Indian J. Genet., **65**(3): 233-235 (2005)

Short Communication

Heterosis and inbreeding depression in three soybean [*Glycine max* (L.) Merr.] crosses

S. V. Bhosle[1], S. P. Taware and V. M. Raut

Department of Genetics, Agharkar Research Institute, (MACS), Pune 411 004

(Received: November 2004; Revised: August 2005; Accepted: August 2005)

Soybean [*Glycine max* (L.) Merr.] is ranked number one in the world oil production (48%) in the international trade markets among the major oil crops [1]. The wild soybean is rich in seed protein (31.1-52.4%) but poor in oil composition (9.1-11.95%) [2], while the cultivated soybean is important crop, due to its high seed protein (38-43%) and rich edible oil content (18-24%), and is gaining importance due to the increasing demand for various soy products. To satisfy the increasing demand of soybean, its yield potential has to be increased by genetic improvement of the existing commercial lines, which requires thorough understanding of the breeding behavior of quantitative traits. Thus, an attempt was made to study some of the quantitative traits, of some promising cultivated varieties of soybean by crossing them.

Three soybean crosses *viz.*, Cross I-'MACS 684' × 'MACS 124', Cross II-'MACS 684' × 'RSC 1', and Cross III-'PK 472' × 'RSC 2', were made during the rainy season of 1999 and the subsequent generations were raised. The further generation was advanced in summer seasons. A trial of three crosses including the parents, F_1, F_2, F_3 and F_4 was grown in a randomized block design (RBD) with three replications during the rainy season of 2001 at Agharkar Research Institute's experimental farm at Hol, Pune.

In each replication, the parents were represented by 2 rows, F_1s and F_2s by two rows, F_3s and F_4s by 6 rows each. Each replication was protected by two border rows of Cv. MACS-57 on either side, so as to nullify the border effect. Observations were recorded on 5 randomly selected plants per row for four quantitative characters *viz.*, Plant height (cm), Pod number, Oil content (%) and Yield (Kg/ha). Performance of the parents (including crosses), heterosis (over mid parent and better parent) and inbreeding depression from F_2 to F_3, F_2 to F_4 and F_3 to F_4 generations were calculated following the analysis of variance (ANOVA) for randomized block design [3].

Analysis of variance for four characters in the three crosses and five generations (Mean squares), showed significance for plant height in the second 'MACS 684' × 'RSC 1' and third cross 'PK 472' × 'RSC 2'. Pod number was seen to be significant in the second cross 'MACS 684' × 'RSC 1'. The oil content was significant in the first cross 'MACS 684' × 'MACS 124' and in the third cross 'PK 472' × 'RSC 2' as well. Significance for the yield (Kg/ha) was seen in the first 'MACS 684' × 'MACS 124' and second cross 'MACS 684' × 'RSC 1'.

The performance of parents and three crosses from the values of generation means (Table 1) indicated that the parents RSC 2, RSC 1 and PK 472 were superior in terms of yield (Kg/ha). The generation's study for yield for all the crosses further reveals an increase in the yield in F_1 generation, highest yield in the F_2 generation, followed by a subsequent decline in F_3 and F_4 generations. The parents, RSC 2, MACS 684 and RSC 1 were superior for oil content (%) but showed a decline in successive generations *viz.*, F_1, F_2, F_3 and F_4. The third cross 'PK 472' × 'RSC 2' showed a significant increase for pod number in the F_2 and F_3 generations but showed a slight decline in the F_4 generation. The first cross 'MACS 684' × 'MACS 124' showed increase for the plant height (cm) in the F_2 generation, declined in F_3 generation and showed increase again in the F_4 generation. The Figures 1 and 2 for the four quantitative traits illustrate the details of the performance of parents and crosses respectively.

The mid-parent heterosis (Hmp) and better parent heterosis (Hbp) (Table 2) for yield was found to be highly significant in cross I-'MACS 684' × 'MACS 124' and significant in cross II and cross III, respectively.

[1]Present address: PTC Division, National Chemical Laboratory, Pune 411 008; [2]Sarvatra Society, B-3/4, Paud Road, Krishna Hospital, Pune 411 029

Table 1. Generation means for parents and crosses for four quantitative traits in soybean

Parents/generations		Plant height (cm)	Pod number	Oil content (%)	Yield (Kg/ha)
MACS 124		55.61	39.48	20.28	1819.50
MACS 684		59.73	40.40	21.30	2076.51
PK 472		37.00	26.53	19.53	2625.94
RSC 1		51.53	33.60	21.00	2911.07
RSC 2		50.53	40.40	22.04	2711.36
*MACS 684 × MACS 124	F_1	60.47	41.00	20.32	3077.31
**MACS 684 × RSC 1	F_1	54.53	53.30	20.68	3221.69
***PK 472 × RSC 2	F_1	55.60	34.07	20.46	2916.22
*MACS 684 × MACS 124	F_2	65.30	41.32	19.55	4281.36
**MACS 684 × RSC 1	F_2	55.48	41.33	20.94	4610.90
***PK 472 × RSC 2	F_2	46.35	37.82	20.61	3082.16
*MACS 684 × MACS 124	F_3	61.15	42.83	20.09	2169.80
**MACS 684 × RSC 1	F_3	55.23	42.05	20.87	2086.01
***PK 472 × RSC 2	F_3	45.53	39.28	19.69	2509.69
*MACS 684 × MACS 124	F_4	64.50	43.47	19.98	2192.38
**MACS 684 × RSC 1	F_4	58.43	35.13	20.67	2386.56
***PK 472 × RSC 2	F_4	52.10	37.03	19.72	2613.84
Standard Error (S.E):		2.04	2.93	0.25	126.06
Critical difference (C.D.) at 5%		5.95	8.51	0.73	366.54
Coefficent of variation (C.V.) (%)		6.55	13.14	2.15	8.035

