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Genetic Variability, Heritability and Genetic Advance of Yield and Related Traits of Soybean (*Glycine max* L.)

M.A. Hossain, S. Naz and L. Rahman
Department of Genetics and Plant Breeding, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

Abstract

Forty-five soybean genotypes collected from BAU-USDA soybean research project were used to study their performance, genetic variability, heritability and genetic advance for six characters viz. days to maturity, plant height, first pod setting height, pods/plant, 100 seed weight, and seed yield/plant. Significant variations were observed among the genotypes for all the characters studied. Genotypic and phenotypic variations were highest for plant height and pods/plant. Characters like days to maturity, 100 seed weight, plant height, first pod setting height, pods/plant and seed yield/plant showed high heritability. The highest genetic advance associated with highest heritability value for plant height and pods/plant suggests a good scope for selection for these characters to increase the productivity of soybean.

Keywords: Variability, heritability, genetic advance and soybean

Introduction

Soybean (*Glycine max* (L.) is an important and well recognized oil seed and grain legume crop of the world. Soybean called "Golden bean" or "Miracle bean" or "Protein hope of future" is now being cultivated and consumed in Bangladesh. Soybean contains higher amounts of both oil and protein than any other legume crops. Soybean seed contains about 40-45% protein and 18-20% oil and provides around 60% of the world supply of vegetable protein and 30% of the oil (Fehr, 1989). For this reasons soybean today is recognized as one of the most important agricultural crops of the world. Soybean is being cultivated in Bangladesh as a minor crop and little attention has been given on the improvement of its yield. In Bangladesh the average yield of soybean is very low in comparison with other soybean growing countries of the world. Low production and acreage of soybean in Bangladesh result from lack of high yielding genotype, poor technological intervention during production, competitions for a place in the existing cropping pattern and food habit. This shortcoming can be overcome by the development of high yielding varieties with wider adaptability and stability. Therefore the development of high yielding varieties of soybean is essential to compete economically with other corps as well as to gear up the production trend of this corp.

The basic key to bring about the genetic improvement to a crop is to utilize the available or created genetic variability. If the variability in the population is largely due to genetic causes with least environmental effects it is easy to isolate superior soybean genotypes to improve yield. A critical review of genetic variability is therefore perquisite for planning and evaluation of a breeding program. This is difficult to judge what proportion of the observed variability is heritable and what proportion is non-heritable. The process of breeding in such population is primarily conditioned by the magnitude and nature of interaction of genotype and environment variations in plant characters. It becomes necessary to partition the observed variability into its heritable and non-heritable components and to have an understanding of parameters such as genetic co-efficient of variation, heritability and genetic advance. Johnson *et al.*, (1955) suggested the necessity of estimating genetic advance along with heritability in order to draw a more reliable conclusion in a selection program. The present study was undertaken to achieve the following objectives:

i) to estimate variability for yield and yield contributing traits among the soybean genotypes;
ii) to estimate heritability and genetic advance of yield and yield contributing characters; and
iii) to construct a suitable selection criterion for higher seed yield in soybean.

Materials and Methods

The experiment was conducted at the experimental farm of the Department of Genetics and Plant Breeding, Bangladesh Agricultural University, Mymensingh, during the period of September to December 2003 using 45 soybean genotypes. Soil of the experimental plot was silty loam in texture and it was medium high land belonging to old Brahmaputra floodplain with soil pH 6.81. Seeds of the soybean genotypes were collected from the BAU-USDA soybean research project. The experiment was laid out in RCBD design with three replications. The unit plot size was 3m × 1.8m. The seeds were sown in lines keeping row-to-row distance 30 cm and 5 cm between seeds within rows. Fertilizers were applied at recommended doses. Other intercultural operations were done as and when necessary. Ten plants from each plot were randomly selected for recording and observation. The characters studied were days to maturity, plant height (cm), first pod setting height (cm), pods/plant, 100 seed weight (g) and seed yield/plant (g).

The data were analyzed to estimate genotypic (S^2g) and phenotypic (S^2p) variances following Burton and De Vane (1953). Genotypic co-efficient of variation (GCV) and phenotypic co-efficient of variation (PCV) were computed according to Burton (1952). Heritability in Brood sense (h^2b), genetic advance (GA) and genetic advance in percentage of mean were estimated using the methods of Johnson *et al.* (1955).

