

HETEROSIS FOR SEED YIELD AND YIELD CONTRIBUTING CHARACTERS IN INDIAN MUSTARD [*Brassica juncea* (L.)]

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ABSTRACT

Fifteen F_1 crosses of mustard (*Brassica juncea*) obtained by half diallel mating using six parents (excluding reciprocal) to estimate useful heterosis for seed yield and yield contributing characters. The parents, crosses and checks were grown in randomized block design replicated thrice in the year *rabi* 2019 at Research Farm of AICRP (Linseed and Mustard), College of Agriculture, Nagpur and observations were taken on seed yield and its contributing characters. The crosses RH-406 \times Pusa Mustard-31, NRCHB-101 \times RH-406, NRCH-101 \times RH-749, Giriraj \times Pusa Mustard-31 and RH-749 \times Pusa Mustard-31 had high mean performance and exhibited significant standard heterosis over the best check TAM 108-1 for yield and most of the characters viz., days to first flower, plant height, number of primary branches plant⁻¹, number of siliquae plant⁻¹, siliqua density on main branch, and thousand seed weight. These crosses identified as superior crosses, which can be utilized for development of hybrid varieties.

(Key words: Indian mustard, heterosis, useful heterosis, yield and yield contributing characters)

INTRODUCTION

Mustard is an important oilseeds crop. It accounts for nearly 20-22% of the total oilseeds produced in the country (Anonymous, 2018). Indian mustard [*Brassica juncea* (L.) Czern and Coss.] belongs to the family Cruciferae (Brassicaceae), commonly known as the mustard family of genus *Brassica*. Indian mustard genome content AABB is a natural amphidiploids ($2n = 36$) of *Brassica rapa* ($2n = 20$) and *Brassica nigra* ($2n = 16$). Oilseed Brassicas grown in India are *B. juncea*, *B. rapa*, *B. napus*, *B. carinata*, and *B. campestris* predominates and account for about 90% area under rapeseed-mustard crops (Chaurasiya, 2018). Mustard is predominantly grown in India for extraction of oil. In terms of area under oilseeds, India holds premier position in the world but the yield of the most of oilseeds is less than the world average. On the other hand, the demand of edible oils is increasing very rapidly with increasing population and has been estimated to be 20.20 million tonnes for the year 2020, 28.40 million tonnes for the year 2030 and 41.6 million tonnes for the year 2050 (Kumar, 2017). Mustard is minor crop in Vidarbha region of Maharashtra. Yield potential of mus-

tard crop is low in Vidarbha region as compared to India, there is need of producing high yielding varieties / hybrids with early maturity and high oil content. Study on heterosis is useful in deciding the direction and prospects of future improvement programme, which might be more promising than the conventional breeding programme.

MATERIALS AND METHODS

The experimental material comprising of six genotypes of Indian mustard (*Brassica juncea*) were crossed in diallel mating design excluding reciprocals to obtained 15 crosses during *rabi* 2018-19. F_1 along with 6 parents and checks viz., TAM 108-1, ACN -9, Kranti and Bio-902 were evaluated in randomized block design with three replications in *rabi* 2019-20 at Research field of AICRP (Linseed and Mustard), College of Agriculture, Nagpur. Observations were recorded on days to first flower, days to maturity, plant height (cm), number of branches plant⁻¹, number of siliquae plant⁻¹, siliqua density on main branch, 1000 seed weight (g) and seed yield plant⁻¹(g). The data were subjected to statistical analysis. (Panse and Sukhatme, 1954.)

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RESULTS AND DISCUSSION

The analysis of variance for heterosis was estimated for days to first flower, days to maturity, plant height (cm), number of primary branches plant⁻¹, number of siliquae plant⁻¹, siliqua density on main branch, 1000 seed weight and seed yield plant⁻¹ and data are presented in Table 1. The mean squares due to genotypes were significant for all the eight characters under study indicating substantial genetic variability among the genotypes for all the traits studied. The variation due to genotypes was further partitioned into variation due to parents, crosses and parent vs crosses. The mean squares due to parents, crosses and parent vs crosses exhibited significant difference for all characters. Similar results were also observed by Patel *et al.* (2010) and Vaghela *et al.* (2010) and Saikia *et al.* (2019) for seed yield and its contributing characters in their studies.

