number of branches varies from genotype to genotype depending upon genetic potential of a variety. In present study the number of branches was significantly affected by the various genotypes. The highest number of branches (5.87) was produced by MTD-451 followed by KANH-33 (5.77) and F-85-11347 (5.67). Similarly SHOHAG and PK-327 had shown very poor performance by showing only 1.80 and 1.87.

Table 1: Analysis of variances of eleven yield and yield related characters of soybean

		Mean sum of square										
SOV	df	DFF	D50%F	DM	PH	BPP	NPP	PL	NSP	SPP	HSW	SYP
Replication	2	1.87**	1.87	00.0	5.57	0.34	21.01*	0.002	0.005	63.42	0.04	0.77
Treatment	27	114.21**	109.32**	151.89**	734.54**	4.67**	272.21**	0.396**	0.016**	1862.98**	15.21**	31.03**
Error	54	0.29	0.87	0.04	4.77	0.11	5.58	0.003	0.002	27.91	0.07	0.39

** = Significant at 1%.

* = Significant at 5%.

DFF = Days to first flowering, D50%F = Days to 50% flowering, DM = Days to maturity, PH = Plant height (cm), BPP = Branches per plant, NPP = Number of pods per plant, PL = Pod length (cm), NSP = Number of seeds per pod, SPP = Seeds per plant, HSW = Hundred seed weight (g), SYP = Seed yield per plant (g).

Table 2: Mean performance of various growth parameter and yield components of 11 characters of 28 genotypes of soybean

Genotype	DFF	D50%F	DM	PH	BPP	NPP	PL	NSP	SPP	HSW	SYP
AGS-79	67.67	70.67	128.00	44.37	2.77	39.20	2.78	2.39	95.07	8.70	8.57
BS-13	75.67	78.67	132.00	64.20	4.70	35.33	3.00	2.37	86.07	11.47	9.80
JOYAWAZA	75.33	78.67	132.00	65.67	5.20	34.70	2.92	2.47	85.60	7.77	6.73
F-85-11347	76.33	79.00	132.00	73.27	5.67	59.57	3.06	2.66	158.37	10.17	16.13
AGS-95	60.67	64.67	120.00	44.80	3.53	39.97	2.73	2.48	98.07	10.23	10.03
GC-82-332411	62.33	65.67	120.00	44.43	4.07	44.33	2.96	2.66	109.20	9.83	10.60
BOAS-5	72.33	76.00	132.00	79.43	5.17	44.57	2.99	2.45	109.10	10.40	11.23
LG-92P-12-18	72.33	76.00	132.00	73.17	5.67	52.40	3.20	2.56	133.13	9.70	12.77
BS-33	67.33	72.67	128.00	44.80	3.40	40.87	3.13	2.60	93.73	10.30	9.57
GC-830059	66.67	70.33	120.00	68.73	4.43	43.07	2.68	2.51	107.33	6.27	6.77
ASSET-95	57.33	61.33	119.00	63.20	3.47	44.07	2.65	2.47	108.17	6.77	7.23
BARI SOYBEAN-6	59.67	63.33	116.00	58.70	3.83	54.10	3.27	2.52	136.07	11.53	15.60
KANH-33	61.33	63.67	121.00	74.13	5.77	41.70	3.08	2.51	104.40	9.17	9.67
NS-1	69.33	72.67	121.00	65.77	5.53	36.20	3.44	2.55	92.73	10.73	9.90
GMOT-17	67.33	70.67	129.00	67.57	4.53	34.70	2.59	2.54	89.07	6.53	5.83
LG-92P-1176	66.33	69.00	128.00	36.77	2.47	39.67	2.67	2.48	96.80	9.63	9.27
CHINA-1	61.33	64.67	121.00	52.20	4.30	34.07	3.54	2.51	94.91	12.90	12.30
MTD-16	66.33	69.00	125.00	40.47	2.40	27.27	2.53	2.44	67.90	11.57	7.87
SHOHAG	58.67	62.33	110.00	34.60	1.80	29.03	3.06	2.49	72.37	12.17	8.83
PK-327	60.00	63.67	119.00	43.97	1.87	24.70	2.54	2.51	62.20	11.87	8.00
AUSTRALIA	51.67	55.33	105.33	21.90	2.30	26.90	2.75	2.54	66.40	13.33	8.90
YESOY-4	70.67	73.67	131.00	49.03	4.47	26.50	3.13	2.46	66.00	13.17	8.70
PI-4174-75	71.67	75.33	132.00	59.63	4.40	38.10	4.19	2.61	102.97	16.57	17.40
MTD-452	70.67	74.33	131.00	47.00	4.63	25.60	3.10	2.43	63.87	11.17	7.10
86017-66-6	65.67	68.33	125.00	44.17	3.27	24.62	2.86	2.49	60.70	9.40	5.73
ASSET-93-19-13	69.33	72.00	127.33	71.83	4.10	45.67	3.13	2.58	117.60	9.53	11.00
BARI SOYBEAN-5	59.00	63.67	116.33	79.17	5.77	49.43	3.15	2.41	122.40	9.87	12.07
MTD-451	69.33	73.33	127.00	79.87	5.87	50.80	3.57	2.47	131.10	13.00	16.90
Mean	66.15	69.60	124.29	56.89	4.12	38.83	3.03	2.51	97.55	10.49	10.16
Minimum	51.67	55.33	105.33	21.90	1.80	24.62	2.53	2.37	60.70	6.27	5.73
Maximum	76.33	79.00	132.00	79.87	5.87	59.57	4.19	2.66	158.37	16.57	17.40
CV%	0.81	1.34	0.15	3.84	8.21	6.09	1.69	1.8	5.42	2.48	6.17

DFF = Days to first flowering, D50%F = Days to 50% flowering, DM = Days to maturity, PH = Plant height (cm), BPP = Branches per plant, NPP = Number of pods per plant, PL = Pod length (cm), NSP = Number of seeds per pod, SPP = Seeds per plant, HSW = Hundred seed weight (g), SYP = Seed yield per plant (g).

