J. Soils and Crops 31 (1) 152-157, June 2021

ISSN 0971-2836 (Print)
ISSN 2582-2756 (Online)

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

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ABSTRACT

The present investigation in Indian Mustard (*Brassica juncea (*L.*)*Czern and Coss) was carried out at Research field of AICRP (Linseed and Mustard), College of Agriculture, Nagpur to study the heterosis for seed yield and contributing traits. Thirty F_1 crosses of Indian mustard (*Brassica juncea* L.) obtained by full diallel fashion using six parents.The parents, crosses and checks were grown in randomized block design replicated thrice and observations were taken 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 analysis of variance for experimental design revealed significant genetic variability among them which allowed its exploitation of material for further analysis. The mean squares due to parents, crosses and parent Vs crosses exhibited significant difference for all the characters.This indicates the suitability of data for estimation of heterobeltiosis and useful heterosis.The crosses ACNM 52 x ACNMM 29, ACNMM14 x ACNMM9 and ACNMM14 x ACNMM27 had high mean performance and exhibited significant standard heterosis over the superior check for yield and most of its contributing characters. These crosses identified as superior crosses, which can be utilized for development of hybrid varieties.

(Key words: Indian mustard, full diallel, heterobeltiosis, standard heterosis)

INTRODUCTION

Rapeseed-Mustard are important oilseed crops of the world being grown in 53 countries across the six continents. The crop is grown both in sub-tropical and tropical countries. In Asia, it is mainly grown in China, India, Pakistan and Bangladesh. Among different oilseed crops grown in India, the Rapeseed-Mustard (*Brassica* spp.) contributes 29.5% in the total production of oilseeds. In India, it is the second most important edible oilseed crop after soybean sharing 27.8% in the India's oilseeds economy. Out of the total cropped area in India, the share of oilseeds is 14.1% and mustard itself accounts for 3% of it (Anonymous, 2018).

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

Thirty crosses along with parents and checks were grown at AICRP on linseed and mustard experimental farm, College of Agriculture, Nagpur during *rabi* 2018-19 in randomized block design with three replications. The spacing of 0.45 x 0.10 m^2 was maintained to accommodate 50 plants in each row. The data 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 statistical analysis was done as per method suggested by Giffing (1956).

RESULTS AND DISCUSSION

The analysis of variance for heterosis was estimated for days to first flower, days to maturity, plant

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height (cm), number of branches plant^{-1}, siliqua density on main branch, number of siliquae plant^{-1}, 1000 seed weight and seed yield plant^{-1} and the data are presented in Table 1. The mean squares due to genotypes, parents, crosses and parents vs crosses were significant for all the eight characters under study indicating substantial genetic variability among the genotypes for all the traits studied. Similar results were also observed by Vaghela *et al.* (2011) and Saikia *et al.* (2019) for seed yield and its contributing characters in mustard. The above scientists concluded the presence of variability among genotypes from the significant mean squares due to genotypes, crosses, parent Vs crosses observed by them. Heterosis breeding is one of the successful breeding options for the improvement of crop. Study of heterosis helps in identifying desirable gene action (Singh *et al.*, 2020).

It was observed that eight crosses exhibited significant negative useful heterosis over check Kranti for days to first flower among all the crosses with the highest negative heterosis being exhibited by the cross ACNMM29 × ACNMM14 (-19.63%). For days to maturity twenty two crosses showed significant useful heterosis over Kranti in desirable negative direction and highest negative useful heterosis was reported in cross hybrid ACNMM29 X ACNMM14 (-8.63%) cross. For plant height, negative significant useful heterosis over Kranti was recorded in fifteen crosses, whereas only four crosses showed positive value. Highly negative significant useful heterosis over Kranti was reported in nine crosses. Highest significant negative useful heterosis was observed in the cross ACN MM27 × ACNMM13 (-24.29%) followed by ACNMM14 × ACNMM9 (-24.02%). Heterosis for plant height was also reported by Meena *et al.* (2015) in crosses PRB-2008-5 × PRB-2004-3-4, PRB-2008-5 × PRE-2009-9, PRE-2009-9 × NDYR-8 and Saikia *et al.* (2019) in cross PM-27 x Pusa Mahek in mustard. The crosses ACNMM14 × ACNMM9 (39.37%) and ACNM52 × ACNMM29 (37.01%) followed by ACN MM14 × ACNMM27 (36.29%) showed highest useful heterosis for number of branches plant^{-1}. Positive significant useful heterosis over best check Kranti were observed in seven crosses, while eleven crosses exhibited positive non significant useful heterosis over Kranti. Patel *et al*. (2010) and Adhikari *et al.* (2017) in their study noted economic heterosis for primary branches plant^{-1} in mustard.

