Genetic variability, heritability and character association for yield and component characters in soybean (G. max (L.) Merrill)

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ABSTRACT

Genetic parameter and correlation of eight quantitative traits including grain yield were studied in thirty one soybean genotypes. Among all the traits, seed yield per plant exhibited highest estimate of PCV (47.74) and GCV (41.83) followed by dry matter weight per plant (PCV=33.99, GCV=31.15) and number of pods per plant (PCV=33.48, GCV=30.16). Heritability was highest for three characters i.e., days to 50 per cent flowering, number of primary branches per plant and 100 seed weight (91%). High heritability coupled with high genetic advance was recorded for number of pods per plant and dry matter weight per plant. Grain yield per plant exhibited highly significant and positive genetic correlation with dry matter weight per plant (r_g=0.491), number of primary branches per plant (r_g=0.403), number of pods per plant (0.631) and harvest index (0.487).

Keywords: Soybean, Variability, Heritability, Correlation coefficient

DETAIL ABSTRACT

The present investigation entitled “Genetic variability, heritability and character association for yield and component characters in soybean (*G. max* (L.) Merrill)” was carried out in thirty one soybean genotypes with following objectives (i) to estimate the variability for different characters, (ii) to estimate the heritability and genetic advance, and (ii) to estimate character association between yield and yield components.

Thirty one soybean genotypes were evaluated at Crop Research Centre, Pantnagar, Uttarakhand, India in Randomized Complete Block Design with two replications. Each genotype was accommodated in experimental plot consisted of 10 rows of 4 m row length and row to row spacing was 60 cm apart. The observations were recorded for eight characters and their mean were subjected to appropriate statistical analysis.

The broad sense heritability estimates were higher for days to 50% flowering followed by 100-seed weight, number of primary branches per plant, dry matter weight per plant, number of pods per plant, harvest index, plant height and seed yield per plant. However, number of pods per plant, dry matter weight per plant, plant height, harvest index and seed yield per plant revealed high genetic advance. The seed yield per plant showed significant genotypic positive correlation with number of pods per plant (0.631), dry matter weight per plant (0.491), harvest index (0.488) and number of primary branches per plant (0.403). These characters were also positively associated with each other.

In conclusion, the study showed the significant differences among genotypes in terms of traits which indicate the existence of genetic variation. Based on the observations derived from this investigation, it is therefore suggested that more emphasis should be given for the improvement of yield components viz. dry matter weight per plant, number of pods per plant, harvest index and seed yield per plant which have shown significant positive correlation. These findings suggest that the characters showing positive correlation could effectively be utilized in crop improvement program and develop new soybean varieties.

Introduction

Soybean (*Glycine max* (L.) Merrill) is considered a miracle crop due to its extraordinary qualities. It contains about 37-42% of good quality protein, 6% ash, 29% carbohydrate and 17-24% oil comprising 85% unsaturated fatty acid with two essential fatty acids (lenoleic and linolenic acid) which are not synthesized by the human body [5], so it is highly desirable in human diet. The health benefits of soy-protein related to the reduction of cholesterol levels, menopause symptoms and reduction in risk for several chronic disease i.e., cancer, heart disease and osteoporosis have been reported. The cholesterol lowering effects of soybean has been attributed to isoflavones [17]. The isoflavones namely daidzein and genistien found in soybean may reduce the risk of a number of cancers [7] and also may help prevent and treat osteoporosis [2]. Soy hull contains approximately 65 per cent dietary fibre and offer a good source of fiber when used in various food applications[21].Being legume it also fixes atmospheric nitrogen to available form. As the best source of protein it truly claims the title “the meat that grows on plant”.

In India, cultivation of soybean has reached about 9.52 million hectare, with the total production of about 9.90 million tones and average productivity of about 1040 kg per hectare in 2008-2009 [10].There is a substantial scope to increase both area and productivity of soybean in India. The crop, which is mainly confined to the central India, could be extended to non-traditional regions. It was already been demonstrated to be a successful crop in north eastern and southern regions for which suitable varieties and production practices have been developed [24].

