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Study of heterosis in Indian mustard [*Brassica juncea* (L.) Czern and Coss]

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Abstract

A 10 parent dialed comprising 10 strains and their 45F_1 hybrids of Indian mustard were evaluated for heterosis over mid parent (MP) and superior parent (SP) or heterobeltiosis. The highest heterosis for seed yield over mid parent was recorded as high as 47.36% and 40.85% by crosses Kranti x BEC-144 and RH-30xBEC-286 respectively. The heterosis for seed yield over superior parent was recorded highest 57.0% by cross combination Kranti x BEC-144 followed by 50.89% by cross combination Pusa Bold x BEC-144.

Key words: Indian mustard, heterosis, heterobeltiosis,

Introduction

Exploitation of heterosis is considered to be one of the outstanding achievement of plant breeding. The development of commercial hybrid varieties in summer forms of both *Brassica napus* and *Brassica compestris* are well advanced in Canada. However, hybrids produced using cytoplasmic male sterile (cms) system to effect parental crossing in todays commercial production of hybrid seed, have not expressed the full level of heterosis in seed and oil yield. That were evident in the hand crossed F_1 hybrids with normal cytoplasm (Downey & Bell, 1990). Exploitation of hybrid vigour in Indian Mustard [*B. jun*cea (L.) Czern and coss] is difficult since cross pollination in this crop is only 5-15

Therefore, an effort has been made to exploit the heterosis in hand made F_1 crosses of Indian mustard involving genetically diverse parents.

Materials and Methods

The present study is based on a diallel set of 10 genetically diverse parents (Table 1). During rabi season 2007 all possible crosses were made (excluding reciprocals) at the Agricultural Research Farm, R.B.S. College, Bichpuri, Agra. In Rabi 2008 all the 45 F_1's along with these parents were grown in a randomized block design with three replications. Each replication consisted of 4 rows of 3mt. length accommodating 20 plants per row and row to row distance was 50 cm. The data were recorded on 5 and 10 randomly selected plants in parent and F_1 population respectively for yield and its contributing characters. The heterosis over mid parent (M.P.) and superior parent (SP) was estimated as follows heterosis over mid parent in percent (H_1).

$$H_1 = \frac{F_1 - MP}{MP} \times 100$$

Where F_1 is the hybrid mean and MP is the mean value of the two parents involved in that cross.

Heterosis over superior parent in percent (H_2)

$$H_2 = \frac{F_1 - SP}{SP} \times 100$$

Where F_1 is the hybrid mean and SP is the mean value of superior parents of that particular cross.

Results and Discussion

Mid parent heterosis and superior parent heterosis (heterobeltiosis) are important parameters as they provide information about the presence of dominance and over dominance type of gene action in the expression of various traits. The results on heterosis (table 2) indicated existence of desirable heterosis over mid parent and superior parent for seed yield and its related traits, in many cross combinations.

Table 1: List of parents involved in the study

Code No.	Parents
1.	Pusa Bahar
2.	Pusa Jaikishan
3.	Pusa Bold
4.	RH-30
5.	Varuna
6.	Kranti
7.	BEC-144
8.	BIO-YSR
9.	BEC-286
10.	RC-781

For days to 50 % flowering heterosis over mid parental value ranged from -8.76 to 7.13 %. The cross combination Pusa Jaikishan X Kranti (2x6) followed by BEC-144 x BIO –YSR (7x8) had high negative heterosis. The heterosis for early flowering over the superior parent ranged from -10.61 to 8.15%. The cross combination Varuna X BEC -144 followed by Varuna X RC-781 showed high negative heterosis over superior parent for earliness -8.1% heterosis was

Table 2: Estimats of hetrosis over superior parent (SP) and mid parent (MP) for 8 character under study in mustard