Most promising cross exhibited useful heterosis over check Kranti was the ACNM52 × ACNMM29 (42.84%) followed by ACNMM14 x ACNMM9 (39.97%) and ACNM52 × ACNMM27 (39.90%) for number of siliquae plant^{-1}. Positive significant useful heterosis over best check Kranti were observed in eleven crosses, while seventeen crosses exhibited positive non significance useful heterosis over Kranti. Higher magnitude of useful heterosis was observed by Nair *et al.* (2018) for number of siliquae plant^{-1} in mustard. The cross combinations ACNMM13 × ACNM52 (67.27%) and ACNMM9 × ACNMM27 (48.48%) showed highest useful heterosis followed by ACNMM13 ×ACNMM 9 (45.45%) for siliqua density on main branch. Out of thirty hybrids, eight hybrids exhibited significant positive useful heterosis over Kranti for siliqua density on main branch. The cross ACNMM52 × ACNMM29 (25.10%) followed by ACNMM14 × ACNMM9 (20.06%) and ACNMM29 × ACNMM14 (19.94%) exhibited significant positive heterosis for thousand seed weight. Positive significant useful heterosis over best check Kranti were observed in six crosses, while three crosses exhibited positive non significance useful heterosis over Kranti. Significant useful heterosis in desirable direction for number of siliquae on main raceme and test weight was reported by Adhikari *et al.* (2017) in mustard. Fifteen crosses were found to be positive significant for useful heterosis over best check Kranti, while ten crosses showed non significance for seed yield plant^{-1}. The cross combination ACNMM52 × ACNMM29 (59.97%) was highly significant and ranked first for useful heterosis over best check Kranti followed by ACNMM14 × ACNMM9 (58.52%) and ACNMM14 × ACNMM27 (54.99%). Adhikari*et al.* (2017), Nair *et al.* (2018) and Saikia *et al.* (2019) observed the significant heterosis for seed yield in their studies.

On basis of high mean performance and significant useful heterosis in desirable direction, the potential crosses were identified for their exploitation are listed in Table 3. Out of 30 crosses,the F_1 hybrid ACNM52 x ACNMM29 (59.97%) was identified as the best hybrid as it was significantly superior over check and showed higly positive significant useful heterosis over check Kranti for seed yield plant^{-1} and also exhibited significant positive useful heterosis over check Kranti for number of branches plant^{-1}, siliqua density on main branch, number of siliqua plant $^{-1}$ and thousand seed weight and negative significant heterosis for plant height and days to maurity. The cross ACNMM14 × ACNMM9 (58.52%) possessed significant superiority and had highly significant positive useful heterosis over Kranti for seed yield plant^{-1} and also exhibited positive useful heterosis for number of branches plant^{-1}, number of siliquae plant^{-1}, siliqua density on main branch and thousand seed weight and negative useful heterosis for plant height. Similarly, cross hybrid ACNMM14 x ACNMM27 (54.49%) also exhibited highly significant positive useful heterosis over Kranti for seed yield plant^{-1}, number of branches plant^{-1}, number of silique plant^{-1} and also for days to maturity showed highly negative significant useful heterosis.

The selection of crosses on basis of heterosis and better *per se* performance was also done by Chavan *et al.* (2019) in maize, Vaghela *et al.* (2013) in mustard and Saikia *et al*. (2019) in mustard. 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.

Table 1. Analysis of variance for heterosis

Source Of variation	Degrees of freedom	Means squares							
		Days to first flower	Days to maturity	Plant height (cm)	Number of branches^{1} plant^{-}	Siliqua density on main branch	Number of siliquae plant^{-1}	1000 seed weight	Seed yield plant^{-1} (g)
Replications	2	11.66	4.42	179.72	0.23	0.02	1280.71	0.53	1.59
Genotypes	35	18.25**	10.70**	701.50**	0.94**	0.06**	2745.96**	1.28**	13.65**
Parents	5	15.31**	6.39**	434.97**	0.85**	0.05**	2941.59**	0.83**	8.06**
Crosses	29	17.70**	10.62**	742.52**	0.84**	0.06**	2139.51**	1.35**	11.09**
Parent Vs crosses	1	48.68**	34.41**	844.70**	4.39**	0.16**	19354.89**	1.40**	115.70**
Error	70	4.43	1.66	120.03	0.25	0.01	734.42	0.20	1.65

Table 2. Crosses selected for heterosis breeding on the basis 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 Kranti for seed yield plant^{-1}(g)	Heterosis superior over best check for other characters
ACNM52 X ACNMM29	15.52	59.97**	DM, PH, NOS, PB, SD, TW
ACNMM14 X ACNMM9	15.38	58.52**	PH, PB, NOS, TW
ACNMM14 X ACNMM27	14.99	54.49**	DM, PB, NOS

