Increasing rapeseed yields through heterosis breeding

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Abstract

The present investigation was under taken to study the magnitude of heterobeltiosis and economic heterosis for seed yield and its attributes by using line (9)×tester (5) mating design. The analysis of variance revealed considerable genetic variation among the genotypes. The degree of heterosis varied from cross to cross for all the traits. The magnitude of standard heterosis was high for seed yield per plant (60.2%), number of effective branches per plant (110.7%) and siliquae per plant (322.1%), whereas, low to medium heterosis was observed for remaining traits. Likewise, high heterobeltiosis (97.2%) was recorded by the hybrid "MYSL 20/YP×PS 66". This hybrid was heterotic over GS 1 for most of various yield components also. The cross combinations "YSC 99×RAUDYS 9708" (60.2%), "MYSL 221×PS 66" (27.9%) and "SSK 9215×RAUDYS 9708" (27.1%) exhibited high significant heterosis over the best commercial check variety GS 1 for seed yield per plant. These hybrids had high heterosis in desired direction for other yield attributing traits.

Key words: Heterobeltiosis, economic heterosis, rapeseed, *Brassica campestris*

Introduction

Since many years, the increase in productivity through varietal improvement have reached to a plateau. The development of hybrids in many crops has brought about the spectacular improvement in the production and productivity. Under experimental condition, great deal of heterosis (>100%) for seed yield has been reported in rapeseed-mustard, which clearly demonstrated the presence of commercially exploitable magnitude of heterosis. In yellow sarson, some available genetic male sterile lines provided the way for pollination control. This will help in the development of rapeseed hybrids, which can bring in quantum jump in productivity of rapeseed. Hence the present investigation was undertaken to study the magnitude of heterobeltiosis and economic heterosis for seed yield and its attributes in Rapeseed [*Brassica campestris* var. Yellow Sarson].

Materials and methods

The crosses were attempted by adopting line (9)×tester (5) mating design during *rabi* 2003-2004. The resultant 45 hybrids along with their 14 parents were evaluated in a Randomized Block Design with three replications during *rabi* 2004-2005 at Main Castor and Mustard Research Station, S.D. Agricultural University, Sardarkrushinagar. The observations were recorded on days to 50% flowering, days to maturity, plant height, effective branches/plant, siliquae on main shoot, siliquae/plant, length of siliqua, seeds/siliqua, 1000-seed weight, oil content, harvest index and seed yield/plant. Heterosis was determined as percentage increase or decrease in F_1 over better parent and released variety 'Gujarat Sarson 1' (standard check).

Results and discussion

The analysis of variance for parents, hybrids and parents vs. hybrids were computed for seed yield and its attributes under study is presented in Table 1. The mean squares due to genotypes were highly significant for all the traits indicating considerably amount of genetic variability among genotypes for various characters studied. Further, partitioning of the genotypic variance into parents, hybrids and parents vs. hybrids, revealed that the parents as well as hybrids exhibited significant differences for all the traits. This indicated the existence of appreciable amount of genetic variability in the experimental material. The comparison of parents vs. hybrids was significant for all the characters except oil content, which indicated that the performance of hybrids was significantly different than that of the parents for most of the traits.

The magnitude of heterosis expressed as per cent increase or decrease of F_1 value over better parent (heterobeltiosis)and the best commercial standard check variety Gujarat Sarson 1 (standard heterosis or economic heterosis or useful heterosis). The three top ranking heterotic crosses for various traits are presented in Table 2. In the present study, out of 45 hybrids, 19 hybrids significantly out yielded the standard check GS 1. Their superiority seemed to have resulted from higher values of yield contributing characters, of which "YSC 99×RAUDYS 9708" recorded the highest economic heterosis (60.2%), whereas, high heterobeltiosis (97.2%) was recorded by the hybrid "MYSL 20/YP×PS 66". These hybrids were heterotic over GS 1 for most of various yield components also. These findings are in agreement with the reports of Labana *et al*. (1978), Prasad and Singh (1985), Varshney (1985), Verma *et al*. (1989), Rai and Singh (1994) and Thakur and Segwal (1997).