It was observed that thirteen crosses exhibited significant negative useful heterosis over check TAM 108-1 for days to first flower in all the crosses with the highest negative heterosis being exhibited by the cross RH-406 × Pusa mustard-31 (24.78 %). None of the crosses showed significant useful heterosis over TAM 108-1 desirable in negative direction for days to maturity. For plant height, negative significant useful heterosis over TAM 108-1 was recorded in five crosses, whereas only two crosses showed positive value. Highly negative significant useful heterosis over TAM 108-1 was reported in four crosses, while one cross was noted for high significant positive value. Highest significant negative useful heterosis was observed in the cross Pusa mustard-31 × Kranti (-20.02%) followed by NRCHB-101 × RH-749 (-19.74%) and NRCHB-101 × Pusa mustard-31 (-17.46%). Heterosis for plant height was also reported by Meena *et al.* (2015) and Saikia *et al.* (2019). The cross NRCHB-101 × RH-749 (24.10%) and NRCHB-101 × RH-406 (24.10%) followed by Giriraj × Kranti (22.89%) showed highest useful heterosis for number of branches plant⁻¹. Positive significant useful heterosis over best check TAM 108-1 were observed in seven crosses, while six crosses exhibited positive non significance. Patel *et al.* (2010) and Adhikari *et al.* (2017) in their study noted economic heterosis for primary branches plant⁻¹.

Most promising cross exhibited useful heterosis over check TAM 108-1 were the Giriraj × Pusa mustard-31 (32.42%) followed by RH-749 × Pusa mustard-31 (30.83%) and NRCHB-101 × RH-749 (30.55%) for number of siliquae plant⁻¹. Positive significant useful heterosis over best check TAM 108-1 were observed in six crosses, while three crosses exhibited positive non significance. Higher magnitude of useful heterosis was observed by Nair *et al.* (2018) for number of siliquae plant⁻¹. The cross combinations Giriraj × Pusa mustard-31 (39.13%) and Pusa mustard-31 × Kranti (39.13%) showed highest useful heterosis followed by NRCHB-101 × RH-749 (33.33%) and Giriraj × Kranti (29.57%) for siliqua density on main branch. Out of fifteen hybrids, nine hybrids exhibited significant positive useful heterosis

over TAM 108-1 for siliqua density on main branch and the cross Giriraj × Pusa mustard-31 (14.66%) followed by RH-406 × Pusa mustard (14.02%) and NRCHB-101 × RH-749 (13.70%) for thousand seed weight. Positive significant useful heterosis over best check TAM 108-1 were observed in six crosses, while two crosses exhibited positive non significance. Significant useful heterosis in desirable direction for number of siliquae on main raceme and test weight was reported by Adhikari *et al.* (2017) in their study. Six crosses were found to be highly significant positive for useful heterosis over best check TAM 108-1, while five crosses showed non significance for seed yield plant⁻¹. The cross combination RH-406 × Pusa mustard-31 (50.32%) was highly significant and ranked first for useful heterosis over best check TAM 108-1 followed by NRCHB-101 × RH-406 (50.02%) and NRCHB-101 × RH-749 (48.21%). Adhikari *et al.* (2017), Nair *et al.* (2018) and Saikia *et al.* (2019) observed the significant heterosis for seed yield in their studies.