Crosses	Days to 50% maturity		Days to maturity		Plant height (cm)		No. of primary branches/plant		No. of Secondary branches/plant		No. of seeds/siliqua		1000 seed weight (g)		Seed yield (g)	
	SP	MP	SP	MP	SP	MP	SP	MP	SP	MP	SP	MP	SP	MP	SP	MP
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1x2	1.61	3.05*	2.06	4.02**	2.58	-2.99	46.32**	31.71**	8.84**	-2.97**	7.05**	5.23**	11.95**	15.51**	27.75**	35.00**
1x3	1.20*	1.73	16.59**	12.13**	-1.05	-3.76	36.63**	26.61**	36.43**	9.55**	16.91**	17.04**	7.46**	14.89**	13.92**	26.43**
1.4	-3.43*	-4.34**	13.32**	11.51	-0.15	-0.33**	-2.14**	6.61	0.00**	-8.82**	-4.74**	-0.86*	-5.15**	-3.43**	16.55**	22.41**
1x5	8.15**	7.13**	12.15**	10.11**	2.51	-3.27	44.66**	35.45--	57.43**	26.62**	-8.35**	-4.80**	4.02**	6.56**	10.37**	17.62**
1x6	5.16**	5.429**	6.50**	8.79**	11.43**	6.64*	23.08**	29.55**	-5.35**	-9.86**	2.03**	-3.97**	-6.20**	-1.00**	5.65**	15.33**
1x7	-2.64	0.05	3.02*	7.25**	-0.17	-2.73	0.71	0.83**	0.33	-8.68**	29.01**	15.32**	42.75**	22.95**	21.04**	24.71**
1x8	-2.03	0.21	1.92	6.13**	16.44**	11.77**	22.12**	20.00**	0.97	-20.76**	-8.45**	-4.96**	-5.63**	-14.74**	23.40**	26.04**
1x9	0.98	1.62	0.80	5.40**	0.61	-2.04	15.79**	14.29**	21.05**	1.81**	1.00*	4.30**	33.45**	19.48**	16.72**	25.04**
1x10	3.88*	-2.14*	0.58	5.45**	10.37**	4.70	8.26**	7.33**	-0.15	-0.955**	27.96**	17.24**	6.12**	4.38**	-2.88**	9.83**
2x3	-0.55	-1.43	18.48**	6.63**	1.26	4.00	64.36**	67.68**	26.95**	15.47**	9.96**	12.40**	-16.66**	-13.54**	6.65**	12.35**
2x4	3.77*	1.32	18.88**	9.62**	1.49	6.82*	24.29**	46.84**	19.05**	21.49**	5.82**	12.37**	13.47**	11.92**	24.33**	23.82**
2x5	4.50*	2.03*	15.60**	6.34**	17.39**	17.16**	55.83**	60.50**	38.35**	20.56**	7.48**	13.91**	27.78**	26.82**	20.05**	21.14**
2x6	-7.08**	-8.76**	6.04**	1.74	4.26	5.45*	22.69**	40.53**	-7.27**	-1.60**	23.58**	18.92**	15.34**	18.06**	9.95**	13.80**
2x7	-8.05**	-6.88**	7.30**	5.04**	8.42*	11.55**	21.97**	40.61**	1.82**	3.74**	-0.59*	-9.06**	11.87**	-7.12**	10.21**	7.29**
2x8	-7.27**	-6.46**	13.01**	10.67**	6.67	8.20**	35.84**	46.19**	46.14**	30.18**	-18.08**	-13.18**	-0.07*	-12.86**	15.39**	11.30**
2x9	-5.01**	5.76**	0.17	-1.47	12.14**	15.28**	46.68**	60.66**	14.94**	9.05**	2.06**	7.55**	17.74**	1.72**	12.06**	13.71**
2x10	-1.60	-1.20	1.05	-0.32	5.10	5.41*	35.65**	47.17**	3.61**	5.12**	27.22**	19.23**	5.64**	0.55**	-6.65**	0.28*
3x4	4.95*	3.41*	18.66**	21.30**	-2.21	0.29	22.86**	42.74**	11.16**	23.47**	2.33**	6.39**	-3.23**	-8.16**	1.33	-4.74**
3x5	4.67*	3.13*	15.59**	17.91**	5.49	2.43	36.89**	38.24**	39.36**	33.98**	-8.34**	-4.92**	-1.51**	-5.93**	13.83**	8.77**
3x6	1.65	1.37	6.25**	12.60**	3.31	1.70	-1.04*	11.39**	-9.81**	3.79**	21.30**	14.03**	11.71**	-12.92**	27.40**	25.04**
3x7	0.43	2.61*	3.61*	11.82**	11.20**	11.41**	-7.58**	4.72**	2.19**	13.35**	9.38**	-2.35**	17.92**	-6.35**	50.89**	34.84**
3x8	0.13	1.90	2.01	10.11**	7.59*	6.23*	58.41**	67.29**	32.43**	29.92**	-21.77**	-18.83**	0.57*	-15.98**	42.85**	30.18**
3x9	3.76*	3.87*	3.35*	12.01**	14.54**	14.66**	51.75**	60.93**	17.35**	21.96**	1.35*	4.55**	-7.92**	-23.07**	39.88**	34.45**
3x10	4.20*	5.55**	3.63*	12.60*0	7.24*	4.67	36.96**	45.83**	3.16**	13.98**	-3.69**	-11.86**	-18.44**	-25.40**	7.98**	10.24**
4x5	1.97	1.97	15.45**	15.19**	4.09	-1.59	30.58**	10.70**	44.38**	22.91**	2.20**	1.99**	6.99**	7.65**	46.47**	47.73**
4x6	3.07*	4.30**	6.55**	10.55**	3.78	-0.49	21.15**	26.30**	4.12**	8.35**	-4.61**	-14.98**	3.41**	7.27**	10.49**	15.07**
4x7	-7.48**	-4.12**	2.60	8.45**	0.11	-2.27	29.92**	26.10**	-23.41**	-23.45**	35.56**	15.73**	18.31**	-0.20	30.57**	27.96**
4x8	-0.21	3.02*	4.52**	10.50	16.14**	11.70**	36.28**	21.74**	27.31**	10.86**	-15.89**	-16.06**	26.85**	12.33**	30.83**	27.04**
4x9	2.51	4.12**	3.29*	9.65**	6.31	3.70	9.65**	-1.57**	32.97**	23.43**	3.00**	2.17**	39.10**	22.05**	37.94**	40.85**
4x10	1.22	4.02**	1.21	7.72**	11.04**	5.54*	23.91**	11.76**	3.01**	2.40**	-0.10*	-12.51**	18.92**	14.81**	16.25**	25.63**
5x6	-7.57**	-6.47**	6.68**	10.91**	9.38**	10.85**	11.15**	24.03**	-5.21**	12.63**	25.32**	13.12**	11.34**	14.81**	22.99**	36.19**
5x7	-10.61**	-7.37**	5.47*	10.76**	11.15**	14.58**	15.91**	30.21**	15.56**	32.56**	26.37**	8.13**	-0.16*	-16.37**	14.85**	10.77**