In case of number of effective branches per plant, high values of heterobeltiosis (81.69%) and standard heterosis (110.7%) were recorded. For siliquae per plant, 24 crosses manifested significant heterobeltiosis and 40 crosses exhibited significant economic heterosis in desired direction. It may be mentioned that for this important yield contributing trait all the 40 heterotic crosses, except two ("YSC 99×GS 1" and "MYSL 221×GS 1") exhibited positive significant standard heterosis indicating that for this trait the genes with positive effect was dominant. The heterobeltiosis and standard heterosis with respect to seeds per siliqua were moderate (21.1% and 26.3%, respectively). These results are in agreement with Labana *et al*. (1978), Prasad and Singh (1985), Rai and Singh (1994) and Thakur and Segwal (1997).

Table 1 : Analysis of variance (mean square) for experimental design for various characters in rapeseed

Sr. No.	Source of variation	d.f.	Days to 50% flowering	Days to maturity	Plant height	Effective branches per plant	Siliquae on main branch	Siliquae per plant	Length of siliqua	Seeds per siliqua	1000-seed weight	Oil content	Harvest index	Seed yield per plant
1.	Replications	2	2.531	3.678	3.751	2.519	11.478	7.050	0.128	4.640*	0.517**	7.340**	15.689*	1.966
2.	Genotypes	58	84.290**	41.763**	849.556**	73.866**	176.682**	28791.297**	1.904**	79.740**	0.618**	3.864**	43.305**	54.334**
a.	Parents	13	176.432**	63.629**	1276.346**	88.554**	207.186**	13639.740**	1.635**	44.826**	0.313**	3.757**	32.167**	40.298**
i	Females	8	227.666**	79.748**	1701.745**	16.846**	152.420**	4451.982**	1.914**	44.221**	0.122**	4.725**	23.059**	49.380**
ii	Males	4	43.670**	44.433**	728.828**	193.332**	284.461**	25463.230**	1.485**	46.175**	0.637**	2.319**	44.097**	27.221**
iii	Females vs. Males	1	297.621**	11.453*	63.187	243.109**	336.210**	39847.810**	0.001	12.263**	0.548**	1.751*	57.303**	19.957
b.	Hybrids	44	58.345**	32.810**	686.496**	68.238**	148.554**	27599.170**	1.970**	83.288**	0.596**	3.967**	47.073**	58.519**
c.	Parents vs. Hybrids	1	27.976**	151.406**	2475.250**	130.526**	1017.812**	278215.500**	2.511**	377.457**	5.502**	0.633	22.365*	52.648**
3.	Error	116	1.669	2.126	19.269	1.993	3.759	48.733	0.039	1.125	0.008	0.398	3.696	5.777

* P ⩽ 0.05, ** P ⩽ 0.01

Table 2: Three top ranking parent and hybrids with respect to *per se* performance and heterosis over better parent and standard check (GS 1).