The presence and magnitude of genetic variability in a gene pool is the pre-requisite of a breeding programme. The knowledge of certain genetic parameters is essential for proper understanding and their manipulation in any crop improvement programme. Genetic parameters like genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability and genetic advance are useful biometrical tools for determination of genetic variability. The grain yield is a complex character, quantitative in nature and an integrated function of a number of component traits. Therefore, selection for yield per se may not be much rewarding unless other yield attributing traits are taken into consideration. Correlation study provides a measure of association between characters and helps to identify important characters to be considered while making elucidates selection. Knowledge of correlation between grain yield and other characters is helpful in selection of suitable plant type. The present investigation was aimed in deciding desirable traits for development of high yielding variety.

Materials and methods

The present investigation was carried out at the Crop Research Centre of G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand. The experimental material was consisted of thirty one soybean genotypes. These genotypes were sown in Randomized Block Design (RBD) with two replications. Each genotype was grown in ten rows of four meter length. Row to row and plant to plant distance was maintained at 60 cm and 5 cm respectively. All the recommended package of practices was followed during the course of experimentation to grow a normal crop. Ten individual plants from each genotype were randomly selected and tagged from each replication for data recording. Data was recorded on whole plot basis for days to 50% flowering where as for plant height, dry matter weight per plant, number of primary branches per plant, number of pods per plant, harvest index, 100-seed weight and seed yield per plant from individual tagged plant. The mean of different characters were calculated on the basis of these individual data recorded for each character in each replication and subjected for statistical analysis. Analysis of variance and variability parameter were estimated following Panse and Sukhatme [16]. Correlation coefficient at genotypic and phenotypic level was computed from the variance and covariance components as suggested by Al-Jibouri et al. [1].

Results and Discussion

Analysis of variance (Table 1) revealed highly significant difference among the genotypes for all the characters studied, indicating the existence of considerable genetic variation in the experimental material.

The estimates of range, mean, genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability and genetic advance are presented in table 2. Considerable range of variation was observed for all the traits under study indicating enough scope for bringing about improvement in the desire direction. Both PCV and GCV estimates were higher for grain yield per plant (47.74/41.83) followed by dry matter weight per plant (33.99/31.15) and number of pods per plant (33.48/30.16).Lowest magnitude of PCV was recorded for days to 50 % flowering (4.55).The difference between PCV and GCV were very small for days to 50 % flowering, number of primary branches per plant and 100 seed weight indicating lesser contribution of environmental variation towards expression of these traits. Thus selection based on phenotypic performance of these characters would be effective to bring about considerable improvement in these characters.

Table 1: Analysis of variance for various yield contributing characters

Source of variance	d. f.	Mean sum of squares Days to 50% flowering	Plant height (cm)	Dry matter weight/ plant (g)	Number of primary branches/ plant	Number of pods/ plant	Harvest index	100-seed weight (g)	Seed yield/ plant (g)
Replication	1	4.12	100.33	335.61	0.03	307.68	32.45	0.52	29.64
Treatments	30	13.50**	372.24**	670.58**	0.84**	1340.21**	171.03**	5.52**	161.61**
Error	30	0.63	45.28	58.33	0.04	139.45	18.45	0.27	21.25

** Significant at 1% level of probability.

Table 2: Estimates of range, mean, coefficient of variation, heritability and genetic advance for quantitative characters.

Characters	Range	GM	SEm	PCV (%)	GCV (%)	h^2 (%)	GA
Days to 50% flowering	52.5 – 62.5	58.35	0.56	4.55	4.34	91.00	4.99
Plant height (cm)	54.25 – 105.0	83.48	4.76	17.30	15.31	78.00	23.30
Dry matter weight/plant (g)	20.05 – 93.17	56.16	5.40	33.99	31.15	84.00	33.03
Number of primary branches/ plant	2.35–4.75	3.66	0.14	18.15	17.29	91.00	1.24
Number of pods/plant	29.55 – 31.00	81.22	8.35	33.48	30.16	81.00	45.46
Harvest index (%)	16.50 – 51.20	35.98	3.04	27.04	24.24	81.00	16.14
100-seed weight (g)	6.73 – 16.08	9.98	0.36	17.04	16.24	91.00	3.18
Seed yield/ plant (g)	6.87 – 42.3	20.02	3.25	47.74	41.83	77.00	15.11

Table 3: Estimates of genotypic (G) and phenotypic (P) correlation coefficients among yield contributing characters.

