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COMBINING ABILITY ANALYSIS IN SOYBEAN

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ABSTRACT

Combining ability analysis was undertaken in 10 × 10 parental diallel progenies for seed yield and its component characters. Pod clusters/plant, seeds/plant, harvest index and seed yield/plant were observed to be controlled mainly by additive genetic variance, while both additive and nonadditive genetic variances were important for the remaining characters, the former being more important. Variety Cocker Stuart was the best general combiner for 6 out of 10 characters. Mean performance of the lines was related with their gca effects. The best specific crosses for seed yield was Hardee × Cocker Stuart, followed by Himso 328 × Himso 353 and Himso 328 × Himso 351. The crosses with high sca effects were involved in majority of cases, both poor or good general combiners, and in some cases, one being good and other being a poor combiner.

Key words: *Glycine max*, diallel, general combining ability, specific combining ability, transgressive segregation.

Most of the soybean varieties grown in different parts of the country are primary introductions from U.S.A., as these were found to be useful for comparable latitudes in India so far as yield potential is concerned. Now, it has been realised that direct introductions may not serve our purpose fully. Therefore, appropriate breeding programme has to be taken up with the released varieties and promising germplasm lines to meet the local requirements. The breeding strategy to be adopted for the improvement of a crop depends primarily on the nature of gene action involved in the expression of quantitative traits of economic importance. Combining ability analysis helps in identification of parents with general combining ability (gca) effects and in locating cross combinations possessing high specific combining ability effects. The present investigation has been undertaken to get information on combining ability of six varieties and four promising germplasm lines of soybean (*Glycine max* (L.) Merrill) in respect of seed yield and its components.

MATERIALS AND METHODS

Six commercial soybean cultivars, viz., Punjab-1, Bragg, Shilajeet, Lee, Hardee and Cocker Stuart; and four promising germplasm collections (Himso 328, Himso 351, Himso 353 and Himso 354) were crossed in a diallel mating design without reciprocals during 1982 and 1983. The final experiment consisting of 45 F_1 and 10 parent lines was conducted in randomised block design with three replications at the experimental farm of Himachal Pradesh Agricultural University, Palampur in 1984. Each entry had a single row of 3 m length. Spacing of 50 cm between rows and 5 cm within the rows was adopted. Guard rows were used around the whole experiment to avoid border effect, if any. Observations were recorded on ten randomly selected plants after leaving the border plants for ten characters (Table 1). Replication means of different characters were used for statistical analysis. The combining ability analysis was performed following Griffing's Method 2, Model 1 [1].

RESULTS AND DISCUSSION

The differences among progenies were highly significant for all the characters under study (Table 1). The magnitude of general combining ability (gca) variance was generally higher than specific combining ability (sca) variance. This is expected since divergent material was included in the study. Both additive and nonadditive gene actions were involved in the expression of days to flowering and maturity, plant height, branches/plant, total pods/plant, and 100-seed weight. The gca variances for these traits were of higher magnitude than the corresponding sca variances, indicating preponderance of additive gene action in the inheritance of characters. However, for pod clusters/plant, seeds/plant, harvest index and seed yield/plant, only additive variance was important. The importance of additive genetic variance as the main component of genetic variance for various economic traits in soybean was emphasized [2, 3]. However, Singh et al. [4] indicated the importance of both additive and nonadditive genetic variance for pods/plant and grain yield in soybean.

Table 1. Analysis of variance for progeny means and combining ability for ten characters in a 10 × 10 diallel cross

Source of variation	d.f.	Mean squares									
		days to flowering	days to maturity	plant height	branches per plant	pods per plant	pod clusters per plant	seeds per plant	harvest index	100-seed weight	seed yield per plant
Progenies	54	147.0**	231.9**	60.6**	6.7**	206.0**	21.5**	706.2**	25.7**	3.3**	61.0**
General combining ability	9	290.3**	404.5**	112.8**	13.7**	344.4**	35.8**	1018.5**	43.6**	6.2**	49.5**
Specific combining ability	45	4.9*	12.4**	1.7**	0.5**	14.3**	1.4	16.4	1.2	0.3*	3.3
Error	108	2.3	0.4	0.5	0.1	1.1	0.8	80.8	1.7	0.1	3.0
$\frac{2\sigma^2 gca}{2\sigma^2 gca + \sigma^2 sca}$		1.0	0.9	1.0	1.0	0.9	0.9	0.8	1.0	0.9	1.0

*, **Significant at 5% and 1% levels, respectively.