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
5x8	-4.53*	-1.44	2.42	8.51**	4.02	5.72*	38.94**	45.37**	5.54**	7.62**	-9.21**	-9.21**	17.88**	3.66**	18.83**	13.55**
5x9	1.31	2.90*	1.77	8.27**	0.52	3.45	22.19**	28.39**	9.19**	17.69**	-6.24**	-6.82**	21.93**	14.95**	13.14**	13.77**
5x10	-8.40**	-5.88**	0.15	6.82**	7.82*	8.36**	37.30**	44.86**	4.52**	19.45**	26.16**	10.75**	17.83**	13.03**	15.81**	23.37**
6x7	-1.88	0.51	4.19*	6.24**	2.46	4.24	2.27**	3.05**	1.67**	-2.63**	6.74**	1.66**	40.19**	13.19**	57.01**	47.36**
6x8	-4.32*	-2.34*	2.73	4.77**	6.12	6.43**	11.50**	3.70**	25.87**	4.57**	-2.26**	7.26**	17.66**	-0.12**	19.94**	11.50**
6x9	1.53	1.91	3.42*	5.92**	3.68	5.41*	17.98**	10.25**	-10.31**	-20.37**	-0.43*	8.66**	31.21**	10.32**	16.72**	14.34**
6x10	-2.60	-1.13	3.25*	6.03**	9.24*	8.33**	50.87**	41.63**	17.62**	12.13**	22.32**	19.25**	26.44**	17.37**	21.83**	26.62**
7x8	-7.06**	-7.43**	4.19*	4.21**	3.75	2.24	46.46**	35.10**	31.47**	14.67**	-13.27**	-0.75*	23.50**	28.79**	22.14**	21.05**
7x9	3.87*	1.73	4.05*	4.52**	1.53	1.45	16.23**	7.72**	-7.39**	-13.88**	-0.88*	12.84**	39.68**	44.49	19.70**	24.62**
7x10	-2.55	-3.40*	1.38	2.12*	7.48	4.71	30.87**	21.86**	-2.26**	-2.68**	18.69**	21.36**	24.26**	39.48**	3.77**	14.21**
8x9	0.87	-0.80	1.34	1.78	2.63	4.04	8.77**	9.25**	-8.76**	-3.45**	-0.51**	-1.12**	46.34**	45.13**	17.86**	23.76**
8x10	-2.55	-3.02*	2.36	3.09*	8.51*	7.28**	12.91**	13.90**	1.36*	13.87**	23.02**	7.99**	20.13**	29.77**	10.43**	22.51**
9x10	-5.24**	-4.14--	1.87	2.16*	7.26*	4.58	18.26**	18.78**	5.42**	12.36**	1.65**	10.16**	15.40	25.61**	19.38**	26.51**