Characters	Level	Days to 50% flowering	Plant height (cm)	Dry matter wt./ plant (g)	No. of primary branches/ plant	No. of Pods/ plant	Harvest index (%)	100-seed weight (g)	Seed yield/ plant (g)
Days to 50% flowering	G	1.000	0.526**	-0.035	0.183	-0.104	-0.095	-0.552**	-0.059
	P	1.000	0.449*	-0.030	0.177	-0.088	-0.036	-0.499**	-0.043
Plant height (cm)	G		1.000	0.100	0.266	0.244	0.263	-0.217	0.185
	P		1.000	0.090	0.236	0.260	0.243	-0.175	0.289
Dry matter wt./plant (g)	G			1.000	0.506**	0.824**	0.546**	0.245	0.491**
	P			1.000	0.491**	0.735**	0.415*	0.191	0.410*
No. of primary branches/ plant	G				1.000	0.544**	0.609**	0.359*	0.403**
	P				1.000	0.488**	0.529**	0.316	0.334
No. of Pods/ plant	G					1.000	0.597**	0.200	0.631**
	P					1.000	0.456**	0.148	0.511**
Harvest index (%)	G						1.000	0.409*	0.487**
	P						1.000	0.351	0.385*
100-seed weight (g)	G							1.000	-0.009
	P							1.000	0.0004
Seed yield/ plant (g)	G								1.000
	P								1.000

* Significant at 5% level of probability, ** Significant at 1% level of probability.

The estimates of heritability ranged between 77 per cent (seed yield per plant) and 91 per cent (days to 50 % flowering, number of primary branches per plant, 100 seed weight).The estimates of heritability were observed to be high in magnitude for days to 50 % flowering, number of primary branches per plant and 100 seed weight. Similar results were also reported by Chauhan and Singh [9] and Pushpendra and Ram [18]. A moderate value of heritability estimates were recorded for dry matter weight per plant, number of pods per plant, and harvest index.

High genetic advance was observed for the number of pods per plant, dry matter weight per plant and plant height where as low estimates were recorded for the days to 50 per cent flowering, number of primary branches per plant and 100 seed weight.

Similar results were reported by Bains and Sood [4], Rashid and Islam [20], and Mehetre et al. [14]. High heritability does not mean a high genetic advance for a particular quantitative character. Johnson et al. [12] reported that heritability estimates along with genetic gain would be more rewarding than heritability alone in predicting the consequential effect of selection to choose the best individual. High estimate of heritability coupled with high genetic advances were observed for the characters viz., number of pods per plant, dry matter weight per plant and plant height which suggested that these characters can be considered as favorable attributes for the improvement through selection and this may be due to additive gene action Panse [15] and thus, could be improved upon by adapting selection without progeny testing. On other hand number of primary branches per plant, 100 seed weight and days to 50 per cent flowering showed high heritability with low genetic advances revealing the predominance of non-additive gene action.

In the present investigation, the genotypic correlation coefficients were generally higher in magnitude as compared to phenotypic correlation coefficients values (Table 3) for most of the character pairs, indicating a strong inherent association between these characters. At genotypic level, seed yield per plant showed highly significant positive correlation with number of pods per plant (r_g = 0.631), dry matter weight per plant (r_g = 0.491), harvest index (r_g = 0.488) and number of primary branches per plant (r_g = 0.403) whereas rest of the characters showed non-significant correlation. At phenotypic level, seed yield per plant showed highly significant positive correlation with number of pods per plant (r_p = 0.511) and significant positive correlation with dry matter weight per plant (r_p = 0.410) and harvest index (r_p = 0.385) whereas, rest of the characters showed non-significant correlation. As regards inter-relationship between yield characters, it was quite interesting to observe that dry matter weight per plant, number of primary branches per plant, number of pods per plant and harvest index were mutually correlated with each other. Positive and strong association of branches per plant, number of pods per plant and 100 seed weight with grain yield revealed importance of these characters in determining grain yield. Khanghah & Sohani [13], Rajanna et al. [19] and Singh & Yadava [23] also reported similar findings for different parameters in soybean. According to Siahsar & Rezai [22] and Chamundeswari et al. [8] number of pod per plant had the greatest genotypic correlation with seed yield in soybean which also confirms the results of present investigation. Basavaraja et al. [6] determined the positive correlation of seed yield with harvest index. Arshad et al.[3], Faisal et al.[11] also reported significant correlation of grain yield with number of branches per plant.

ACKNOWLEDGEMENTS

The Authors are sincerely grateful to Dr Basant Ram, Director, Experiment Station, GB Pant University of Agriculture and Technology, Pantnagar for providing facilities.

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