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COMBINING ABILITY IN RELATION TO SOYBEAN BREEDING *Glycine max (L.)* MERRILL

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Combining ability was studied in a 6x6 diallel set of soybean *Glycine max* (L.) Merrill for seed yield and its components. Analysis of variance for treatment showed a wide range of variability. Both general and specific combining ability variances were significant. The higher magnitude of gca variance indicated the importance of additive and additive x additive components of genetic variance in the inheritance of these characters. 'Monetta' and 'EC 7034' were best general combiners for a majority of traits. Five F_1 hybrids, viz., 'Bragg' x 'Wills', 'EC 7034' x Hernon-49' 'Monetta' x Hernon-49', 'EC 7034' x 'Monetta' and 'Punjab-1' x 'EC 7034' were identified as promising and their use in hybrid breeding programme in soybean would be most advantageous.

Success of plant breeding largely dependsupon the choice of right parents. Though the performance of parents themselves gives some indication regarding the usefulness, their long term potentialities are least known at the beginning of the breeding programme. Combining ability analyses, proposed by Griffing (1956), assess the utility value of the crosses with other types. Hence, the present study was projected to collect information on the genetic parameters in a 6x6 diallel cross of soybean [*Glycine max* (L.) Merrill].

MATERIAL AND METHODS

Six varieties, namely 'Bragg', 'Wills', Punjab-1', 'EC 7034', Monetta' and 'Hernon-49' and their 15 nonreciprocal progenies were grown in a randomized block with three replications. The single row plots had 10 plants at spacing of 60 x 20 cm. Observations were recorded on 5 randomly selected plants for six characters, viz., days to flower, days to maturity, plant height (cm) number of pods/plant, 100-seed weight (g) and seed yield/plant (g).

The analysis of general and specific combining ability was done according to Method 2 and Model I of Griffing (1956).

RESULTS AND DISCUSSION

The analysis of variance revealed that there were significant differences between the progenies for all the characters (*Table* 1). It gave an indication of available genetic variability in the population for all the traits. The gca variance estimates were considerably higher than the sca variance estimates which in turn were also highly significant for all the characters. Predominance of additive gene action was also indicated by the

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ratio of gca variance to sca variance. Hanson and Weber (1961) and Croissant and Torrie (1971) also reported similar inferences for various traits in soybean.

For the choice of right parents, the performance of parents *per se*, the F_1 performance and combining ability estimates are obviously essential. In the present study, the performance of parents *per se* was an indication of their gca effect. This finding confirms the earlier reports by Srivastava *et al.* (1978) and Kaw and Madhava Menon (1980) that there existed positive association between the two. However, considering both direction and magnitude of gca effects and corresponding mean performance, the best parents were ,Bragg', 'Hernon-49' and 'Monetta' for early flowering; 'Monetta', 'Hernon-49' and 'Bragg' for early maturity; 'Monetta' and ,EC 7034, for tall plants; 'Monetta' 'EC 7034' and 'Hernon-49' for larger number of pods per plant; 'Punjab-1', Bragg' and 'Wills' for greater seed weight and 'EC 7034', 'Monetta' and 'Bragg' for higher seed yield per plant. Thus the results showed that none of the parents is a good general combiner for all the characters simultaneously. In such a situation, use of desirable multiple parents put into a central gene pool might prove fruitful (Jenson, 1970).

The s c a effects for different characters are presented in *Table 3*. Seven hybrids, as judged from significant and desirable sca effects for seed yield per plant involve all the three possible combinations between the parents of high and low g c a effects, high x high, high x low and low x low. The hybrid 'EC 7034' x 'Monetta' came in the first category where both parents had significant and desirable gca effects for seed yield. On the other hand, the crosses namely, 'Bragg' x 'Wills', 'EC 7034' x ' Hernon-49', ' Monetta ' x 'Hernon-49' and 'Punjab-1' x 'EC 7034' involved atleast one parent with significant gca. effect and other with poor gca effect. the highxhigh combiners gave highly significant sca effect but not to the extent as shown by high x low combiners. The cross combinations mentioned above also discerned the highest or average sca effects in desirable direction for direct and indirect yield components. Therefore, sca of yield may be influenced by the sca of yield components and combining ability of the parents may be considered a reliable guide in the yield potential of a cross Such a parallelism was also reported by Srivastava *et al.* (1978) in soybean. For crosses 'Wills' x 'Punjab-1' and 'Punjab-1 x 'Hernon-49,, significant positive s.c.a. effects were associated with low x low gene effects reflecting a non-additive type of gene action. Hence these cross combinations are unpredictable. Similar results have also been reported by Singh *et al.* (1974) and Singh (1979) in soybean and bread wheat, respectively. Besides, it was also noted that two superior parents of similar attributes related to either through geographic proximity, selection history or pedigree may give poor or negative estimates of s c a effects viz., 'Bragg' x 'EC 7034' and *vice-versa* is also true for seed yield and some other characters also. Hence it is not necessary that parents having higher estimates of gca effects would also give higher s c a effects.