Effective utilization of heterosis to develop high yielding hybrids is one of the major objectives of *Brassica* oilseed breeding in the recent years. On basis of high mean performance and significant useful heterosis in desirable direction, the potential crosses were identified for their exploitation and are listed in Table 3. Out of 15 crosses, the F₁ hybrid RH-406 × Pusa Mustard-31 was identified as the best hybrid as it was significantly superior over check and showed highly positive significant useful heterosis over check TAM 108-1 for seed yield plant⁻¹ and also exhibited significant positive useful heterosis over check TAM 108-1 for number of siliquae plant⁻¹, siliqua density on main branch and thousand seed weight and highly negative significant heterosis for days to first flower. The cross NRCHB-101 × RH-406 possessed significant superiority and had highly significant positive useful heterosis over TAM 108-1 for seed yield plant⁻¹. Similarly, this hybrid also exhibited highly significant positive useful heterosis over TAM 108-1 for number of primary branches plant⁻¹, number of siliquae plant⁻¹ and thousand seed weight and highly negative significant useful heterosis for days to first flower.

The cross combination NRCHB-101 × RH-749 was significantly superior over TAM 108-1 for seed yield plant⁻¹ and exhibited highly significant positive useful heterosis for seed yield plant⁻¹, number of primary branches plant⁻¹, number of siliquae plant⁻¹, siliqua density on main branch and thousand seed weight and highly negative significant for plant height. The cross Giriraj × Pusa Mustard-31 was found to be significantly superior over TAM 108-1 for seed yield plant⁻¹ and also expressed high significant positive useful heterosis for seed yield plant⁻¹, number of primary branches plant⁻¹, number of siliquae plant⁻¹, siliqua density on main branch and 1000 seed weight and desirable negative significant useful heterosis for days to first flower.

The cross RH-749 × Pusa Mustard-31 showed highly positive significant useful heterosis and was significantly superior over check TAM 108-1 for seed yield plant⁻¹ and exhibited highly significant positive heterosis

Table 1. Analysis of variance for heterosis

Source	d.f	Mean square						
		Days to first flower	Days to maturity	Plant height (cm)	Number of branches plant ⁻¹	Number of siliquae plant ⁻¹	Siliqua density on main branch	Thousand seed weight (g)
Genotypes	20	28.23**	40.471**	885.24**	0.90**	12693.46**	0.03**	0.66**
Parents	5	19.20**	34.62**	290.28**	0.51**	7973.72**	0.03**	0.03**
Crosses	14	26.95**	30.59**	1116.28**	0.88**	10481.05**	0.03**	0.92**
Parents vs Crosses	1	91.42**	208.01**	625.51**	3.20**	67265.86*	0.05**	0.08**
Error	40	4.9	9.46	73.21	0.13	1583.35	0.001	0.006

** = Significant at 1 % level.

* = Significant at 5 % level

Table 3. Crosses selected for heterosis breeding on the basis of mean performance, useful heterosis over check TAM 108-1 for yield and other traits

Cross	Mean performance for seed yield plant ⁻¹ (g)	Useful heterosis over check TAM 108-1 for seed yield plant ⁻¹ (g)	Heterosis superior over best check for other character
RH-406 × PM-31	16.38	50.32**	DFF, NoS, SD and TW
NRCHB-101 × RH-406	16.35	50.02**	DFF, PB, NoS, and TW
NRCHB-101 × RH-749	16.15	48.21**	PH, PB, NoS, SD and TW
Giriraj × PM-31	15.95	46.38**	DFF, PB, NoS, SD and TW
RH-749 × PM-31	15.31	40.47**	PB, NoS, SD and TW

** = Significant at 1 % level.

* = Significant at 5 % level.

DFF-Days to first flower, DM- Days to maturity, PH- Plant height (cm), PB- Number of branches plant⁻¹, NoS- Number of siliquae plant⁻¹, SD- Siliqua density on main branch and TW- Thousand seed weight (g)