Character	Best performing parent	Bestperforminghybrids	*per se*	Heterosis over better parent: Heterotic crosses	Heterosis over better parent: Heterobelt-iosis (%)	Heterosis over standard check (GS 1): Heterotic crosses	Heterosis over standard check (GS 1): Standard heterosis (%)
Days to 50% flowering	MYSL 20/YP	MYSL20/YP×RS1	43.3	-	-	MYSL20/YP×RS1	-9.44**
	MYSL 221	MYSL20/YP×RAUDYS9708	43.3	-	-	MYSL20/YP×RAUDYS9708	-7.81**
	RS 1	MYSL221×GS1	44.7	-	-	PYS9804×RS1	-4.96*
Days to maturity	MYSL 20/YP	MYSL20/YP×RAUDYS9708	100.3	SSK9215×RAUDYS9708	- 6.48**	MYSL20/YP×RAUDYS9708	-7.38**
	MYSL 221	SSK9215×RAUDYS9708	101.0	SSK9215×PS66	- 5.76**	SSK9215×RAUDYS9708	-6.77**
	RS 1	MYSL221×GS1	102.3	SSK9215×YST151	- 5.45**	MYSL221×RS1	-6.15**
Plant height	MYSL 20/YP	MYSL20/YP×PS66	113.8	-	-	MYSL20/YP×PS66	-9.49**
	MYSL 221	MYSL20/YP×GS1	115.9	-	-	MYSL20/YP×GS1	-7.84**
	PS 66	MYSL20/YP×YST151	120.8	-	-	-	-
Effective branches per plant	RS 1	MYSL20/YP×RS1	27.7	SSK9215×YST151	81.61**	MYSL20/YP×RS1	110.74**
	RAUDYS 9708	SSK9215×YST151	27.2	MYSL221×YST151	71.13**	SSK9215×YST151	106.78**
	PYS 9804	SSK9215×RS1	25.7	MYSL20/YP×YST151	69.68**	MYSL221×YST151	88.35**
Siliquae on main branch	RAUDYS 9708	PROYS9805×RS1	57.4	MYSL221×YST151	68.50**	PROYS9805×RS1	74.75**
	RS-1	MYSL221×YST151	57.1	PROYS9805×RS1	41.49**	MYSL221×YST151	73.62**
	SSK 9215	YSB2001×RS1	52.7	PYS9804×PS66	38.42**	YSB2001×RS1	60.18**
Siliquae per plant	RAUDYS 9708	SSK9215×YST151	605.0	SSK9215×YST151	215..95**	SSK9215×YST151	322.10**
	RS 1	MYSL221×RAUDYS9708	416.7	MYSL20/YP×PS66	161.40**	MYSL221×RAUDYS9708	190.63**
	SSK 9215	MYSL20/YP×YST151	401.6	MYSL221×PS66	143.65**	MYSL20/YP×YST151	180.19**
Length of siliqua	YSC 35	YSC99×YST151	7.5	MYSL221×RAUDYS9708	18.03**	YSC99×YST151	35.80**
	YSPB 24	YSC35×YST151	7.4	MYSL20/YP×RAUDYS9708	10.70**	YSC35×YST151	32.91**
	PS 66	YSB2001×YST151	7.3	YSC35×YST151	7.09**	YSB2001×YST151	32.73**
Seeds per siliqua	MYSL 20/YP	YSC35×YST151	27.5	YSC35×YST151	21.11**	YSC35×YST151	26.28**
	YSPB 24	YSC99×GS1	26.8	YSC99×GS1	13.88**	YSC99×GS1	22.94**
	PS 66	YSB2001×GS1	25.7	YSB2001×GS11	12.79**	YSB2001×GS1	17.98**
1000 -seed weight	GS 1	PROYS9805×GS1	5.8	MYSL221×PS66	23.13**	PROYS9805×GS1	13.87**
	YSB 2001	PYS9804×GS1	5.8	PYS9804×PS66	21.90**	PYS9804×GS1	13.09**
	YSPB 24	MYSL221×PS66	5.8	MYSL20/YP×PS66	16.74**	MYSL221×PS66	12.30**
Oil content	MYSL 20/YP	YSC35×GS1	43.6	YSC35×YST151	3.63**	YSC35×GS1	2.59*
	PROYS 9805	MYSL20/YP×YST151	43.2	YSPB24×YST151	3.54**	-	-
	GS 1	MYSL20/YP×PS66	43.2	YSC35×PS66	2.97*	-	-
Harvest index	GS 1	MYSL221×GS1	30.7	YSB2001×PS66	34.46**	-	-
	PR0YS 9805	YSB2001×PS66	30.7	SSK9215×PS66	31.83**	-	-
	RS 1	YSPB24×GS1	30.4	YSC35×YST151	21.41**	-	-
Seed yield per plant	GS 1	YSC99×RAUDYS9708	29.5	MYSL20/YP×PS66	97.18**	YSC99×RAUDYS9708	60.22**
	PROYS 9805	MYSL221×PS66	23.5	YSC99×RAUDYS9708	51.35**	MYSL221×PS66	27.88*
	RS 1	SSK9215×RAUDYS9708	23.4	YSB2001×PS66	42.12**	SSK9215×RAUDYS9708	27.12*

*P⩽ 0.05, ** P⩽0.0!

The heterosis over better parent and standard check for 1000-seed weight and harvest index were also moderate. Similar results were reported by Varshney (1985) and Verma *et al*. (1989). In case of oil content, the values of heterobeltiosis (3.6%)

and standard heterosis (2.6%) were very low. Similar trend was also noticed by Prasad and Singh (1985), Rai and Singh (1994) and Thakur and Segwal (1997).

The cross "YSC 99×RAUDYS 9708" had highest *per se* performance (29.5g/plant) and highest standard heterosis (60.2%) for seed yield per plant and yield components viz., branches per plant and siliquae per plant. Therefore, this hybrid has potential for commercial exploitation of heterosis if stable restorer is available.

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