* Significant at 5% level ** Significant at 1% level

reported by Asthna and Pandey (1977) but Pandey et al. (1977) did not find any hybrid to be earlier than the earliest flowing parent. This contradiction could be attributed to the differences in the genotypes. The overall heterosis for maturity was not appreciable and only two crosses over mid parent and one cross over superior parent showed non-significant negative heterosis.

The heterosis for number of primary and secondary branches /plant over the mid parental value ranged from -1.57 to 67.68% and -1.60 to 33.98 while the heterosis over superior parent ranged from -1.04 to 64.36 and -0.15 to 57.43% respectively. The cross combination Pusa Jaikishan X Pusa Bold (2x3) and Pusa Bold xBIO-YSR (3x8) showed high heterosis over both mid parent and superior parent for number of primary branches/plant, while for number of secondary branches/plant cross combination Pusa Bold X varuna (3x5) over mid parent and Pusa Bahar x Varuna (1x5) over superior parent exhibited high heterosis.

For number of seeds /siliqua , heterosis over mid parent and superior parent ranged from 0.86 to 21.36% and -0.43 to 35.56% respectively. The cross BEC -144 x RC-781 (7x10) showed high desirable heterosis over mid parent while RH-30x BEC-144 (4x7) showed high heterosis over superior parent. For 1000 seed weight heterosis over mid parent and superior parent ranged from 0.12 to 45.13 % and -0.07 to 46.34% respectively. The cross combination BIO-YSR X BEC-286 (8x9) showed high desirable heterosis over both the mid parent and superior parent.

Heterosis for seed yield over mid parent ranged from -4.74 to 47.73% and over superior parent ranged from -6.65 to 57.01%. The cross RH-30 x Varuna (4x5) and Kranti x BEC -144 (6x7) and Pusa Bold x BEC -144 (3x7) over superior parent showed high desirable heterosis . The cross Kranti x BEC -144 (6x7) exhibited high heterosis over both mid and superior parent for seed yield. The crosses while exhibited high heterosis for seed yield no. of seeds /siliqua and 1000 seed weight may throw desirable recombinants in segregating generations or may also be used to develop the base population for S_2 selection.

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