Crosses	Days to first flower		Days to maturity		Plant height (cm)		Number of branches plant ⁻¹		Number of siliquae plant ⁻¹		Siliqua density on main branch		Thousand seed weight (g)		Seed yield plant ⁻¹ (g)	
	Mean	H	Mean	H	Mean	H	Mean	H	Mean	H	Mean	H	Mean	H	Mean	H
NRCHB-101 × RH-749	44.33	-1.92	117.33	3.83	154.73	-19.74**	6.87	24.10**	423.67	30.55**	0.55	33.33**	5.87	13.70**	16.15	48.21**
NRCHB-101 × Gimiraj	44.33	-1.92	117.67	4.13	175	-9.23*	5.87	6.02	358.47	10.46	0.35	-23.19**	5.25	1.68	12.94	18.72
NRCHB-101 × RH-406	38.67	-14.45**	108.67	-3.83	186.07	-3.49	6.87	24.10**	421.47	29.87**	0.47	2.17	5.74	11.24**	16.35	50.02**
NRCHB-101 × Pusa mustard-31	40.67	-10.03*	115.67	2.36	159.13	-17.46**	5.4	-2.41	352.53	8.63	0.56	21.70**	5.08	-1.61	12.37	13.52
NRCHB-101 × Kranti	38.33	-15.19**	111	-1.77	173.4	-10.06**	6.6	19.28**	405.27	24.88*	0.52	13.77*	4.23	-18.09**	15.06	38.21**
RH-749 × Gimiraj	36.33	-19.62**	109.33	-3.24	184.2	-4.46	6.33	14.46**	271.33	-16.39	0.46	0.72	4.18	-19.06**	10.83	-0.64
RH-749 × RH-406	37.33	-17.40**	110	-2.65	187.13	-2.94	5.87	6.02	279.5	-13.88	0.34	-25.36**	5.09	-1.42	9.41	-13.61
RH-749 × Pusa mustard-31	41	-9.29*	111.33	-1.47	193.53	0.38	6.63	19.88**	424.6	30.83**	0.36	20.87**	5.71	10.66**	15.31	40.47**
RH-749 × Kranti	39.67	-12.24**	110.67	-2.06	183.93	-4.6	6.07	9.64	314.13	-3.2	0.54	17.47**	5.08	-1.61	10.91	0.15
Gimiraj × RH-406	36.67	-18.88**	110	-2.65	187.2	-2.9	5.6	1.2	291.13	-10.29	0.4	-12.32	5.11	-1.03	10.36	-4.89
Gimiraj × Pusa mustard-31	35.33	-21.83**	111.33	-1.47	201.27	4.39	6.77	22.29**	429.73	32.42**	0.44	39.13**	5.92	14.66**	15.95	46.38**
Gimiraj × Kranti	39.33	-12.98**	117	3.54	223.07	15.70**	6.8	22.89**	368.27	13.48	0.6	29.57**	4.68	-9.30**	10.42	-4.34
RH-406 × Pusa mustard-31	34	-24.78**	109	-3.54	187.07	-2.97	5.93	7.23	407.13	25.45*	0.59	28.99**	5.88	14.02**	16.38	50.32**
RH-406 × Kranti	41.33	-8.55*	114.67	1.47	210.53	9.20*	5.73	3.61	309.87	-4.52	0.49	5.8	5.32	3.04*	12.78	17.31
Pusa mustard-31 × Kranti	37.67	-16.67**	112.67	-0.29	154.2	-20.02**	5.4	-2.41	296.03	-8.78	0.64	39.13**	5.19	0.58	12.72	16.7
TAM 108-1	45.33		113.00		192.80		5.53		324.53		0.46		5.16		10.90	
CD (5%)	3.65		5.08		14.11			0.59	65.66			0.05		0.14		2.24
CV	5.45		2.66		4.57		7.33		10.48		7.17		1.52		10.11	

for number of primary branches, number of siliqua plant⁻¹, siliqua density on main branch and thousand seed weight.

The selection of crosses on basis of heterosis and better *per se* performance was also done by Vaghela *et al.* (2013), Barupal *et al.* (2016) and Saikia *et al.* (2019). So the above crosses after the evaluation in various yield trials can be used for development of hybrids after conversion of female line into CMS background as conventional hybrids are not economically feasible in mustard

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