However, for seed yield per plant it is difficult to bring together all the desirable genes by this method due to non-additive genetic variation and also some genetic barriers. In order to utilize them efficiently, *inter se* crossing of desirable F_1s in all possible combinations should be undertaken for multiple parents input into a central gene pool which will further supplement speedy recombinations and also in breaking strong genetic barriers if present. At F_4 or F_5 selection should be applied to whole population across environments for extracting superior lines. Since the plant or line performance would be repeatable and unbiased in the subsequent generations, the superior lines isolated could then be tested across environments to minimize the bias caused by genotype x environment interactions which have been found to be large in soybean (Johnson and Bernard, 1963).

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Table 1. Analysis of variance for six characters in soybean

Source	df	Days to flower	Days to maturity	Plant height	No. of pods plant	100-seed weight	Seed yield plant
Replications	2	0.3	0.4	5.8	1.2	0.02	0.21
Progenies	20	128.3**	377.3**	876.8**	1271.9**	27.6**	20.5**
Error	40	0.6	0.4	19.7	5.4	0.8	0.91
G C A	6	148.1**	407.2**	867.2**	1224.8**	31.5**	21.1**
S C A	15	4.3**	32.0**	100.6**	117.7**	1.14**	1.70**
Error	40	0.2	0.12	6.6	1.8	0.27	0.30
G C A / S C A		34.8	12.73	8.6	10.4	27.7	12.4

** Significant at 1% level.

Table 2. Eistimates of g.c.a. effects for six characters in soybean.

Parent	Days to flower	Days to maturity	Plant height	No. of pods/plant	100-seed weight	Seed yield/plant
Bragg	-4.46**	-4.14**	-1.13	-0.54	1.38**	0.84**
Wills	-4.68**	6.78**	-9.02**	-9.89**	1.22**	-1.38**
Punjab-1	5.86**	9.30**	-13.86**	-18.55**	2.35*	-1.57**
EC7034	0.39*	1.82**	8.65**	9.76**	0.54*	1.93**
Monetta	-2.55**	-8.03**	14.89**	14.25**	-2.80**	0.92**
Hernon-49	-3.81**	-5.71**	0.47	4.97**	-1.61**	-0.74**
S. E. (gi-gj)	±0.23	±0.17	±1.64	±0.67	±0.26	±0.27

Table 3 Estimates of sca. effects for six charactars so, be

Ctoss	Daya to flower	Days to maturity	Plant height	No of pods/plant	100-seed weight	Seed yield/plant
Bragg X Wills	-4.34**	-7.94**	7.45**	6.41**	0.26	2.50**
Bragg X Punjab-1	-4.13**	-6.34**	10.05**	14.23**	1.03*	0.06
Bragg X EC7034	-0.65	-0.01	-4.16	-2.80	1.05*	0.15
Bragg X Monetta	0.17	0.90**	-0.78	-4.56**	0.35	0.17
Bragg X Hernon-49	0.46	1.63**	-4.28	-7.42**	1.07*	0.57
Wills X Punjab-1	-0.57	-3.34**	8.18**	15.46**	0.82	2.48**
Wills X EC7034	0.30	0.22	-7.44**	-8.76**	-0.38	1.75**
Wills X Monetta	2.27**	8:12**	-10.74**	-11.11**	0.31	2.15**
Wiils X Heruon-49	2.39**	6.75**	-0.13	-11.08**	0.20	3.45**
Puujab-1 x EC7034	0.89*	4.77**	-12.84**	-12.99**	1.62**	1.43**
Punjab-1 x Monetta	1.08**	6.56**	-14.94*	-17.58**	0.61	-0.43
Punjab-1 x Hernon-49	1.23**	7.06**	-1.56	-13.21*	-0.04	1.52**
EC7034 x Monetta	1.53**	-4.01**	8.53**	10.02**	1.39**	1.44**
EC7034 x Hernon-49	-1.22**	-4.42**	10.88**	7.41**	0.99*	1.80**
Monetta x Hernon-49	-0.29	7.41**	11.59**	17.00**	0.29	1.77**
S.E.(Sij)	±0.40	±0.31	±2.27	±1.19	±0.46	±0.48
S.E.(Sij-Sik)	±0.60	±0.46	±3.39	±1.78	±0.69	±0.73
S.E.(Sij-Skl)	±0.56	±0.43	±3.14	±1.65	±0.64	±0.67

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