Table 1. Mean values of F_1 hybrids and commercial cultivars for different characters

Genotypes	Seed yield (g)	Branches/plant Primary	Branches/plant Secondary	Siliquae/plant	1000-seed wt. (g)	Harvest Index (%)	Days to 50% flowering	Oil content (%)	Oil yield (g)
fms x YSR 1-P2	26.90	5.73	16.60	571.1	3.36	20.33	57.50	42.10	11.32
fms x RLC 1105	23.75	4.60	16.08	599.9	2.92	23.41	56.25	42.10	10.00
fms x Kranti	27.13	4.78	16.00	613.5	4.24	21.99	56.25	42.63	11.57
fms x RLM 629	20.88	4.73	14.45	579.6	2.81	29.08	54.00	41.95	8.76
fms x Pant Rai 1002	34.88	4.75	14.48	662.7	4.21	28.21	62.00	42.70	14.89
fms x Varuna	20.38	5.20	15.28	565.8	3.92	19.36	54.00	43.20	8.80
fms x RLC 1359	24.13	5.10	16.00	688.9	3.38	23.26	62.50	42.00	10.14
fms x RH 3811	19.75	5.20	16.45	601.2	3.51	20.95	54.25	42.00	8.30
fms x RW 11841/26	26.50	4.88	16.28	694.8	4.05	21.67	60.00	40.63	10.77
fms x RLC 1031	27.50	5.05	15.98	610.9	3.72	24.10	55.50	41.65	11.45
fms x RH 848	29.00	5.55	16.10	802.5	3.47	21.96	63.00	42.88	12.44
fms x RLC 1047	31.75	5.88	17.08	735.4	2.96	23.28	61.50	42.40	13.46
fms x RLC 1209	22.50	5.05	15.25	596.6	3.40	20.08	59.75	41.35	9.30
fms x RLM 619	25.25	6.08	16.78	610.5	3.17	18.70	59.50	43.38	10.95
fms x RFD 4	16.75	4.90	14.93	654.3	3.81	17.61	57.75	41.40	6.94
fms x RLC 1355	22.25	5.55	14.40	476.6	3.11	20.61	59.50	42.70	9.50
fms x RLM 240	24.00	4.95	16.08	655.0	3.42	23.09	55.50	42.35	10.16
fms x RLM 1357	23.38	5.50	17.05	442.9	3.04	21.52	54.00	40.90	9.56
fms x CDA 39	26.13	6.80	20.48	729.9	3.91	16.46	64.00	39.73	10.38
RLM 514	19.25	5.85	15.20	472.0	2.74	17.35	69.75	40.65	7.83
RLM 619	19.13	5.28	13.80	432.5	3.87	19.73	58.50	42.60	8.15
RLC 1359	16.38	4.60	12.80	555.1	3.82	16.48	54.75	41.30	6.77
Kranti	14.75	4.55	12.95	474.5	3.60	21.25	55.50	40.68	6.00
Varuna	14.63	4.35	11.98	508.7	3.75	21.45	54.50	40.20	5.88
Range of hybrids	16.75 to 34.88	4.60 to 6.80	14.40 to 20.48	442.9 to 802.5	2.81 to 4.24	16.46 to 29.08	54.00 to 64.00	39.73 to 43.38	6.66 to 15.13
Mean of hybrids	24.83	5.28	16.08	625.9	3.50	21.87	58.25	42.00	10.43
Range of commercial cultivars	14.63 to 19.25	4.35 to 5.85	11.98 to 15.20	432.5 to 555.1	2.74 to 3.87	16.48 to 21.45	54.50 to 69.75	40.20 to 42.60	5.88 to 8.20
Mean of commercial cultivars	16.83	4.93	13.35	488.56	3.56	19.25	58.60	40.70	6.85
* CD ($P \leq 0.05$)	9.28	0.88	3.23	157.85	0.73	5.93	5.11	1.52	
**CD ($P \leq 0.01$)	12.34	1.17	4.30	209.94	0.97	7.89	6.79	2.03	

Table 2. Best hybrids for different characters and their level of heterosis

Character	Best F_1	Average level of heterosis (%) over 5 checks	Level of heterosis (%) over best check
Seed yield per plant	fms x Pant Rai,1002	110.37	81.19
Primary branches per plant	fms x CDA-39	39.73	16.24
Secondary branches per plant	fms x CDA-39	54.45	34.75
Siliquae per plant	fms x RH-848	65.41	44.67
Main shoot length	fms x RLC 1359	21.78	15.97
Siliquae on main shoot	fms x RLC 1047	31.56	16.97
Siliqua length	fms x RLC 1047	4.35	-
Seeds per siliqua	fms x RLC 1105	12.22	9.77
1000-seed weight	fms x Kranti	21.20	9.61
Plant height (dwarf)	fms x RLM-629	(6.90)	0.00
Harvest index	fms x RLM-629	52.77	35.57
Days to 50% flowering (earliness)	fms x RLM-629 fms x Varuna fms x RLM-1357	(7.05)	(0.90)
Oil content	fms x RLM-629	6.72	1.83

( ) indicates negative value
- indicates check cultivar better than best F_1's for this character

Table 3. Superior Hybrids over the best check for different characters

Character	Best check	F_1 hybrids better than check with heterosis in brackets
Seed yield	RLM 514	fms x Pant Rai, 1002 (81.19%) fms x RLC 1047 (64.94%) fms x RH 848 (50.65%)
Oil yield	RLM 514	fms x Pant Rai, 1002 (107.0%) fms x RLC 1047 (86.2%) fms x RH 848 (72.1%)
Oil content (%)	RLM 619	fms x RLM 619 (1.83%) fms x Varuna (1.41%) fms x RH 848 (0.66%)
Primary branches	RLM 514	fms x CDA-39 (16.24%)
Secondary branches	RLM 514	fms x CDA-39 (34.75%)
Siliquae per plant	RL 1359	fms x RH 848 (44.57%) fms x RLC 1047 (32.48%)
Seeds per siliqua	Kranti	fms x RLC 1105 (9.77%)
Harvest Index (%)	Varuna	fms x RLM 629 (35.15%)

commercial cultivars. Similarly, harvest index, oil content and some other economic characters exhibited superiority of the hybrids over the commercial check cultivars. The overall mean of the hybrids for seed yield (24.83 g) per plant was higher than the mean of the commercial cultivars (16.83 g). Similar trend was also observed for other characters.