The gca effects of parents for different characters showed that variety Lee was the best general combiner for early flowering and maturity, followed by Himso 351, Himso 328 and Shilajeet. Varieties Cocker Stuart and Hardee were graded as the best combiners not only for seed yield/plant, but also for other yield components such as branches/plant, total pods/plant, pod clusters/plant, seeds/plant, harvest index, and seed yield/plant. High gca effects are mostly due to additive gene effects or additive × additive interaction effects [1]. In view of this, varieties Cocker Stuart, Hardee, Lee, Himso 351 and Himso 328 offer the best possibilities of exploitation for the development of improved lines of soybean. The parents showing higher mean

Table 2. Estimates of general combining ability effects in soybean

Parent	Characters									
	days to flowering	plant maturity	branches height	pods per plant	pod per plant	seeds clusters per plant	harvest per plant	100-seed index	seed yield weight	per plant
Himso 328	−3.6**	−3.4**	−1.8**	−1.4**	−5.67**	−1.0**	−9.7**	−1.6**	1.2**	1.0
Shilajeet	−1.8*	−4.2**	−0.4*	−0.5**	−4.15**	−1.0**	−9.9**	−0.1	−0.2**	0.1
Himso 351	−4.3**	−4.2**	−2.3**	−0.5**	−3.79**	−2.0**	−5.1**	−2.9**	0.5**	−1.4**
Himso 353	0.5	0.4	1.0**	−0.5**	0.54	1.1**	−1.0	2.2**	0.7	0.6
Himso 354	−0.8	−1.6**	1.1**	0.1*	−0.11	0.3	1.6	0.8**	−0.3**	−0.9
Punjab-1	1.1*	−0.9**	1.2**	0.5**	−0.87**	0.4	−12.2**	−1.5**	−1.4**	−3.5**
Bragg	−0.6	−1.4**	0.9**	0.2**	0.33	0.2	−0.5	0.4	0.1	−1.9**
Lee	−5.5**	−5.6**	3.8**	0.3**	4.28**	2.6**	−5.9**	−1.9**	0.2	0.1
Hardee	8.3**	10.3**	4.7**	1.3**	9.16**	2.4**	15.1**	2.0**	−0.5	2.0**
Cocker Stuart	9.0**	10.7	5.8**	1.7**	9.54**	2.5**	16.4**	2.5**	−0.1	3.6**
SE ($\hat{g}_i$)	0.4	0.2**	0.2	0.1	0.28	0.2	2.4	0.3	0.1	0.5

*, **Significant at 5% and 1% levels, respectively.

performance generally proved to be good general combiners for days to flowering and maturity, branches/plant, total pods/plant, seeds/plant, 100-seed weight, and seed yield/plant. In such cases, additive effects are more important and the choice of parents should be dependent on their performance. However, there was no correspondence between the performance of the parents and their gca effects for plant height, pod clusters/plant, and harvest index, which was due to nonadditive gene action. Under the circumstances, there is no alternative, but to restrict the choice of the parents on their gca effects. The best parent, the best general combiner, the best F_1, and the best specific cross combinations for different characters were identified (Table 3). The best specific crosses for seed yield/plant were Hardee × Cocker Stuart, followed by Himso 328 × Himso 353 and Himso 328 × Himso 351. In contrast to the gca effects, sca effects represent dominance and epistatic components of variation which are nonfixable and hence sca studies would not contribute in the genetic improvement of self-pollinated crops exept in cases where commercial exploitation of heterosis is feasible. Both the parents involved in the production of the highest yielding F_1 hybrid, Hardee × Cocker Stuart, had the highest gca for seed yield and its important components. Cross Hardee × Cocker Stuart showed the highest sca for seed yield and its components, and also involved parents with high gca, could be exploited in soybean breeding. However, both the parents are the poorest combiners for early maturity. The soybean breeding programme aimed at earliness and higher seed yield is of great significance for Himachal Pradesh. Based on these considerations and the present investigations, a breeding programme could be envisaged by crossing varieties Cocker Stuart and Hardee with Lee, Himso 328 and Himso 351 and selecting recombinants for higher seed yield and earliness in the segregating generations.

Table 3. Best parent, best general combiner, best F_1 hybrid, and best specific combination for each character

Character	Best parent	Best general combiner	Best F_1 hybrid	Best specific cross
Days to flowering	Lee	Lee	Himso 328 × Lee	Himso 353 × Cocker Stuart
Days to maturity	Lee	Lee	Himso 328 × Lee	Shilajeet × Hardee
Plant height	Lee	Himso 351	Himso 351 × Lee	Himso 351 × Punjab-1
Branches/plant	Cocker Stuart	Cocker Stuart	Hardee × Cocker Stuart	Bragg × Lee
Total pods/plant	Cocker Stuart	Cocker Stuart	Hardee × Cocker Stuart	Himso 328 × Cocker Stuart
Pod clusters/plant	Hardee	Cocker Stuart	Hardee × Cocker Stuart	Hardee × Cocker Stuart
Seeds/plant	Cocker Stuart	Cocker Stuart	Hardee × Cocker Stuart	Himso 354 × Lee
Harvest index	Hardee	Cocker Stuart	Hardee × Cocker Stuart	Lee × Cocker Stuart
100-seed weight	Himso 328	Himso 328	Himso 328 × Himso 353	Himso 351 × Cocker Stuart
Seed yield/plant	Cocker Stuart	Cocker Stuart	Hardee × Cocker Stuart	Hardee × Cocker Stuart

The other high sca crosses, Himso 328 × Himso 351 and Himso 328 × Himso 353, involved one good general combiner and other poor general combiner. The high sca of such cross is due to occurrence of desirable transgressive segregates of the additive system present in the good combiner and complementary epistatic effect, if present, in the cross acting in the same direction so as to maximise the desirable plant attributes.

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