Table 3: Z1-Z2 score of 28 genotypes of soybean

Genotype	PCA 1	PCA 2
AGS-79	7.02	4.22
BS-13	5.84	-19.42
JOYAWAZA	5.99	-20.71
F-85-11347	-66.66	3.78
AGS-95	5.37	13.58
GC-82-332411	-5.39	17.33
BOAS-5	-22.56	-17.03
LG-92P-12-18	-42.56	-3.58
BS-33	7.25	3.17
GC-830059	-14.2	-2.1
ASSET-95	-11.56	9.19
BARI SOYBEAN-6	-36.76	23.36
KANH-33	-13.1	-2.4
NS-1	0.83	-8.54
GMOT-17	3.61	-13.34
LG-92P-1176	8.86	10.77
CHINA-1	6.44	6.51
MTD-16	35.65	-2.18
SHOHAG	35.76	15.26
PK-327	40.91	0.35
AUSTRALIA	48.09	27.97
YESOY-4	32.73	-14.25
PI-4174-75	-7.19	-7.01
MTD-452	35.7	-14.25
86017-66-6	41.11	-7.06
ASSET-93-19-13	-25.95	-4.54
BARI SOYBEAN-5	-32.44	5.0
MTD-451	-42.79	-4.06

branchesper plant, respectively. These results are in harmony with the findings of Oz *et al*. [16] and Malik *et al*. [17], who reported that number of branches showed significant variation in different soybean genotypes.

Pod length (cm) and number of seeds per pod are very important yield parameters for soybean. Both pod length and number of seeds per pod were highly significantly affected among soybean genotypes. The pod length was ranged from 2.53 to 4.19 cm. The longest pods was found at genotype PI-4174-75, followed by some genotypes namely MTD-451, CHINA-1 and NS-1 with a pod length of 3.57, 3.54 and 3.44 cm, respectively. Similarly, the highest number of seeds per pod was recorded with genotype F-85-11347 with an average 2.66 seeds per pod, while the line BS-13 was observed with less number of seeds 2.37 in individual pods. Earlier findings of Sirohi *et al*. [18] also showed significant variability in pod length and number of seeds per pod in various soybean genotypes.

In the present study seeds per plant was ranged from 60.70 to 158.37. The highest seeds per plant was noticed at F-85-11347, followed by BARI soybean 6 and LG-92P-12-18 with an average 158.37, 136.07 and 133.13, respectively, while the lowest seeds per plant was found with 86017-66-6.

Seed weight is an important yield parameter and is vary from genotype to genotype. In the present study 100 seeds weight (g) ranged from 6.27 to 16.57 g. Genotype PI-4174-75 showed maximum 100 seeds weight (16.57 g), while the minimum (6.27 g) was produced by GC-830059. Similarly AUSTRALIA and YESOY-4 (13.33 and 13.17 g, respectively) were also recorded superior genotypes with high seed weight.

Seed yield being complex trait is highly influenced by various environmental factors including biotic and a biotic factors. It is also interplay of various morphological characters which either favor or worsen the final yield. Seed yield was found to be highly significantly different

due to different soybean genotypes. The genotype PI-4174-75 superseded all the genotypes with highest yield of 17.40 g per plant. It was closely followed by another high yielding line MTD-451 with seed yield of 16.90 g per plant. The genotype 86017-66-6 and GMOT-17 showed poor performance in this experiment producing only 5.73 and 5.83 g of seed yield per plant respectively. It was further observed that the lines with highest seed weight and more pod numbers had produced higher seed yield. These findings are in accordance with the results of Oz *et al*. [16], Malik *et al*. [17] and Sirohi *et al*. [18].

Contribution of Genotypes Towards Diversity: Genetic diversity is very much important factor for any hybridization program aiming at genetic improvement for yield especially in self pollinated crops [9]. The genotypes contributing maximum to the divergence are given greater emphasis for deciding on the cluster for hybridization. Contribution of genotypes towards divergence obtain from Coefficient of Variation (CVA) is presented in Table 3, where the values of Principal Component Analysis (PCA 1 and PCA 2) revealed that contribution of AGS-79 followed by AGS-95, BS-33, LG-92P-1176, CHINA-1, SHOHAG, PK-327 and AUSTRALIA were found prominent to the total divergence. In PCA 1, the other important genotypes responsible for differentiation were BS-13, JOYAWAZA, NS-1, GMOT-17. MTD-16, YESOY-4, MTD-452 and 86017-66-6, while in PCA 2, the F-85-11347, GC-82-332411, ASSET-95, BARI soybean5 and BARI soybean6 were important.

CONCLUSION

Most of the genotypes showed highly significant variations among the traits and the variations could be used in plant improvement program. Based on the results of this experiment, it may be concluded that breeding program can be undertaken selecting F-85-11347, MTD-451, CHINA-1, PI-4174-75 and YESOY-4 as parental genotypes following by selection of superior segregants from the successive generations. Therefore, emphasis should be given on these genotypes during selection in breeding program in order to increase seed yield.

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