Performance of the best hybrids for each character regarding the level of heterosis over the average of five commercial checks and the best check cultivar are given in Table 2. The table 2 shows that for seed yield fms x Pant Rai-1002 recorded 110.37% heterosis over the average of five commercial checks. Three hybrids, viz. fms x Pant Rai-1002, fms x RLC-1047 and fms x RH-848 were found to be significantly superior to the best commercial cultivar (RLM 514) by recording heterosis - 81.19%, 64.94% and 50.65% for seed yield and 107.0%, 86.2%, 72.1% for oil yield respectively. In Indian mustard, Banga and Labana (1984) reported 56% heterosis of a hybrid for seed yield over RLM 514. In this study, fms x CDA-39 recorded 16.24% and 34.75% heterosis over RLM 514 for primary and secondary branches respectively. Hybrid fms x RH-848 recorded the highest level of heterosis (44.57%) over the best check RL 1359 for number of siliquae per plant. For siliqua length, fms x RLC-1047 recorded 4.35% heterosis over the mean of the five cultivars. For seeds per siliqua fms x RLC 1105 recorded 9.77% heterosis over Kranti. For dwarf plant height and harvest index fms x RLM 629 recorded 6.90% and 35.51% heterosis over Varuna respectively. None of the hybrids was earlier in flowering than Varuna and late than RLM 514. For oil content fms x RLM 619 was the best hybrid giving 6.72% heterosis over the average of the five commercial cultivars and 1.83% heterosis over the best variety RLM 619 (Table 3).

Overall heterosis based on the mean of 19 hybrids against the mean of the five commercial cultivars is depicted in Fig. 1. This figure shows that seed yield recorded the highest level of heterosis (59.69%). Grant and Beversdorf (1985) viewed that 10-20% average heterosis in Brassica napus justifies the efforts currently underway to develop cytoplasmic male sterile lines and genetic restorers for production of hybrid seed. The number of siliquae per plant, secondary branches, siliauae on main shoot and harvest index exhibited 25.26%, 21.61%, 16.16% and 14.87% heterotic superiority respectively. The positive contribution to yield heterosis by number of siliquae per plant, primary branches and secondary branches has also been reported by Labana and Badwal (1975) and Banga and Labana (1984). Primary branches and main shoot length each gave heterosis of about 9%. The character 1000-seed weight recorded 0.49% heterosis, whereas siliqua length and seeds per siliqua showed an overall negative trend for heterosis. Low level of heterosis for these characters was also reported by Gupta (1976) in intervarietal crosses of Indian mustard. Plant height and oil content also recorded a low level of heterosis of 2.5%.

CONCLUSION

The observed high level of commercial heterosis of F_1 hybrids over the released pure line cultivars open up new vistas for increasing the productivity of mustard in the Indian sub continent.

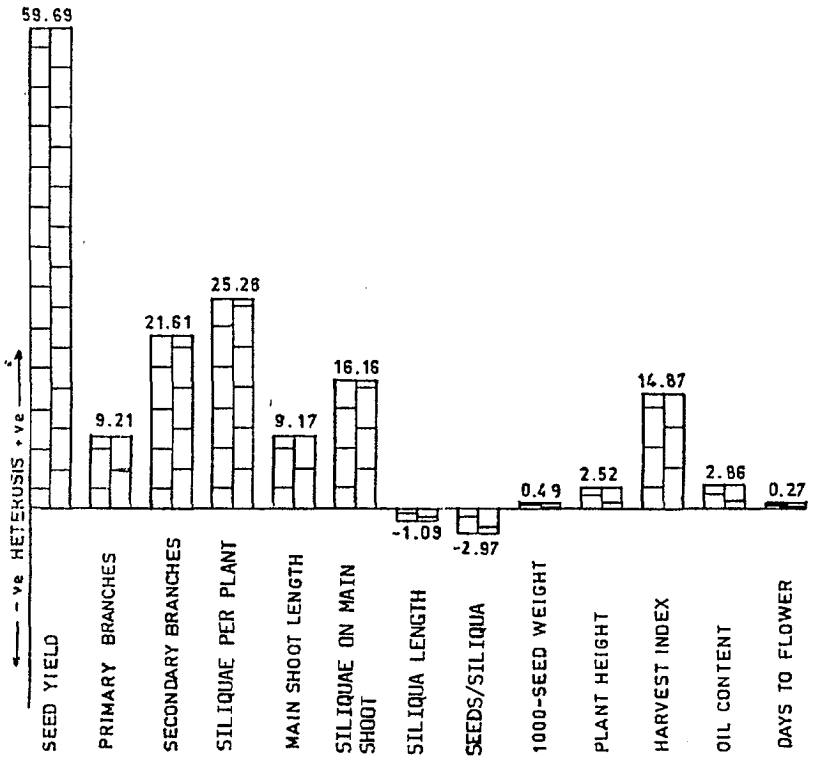

Fig. 1 OVERALL HETEROSIS FOR DIFFERENT CHARACTERS(%)

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