Results and Discussion

Analysis of variance showed significant variations among the genotypes for all the characters studied (Table 1). The men value (Table 2) exhibited that genotypes Gaurab required least day's (80.67) to mature followed by Columbus, G-2120 and Forest whereas the genotype NS-1 required maximum day's (133.3) to mature. The highest plant height (103.20 cm) was observed in the genotype MTD-469 followed by MTD-176 and ST-2 and the lowest (24.51 cm) in PK-472. The highest first pod setting height (28.17 cm) was observed in the genotype MTD-176 followed by MTD-178 and the lowest (4.88 cm) observed in the genotype PK-472. Maximum number of pods/ plant (57.80) was produced in the genotype Amber followed by Samantarosa, PK-472 and BS-60 whereas Rehimc produced the lowest (13.00). The highest 100 seed weight (24.40 g) was observed in the genotype AGS-190 followed by Asset-93-19-6, AGS-297 and PK-472. Maximum seed yield /plant (8.39g) was recorded in the genotype AGS-302 followed by CM-60, LG-92p-1819, Shohag and NS-1 and the lowest (2.21g) in the genotype Minahai.

Table 1. Analysis of variance (MS) for yield and different yield contributing characters of soybean

Characters	Sources of variation		
	Replication (df 2)	Genotype (df 44)	Error (df 88)
Days to maturity	2.54	455.31**	2.05
Plant height	5.86	859.01**	6.57
First pod setting height	0.46	58.13**	0.67
Pods/plant	3.73	325.76**	12.04
100 seeds weight	0.99	47.96**	0.31
Yield/Plant	1.72	6.86**	0.34

** Significant at 1% level of probability

The estimated genetic parameters regarding variability and heritability for yield and different yield contributing characters are presented in Table-3. Highest genotypic and phenotypic variation was found in plant height and pods/plant. Similar results were also observed by Chowdhury *et al.*, (1994) and Rahman *et al.*,(1996) Low magnitude of s^2g and s^2p was found in yield/plant. The highest GCV (35.80) was found in 100 seed weight followed by plant height (33.03), first pod setting height (31.66), no of pods/plant (30.26) and yield/plants (29.15). Similar results were also obtained by Mehetre *et al.*, (1998) and Bhandarkar (1999). The high GCV of these traits indicated the possible scope for effective selection. In contrast, low value of GCV for days to maturity (11.98) indicated low genetic variability and limited scope for improvement. Furthermore low difference between GCV and PCV for days to maturity, plant height, first pod setting height, pods/plant, 100 seed weight and yield/plant indicates little environmental influences on the expression of these characters. Chowdhury *et al.*, (1994) and Rahman *et al.*, (1996) had also observed lower environmental effects on these characters in soybean.

Heritability is important in selecting out a character for improvement. High heritability was observed for days to maturity (98.65) followed by 100 seed weight, plant height, and first pod setting height, pods/plant and seed yield/plant. These results agree with the findings of Bhandarkar (1999), Mehetre *et al., (1998)* Chowdhury *et al.,* (1994), Islam *et al.,* (1991), Begun and Alam (1990), Rahman *et al.*, (1996))

Highest genetic advance was recorded for plant height (34.33) followed by days to maturity (21.25), pods/ plant (19.95) and 100 seed weight (8.13). Thus selection based on these characters for the improvement of yield would be more effective. Highest expected genetic advance in percentage of mean was observed for 100 seed weight (73.05), followed by plant height (67.27), first pod setting height (64.12), pods/plant (59.03) and yield/plant (55.83)