* : Cross I, ** : Cross II, *** : Cross III, respectively.

This study confirms the earlier findings for the positive heterosis over better parent [4]. The pod number showed highly significant Hmp and Hbp in cross II-'MACS 684' × 'RSC 1', and was found non significant in the other crosses. The plant height showed highly significant Hmp and Hbp in cross III-'PK 472' × 'RSC 2'. For oil content, values for heterosis were negative and non significant. The mid-parent heterosis for yield, plant height and 100 seed weight reported earlier in soybean [5] are supported by this study.

Inbreeding depression (Table 2) was significant for yield [6] in cross I-'MACS 684' × 'MACS 124' and cross II-'MACS 684' × 'RSC 1', but was found to be low in cross III-'PK 472' × 'RSC 2', showing some variability [7]. Inbreeding depression was found to be non significant for the other three characters except for oil concentration in cross III.

The present study indicates that the chances of getting better selections in further generations are more

Table 2. Heterosis (%) over mid-parent and over better parent and inbreeding depression in three soybean crosses for four quantitative traits

Characters	Heterosis (%)		Inbreeding depression (%)		
	Over mid parent	Over better parent	F_3 over F_2	F_4 over F_2	F_4 over F_3
Cross I 'MACS 684' × 'MACS 124'					
Plant height	4.85*	1.23	6.3553	1.2251	–5.4783
Pod number	2.65	1.48	–3.6544	–5.2033	–1.4943
Oil concentration	-2.26	–4.60*	–2.7621	–2.1995	0.5475
Yield Kg/ha	57.97**	48.19**	49.3198**	48.7924**	–1.0406
Cross II 'MACS 684' × 'RSC 1'					
Plant height	–1.97	–8.70**	0.4506	–5.3172	–5.7940
Pod number	44.05**	31.18**	–1.7421	15.0012	16.4566
Oil concentration	–2.22	–2.91	0.3343	1.2894	0.9583
Yield Kg/ha	29.18**	10.67**	54.7592**	48.2409**	–14.4079
Cross III 'PK 472' × 'RSC 2'					
Plant height	27.74**	10.03**	1.7691	–12.4056	–14.4300
Pod number	1.82	–15.66**	–3.8604	2.0888	5.7281
Oil concentration	–1.53	–7.16*	4.4639*	4.3183*	–0.1524
Yield Kg/ha	9.27**	7.55*	18.5737*	15.1945*	–4.1499

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

in cross III as compared to the other two crosses because of low inbreeding depression in the third cross and these parents can be exploited for further improvement and getting better hybrids. The inbreeding depression of F_3 over F_2 reported earlier for some quantitative traits [8] are supported by this study.

References

1. **Singh R. J. and Hymowitz T.** 1999. Soybean genetic resources and crop improvement. Genome, **42**: 605-616.
2. **Hymowitz T., Palmer R. G. and Hadley H. H.** 1972. Seed weight, protein, oil and fatty acid relationship with the genus *Glycine*. Trop. Agric. (Trinidad), **49**: 245-250.
3. **Gomez K. A. and Gomez A. A.** 1984. Statistical Procedures for Agricultural Research, John Wiley & Sons Inc. New York. Edn, p 2,680
4. **Taware S. P., Halvankar G. B., Raut V. M. and Patil V. P.** 1990. Hybrid vigour in soybean (*Glycine max*). Indian J. Agric. Sci., **60**: 545-6.
5. **Manjarrez-Sandoval P., Carter T. E. (Jr)., Webb D. M. and Burton J. W.** 1997. Heterosis in soybean and its prediction by genetic similarity measures. Crop Sci., **37**: 1444-52.
6. **Kunta T., Edwards L. H. and Keim K. R.** 1997. Heterosis, inbreeding depression and combining ability in soybeans [*Glycine max* (L.) Merrill]. Society for the Advancement of Breeding Researches in Asia and Oceania Journal of breeding and Genetics, **29**: 21-32.
7. **Sabbouth M. Y., Edward L. H. and Keim K. R.** 1998. Heterosis and combining ability for protein and oil concentration in the seeds of soybean [*Glycine max* (L.) Merrill]. Society for the Advancement of Breeding Researches in Asia and Oceania Journal of breeding and Genetics, **30**: 7-17.
8. **Rahangdale S. R. and Raut V. M.** 2002. Heterosis and inbreeding depression in soybean (*Glycine max*). Indian J. Agric. Sci., **72**: 367-9.