Table 2. Mean performance of 45 soybean genotypes for different characters

Genotypes	Days to maturity	Plant height (cm)	First pod setting height (cm)	Pods/plant	100 Seeds Weight (g)	Yield/ Plant (g)
AGS – 297	107.30 f-g	41.01 l-q	13.83 g – j	42.70 d-g	16.63 b – c	3.87 l – o
AGS – 276	105.70 g-h	60.38 e-f	11.65 l – m	35.60 g – o	5.66 t	3.31 n – p
AGS – 129	103.30 h	60.88 e-f	13.71 g – j	36.13 g – n	5.87 t	4.25 k – n
AGS – 302	111.00 d-e	49.76 h-i	9.74 n	39.04 e – j	11.70 i – m	8.39 a
AGS – 190	111.70 d-e	37.23 o-r	12.76 h – l	38.47 e – k	24.40 a	5.69 e – i
AGS – 95	110.30 d-f	74.54 d	17.65 d – e	24.99 q – w	11.34 j – n	2.96 o – p
MTD – 459	88.33 l- m	62.99 e	16.86 d – e	30.25 l – s	15.10 e – f	3.57 m – o
MTD – 451	91.60 j-k	56.80 f-g	12.90 h – l	37.13 f – m	12.44 h – j	6.16 b – h
MTD – 65	97.30 l	61.79 e-f	20.39 b	29.87 m – t	12.27 h – k	5.76 e – i
MTD – 176	97.60 l	91.09 b	28.17 a	23.93 r – x	12.38 h – k	5.69 e – i
MTD – 469	99.00 I	103.2 a	21.14 b	23.43 s – x	12.78 h – i	6.40 b - g
MTD – 16	110.30 d-f	74.89 d	20.04 b – c	30.38 l – s	11.29 j – n	5.13 h – k
MTD-9	112.70 d-e	62.34 e	14.99 f – g	41.61 d – h	13.47 g – h	5.76 e – i
MTD – 178	105.70 g-h	63.96 e	21.22 b	42.87 d – g	16.25 c- e	5.98 c – h
ASET – 93-19-6	89.33 k-l	51.62 g-h	16.22 e – f	25.33 q – v	17.56 b	5.83 d – i
GC – 82341-14-2	111.30 d-f	73.62 d	11.72 k – m	34.34 h – p	10.98 l – o	6.51 b – f
MTD – 6	105.70 g-h	63.15 e	18.43 c-d	40.20 e-i	15.91 c- e	6.94 b-e
LG – 92P – 1819	120.30 b-c	56.33 f-g	6.18 o	37.00 f – m	15.47 c – f	7.20 a – c
G – 2120	82.67 n-p	41.76 k-p	12.44 j – l	27.40 p – v	5.41 t	3.74 l – o
Forest	85.67 m-n	28.45 t-u	9.74 n	31.75 j – q	9.86 o – r	3.34 n - p
Gaurab	80.67 p	40.31 m-q	14.38 g – i	33.93 i – p	5.45 t	3.72 l – o
Kadsing	85.67 m-n	31.78 r-t	9.21 n	38.93 e – j	5.61 t	3.65 m – o
Minahai	85.00 n-o	44.04 j-n	12.21 j – l	21.45 u – x	6.03 t	2.21 p
Rihime	110.00 d-e	29.36 t-u	13.46 g – k	13.00 y	9.72 p – r	5.18 g – k
Colombus	82.00 o-p	45.69 i-m	10.18 m – n	37.47 f – l	4.96 t	2.94 o – p
Gaism	85.67 m-n	39.63 n-q	9.19 n	48.95 b – d	8.85 r	4.92 h – l
NS – 1	133.30 a	44.90 i-n	14.42 g – h	29.07 n – t	9.86 o – r	7.06 b – d
BS – 3	82.67 n-p	31.30 s-t	12.13 j – l	33.03 i – p	9.73 p – r	6.01 c – h
BS – 29	105.70 g-h	39.89 n-q	16.41 e – f	20.60 v – x	15.36 d – f	5.72 e – i
BS – 60	105.00 g-h	46.01 i-l	8.69 n	51.70 a – c	9.12 q – r	6.81 b – e
BR – 33	111.00 o-e	51.66 g-h	13.15 h – l	20.93 v-x	10.73 m – p	3.69 l - o
Davis	103.30 h	35.61 q-s	13.81 g – j	17.20 x-y	12.08 i – l	2.92 o – p
Shillagood	99.33 I	29.52 t-u	10.27 m – n	31.17 k – r	10.87 m – p	5.52 f – j

Table 2 contd.

Genotypes	Days to maturity	Plant height (cm)	First pod setting height (cm)	Pods/plant	100 Seeds Weight (g)	Yield/ Plant (g)
PK – 5	99.00 I	47.12 h-k	13.04 h – l	17.87 w – y	12.46 h - -j	2.86 o – p
AC C – 1222	92.67 j	36.60 p-s	13.38 g – l	22.60 t – x	5.41 t	2.77 o – p
BAU – 20	96.67 I	49.52 h-j	12.32 j – l	33.07 i – p	7.52 s	3.81 l – o
Amber	104.30 g-h	52.12 g-h	12.82 h – l	57.80 a	8.69 r – s	5.27 f – k
Shohag	104.70 g-h	41.37 l-p	9.30 n	43.93 d – f	10.72 n – q	7.06 b – d
ST – 2	105.30 g-h	83.57 c	19.49 b – c	28.67 o – u	8.74 r	4.23 k – m
PK – 472	121.00 b	24.51 u	4.88 o	54.00 a – b	16.51 b – d	5.97 c – i
MACS – 57	109.70 e-f	40.78 l-q	16.36 e – f	23.27 s – x	11.22 k – n	4.72 i – m
SJ – 5	113.30 d	42.74 k-o	12.63 i – l	44.93 c – e	10.16 n – q	5.69 e – i
CM – 60	112.00 d-e	44.24 j-n	8.64 n	36.40 g – n	14.48 f – g	7.27 a - b
Samantarosa	121.30 b	49.27 h-j	13.79 g-j	54.80 a – b	11.42 j – m	6.48 b – f
Kerater	117.30 c	59.00 e-f	18.33 c-d	33.67 i – p	8.87 r	4.38 j - n
Mean	**102.54**	**51.02**	**13.82**	**33.79**	**11.03**	**5.05**
Range	**133.3-80.6**	**103.2-24.5**	**28.1-4.8**	**57.8-13.0**	**24.4-4.9**	**8.3-2.2**
CV(%)	**1.40**	**5.02**	**5.92**	**10.27**	**5.02**	**11.51**

Table 3. Genetic parameters of six different characters of the soybean genotypes

Genetic parameters	Days to maturity	Plant height (cm)	First pod setting height (cm)	Pods/ plant	100 seed weight (g)	Seed yield/ plant (g)
Genotypic variance (S^2g)	151.08	284.14	19.15	104.57	15.88	2.17
Phenotypic variance (S^2p)	153.14	290.71	19.82	116.61	16.19	2.51
Genotypic co-efficient of variation (%)	11.98	33.03	31.66	30.26	35.80	29.15
Phenotypic coefficient of variation (%)	12.06	33.41	32.21	31.96	36.15	31.35
Heritability in broad sense (%)	98.65	97.74	96.59	89.66	98.07	86.45
Genetic advance	25.15	34.33	8.86	19.94	8.13	2.82
Genetic advance in percentage of mean	24.52	67.27	64.12	89.03	73.05	55.83

Hanson (1961) reported that heritability and genetic advance are complementary. Therefore heritability and genetic advance should be considered together for making an effective selection. In the present study, plant height and pods/plant had high heritability with high genetic advance and also high genetic advance in percentage of mean compared to other yield contributing character. Similar results were also obtained by Rajput and Sarwar (1988). This indicates the possibility of involvement of additive gene effects in controlling these characters and suggesting good response through continued selection. Days to maturity, first pod setting height, 100 seed weight and seed yield/plant had high heritability with considerable genetic advance and genetic advance in percentage of mean, indicating that direct selection of these characters should be moderately effective.

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References

Bagum, H. and Alam, S. 1990. Variability, character association and path analysis in soybean (*Glycine max* (L.) Merrill). Bangladesh J. Plant. Genet. 3 (1&2): 77-80.

Bhandarkar, S. 1999. Studies on genetic variability and correlation analysis in soybean (*Glycine max* (L.) Merrill). Mysore Journal of Agricultural Sciences. 13 (3): 130-132

Burton, G.M. 1952. Quantitative inheritance in grasses. Prc.6Th Int. Grassland Cong. 1: 277-283.

Burton, G.M. and De Vane, E.H. 1953. Estimating heritability in tall fescue (*Festuca arundinacea*) from replicated clonal material. Agronomy J. 45: 478-481.

Chowdhury, M.A.Z., Uddin, M.J., Pandit, D.B. and Badrul Ahsan, A.T.M. 1994. Genetic parameters, inter-relationship and path co-efficicnt analysis in soybean (Glycine max (L). Merr) Bangladesh J. Plant Breed. Genet. 7 (2): 61-64.

Fehr, W.R. 1989. Soybean. In oil crops of the world by Robbelin, G. Downey, R.K. and Ashri, A. Mc Graw Hill publishing Comp. London

Ghatge, R.D. and Kadu, R.N. 1993. Advances in plant Sciences. 6 (2) : 224-228

Hanson, W.D. 1961. Heritability, Statistical Genetics and Plant Breeding. National Academy of Science. National Research Council, washington. PP. 125-140.

Islam, M.S., Khan, S., Shaha, S.R. and Hossain, S.M.M. 1991. Variability genetic parameters and correlation in vegetable soybean (*Glycine max* (L.) Merrill). Bangladesh J. Plant. Breed. Genet. 41 (1-2): 41-44.

Johnson, H.W., Robinson, H.F. and Comstock, R.F. 1955. Genotypic and phenotypic correlation in Soybean. Agronomy J. 47: 477-483.

Mehetre, S.S., Shinde, R.B., Borle, V.M. and Surna, P.D. 1998. Studies on variability, heritability and genetic advance for some morpho-physiological traits in Soybean (*Glycine max* (L.) Merrill). Advances in Plant Sciences 11(1): 27-31

Rahman, M.M., Kader, M. and Debi, B.R. 1996. Study of variation for yield and yield contributing characters and relation between then in soybean. Progress. Agril.7 (2): 61-64

Rajput, M.A and Sarwar, G. 1998. Induced variability studies in soybean. Soybean-Genetics-News letter. 15(8): 67-73