** = 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 siliqua plant^{-1}, SD- Siliqua density on main branch and TW- Thousand seed weight (g)

Table 3. Mean performance and magnitude of useful heterosis over Kranti (H)

Crosses	Days to first flower		Days to maturity		Plant height (cm)		Number of branches plant^{-1}		Number of siliqua 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
ACNMM29xACNMM13	39.47	-0.17	109.45	2.97**	175.32	-11.55*	3.24	-0.12	212.33	14.06	0.46	-15.76	5.02	-4.01	10.47	7.90
ACNMM29 x ACNM52	40.85	3.33	102.77	-3.31**	184.86	-6.74	3.35	3.27	233.20	25.27*	0.47	-13.94	4.94	-5.67	10.71	10.45
ACNMM29xACNMM14	31.77	-19.63**	97.12	-8.63**	186.18	-6.08	4.08	25.80*	207.14	11.27	0.42	-23.64	6.28	19.94**	11.20	15.46
ACNMM29xACNMM27	38.07	-3.71	102.07	-3.97**	156.84	-10.78*	3.47	7.18	217.31	16.73	0.68	24.24	5.14	-1.85	12.38	27.59*
ACNMM29 x ACNMM9	39.51	-0.07	101.00	-4.98**	158.55	-20.01**	3.24	0.08	257.20	38.16**	0.44	-19.64	5.22	-0.32	9.43	-2.78
ACNMM13XACNMM29	38.55	-2.50	103.59	-2.54*	186.41	-5.96	3.79	16.85	197.60	6.15	0.57	4.24	4.94	-5.54	10.21	5.30
ACNMM13 x ACNM52	39.51	-0.07	105.00	-1.21	191.33	-3.47	4.14	27.75*	188.40	1.21	0.92	67.27**	4.76	-8.98	12.14	25.15*
ACNMM13xACNMM14	39.80	0.67	104.05	-2.10*	191.27	-3.50	3.24	-0.02	180.66	-2.95	0.65	18.18	4.78	-8.73	13.52	39.42**
ACNMM13xACNMM27	39.07	-1.18	104.08	-2.08*	194.21	-2.02	3.42	5.53	211.74	13.74	0.49	-10.91	4.97	-4.97	10.83	11.62
ACNMM13 x ACNMM9	37.87	-4.21	104.20	-1.97	178.93	-9.73*	3.97	22.61	199.57	7.20	0.80	45.45**	6.22	18.85**	9.17	-5.50
ACNM52X ACNMM29	36.22	-8.38	103.47	-2.66*	156.47	-21.06**	4.44	37.01**	265.91	42.84**	0.80	44.85**	6.55	25.10**	15.52	59.97**
ACNM52X ACNMM13	37.34	-5.56	104.00	-2.15*	187.02	-5.65	3.78	16.75	241.03	29.48*	0.68	23.64	4.45	-15.03*	12.09	24.67*
ACNM52 x ACNMM14	36.59	-7.45	104.00	-2.15*	202.68	2.25	4.28	31.97*	254.97	36.97**	0.78	41.82*	4.85	-7.39	14.94	53.99**
ACNM52 x ACNMM27	32.35	-18.16**	104.67	-1.53	203.50	2.66	3.83	18.19	260.44	39.90**	0.72	30.30	6.19	18.22*	11.40	17.56
ACNM52 x ACNMM9	38.97	-1.43	102.33	-3.72**	196.25	-0.99	3.40	5.02	194.34	4.40	0.44	-20.61	4.84	-7.52	11.29	16.43
ACNMM14xACNMM29	39.84	0.78	103.18	-2.92**	180.22	-9.08*	3.23	-0.23	238.69	28.22*	0.69	24.85	5.46	4.39	10.11	4.26
ACNMM14xACNMM13	41.80	5.73	104.33	-1.84	184.65	-6.84	4.10	26.52*	207.96	11.71	0.68	23.64	4.31	-17.71*	12.16	25.36*

Continued Table 3……..,

Crosses	Days to first flower		Days to maturity		Plant height (cm)		Number of branches $plant^{-1}$		Number of siliqua $plant^{-1}$		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
ACNMM14xACNM52	33.34	-15.66**	103.76	-2.38*	199.67	0.73	3.61	11.41	230.00	23.55	0.67	21.82	4.27	-18.41**	13.57	39.86**
ACNMM14xACNMM27	35.15	-11.08*	103.17	-2.94**	207.03	4.44	4.42	36.29**	247.20	32.79**	0.61	10.91	6.17	17.90*	14.99	54.49**
ACNMM14x ACNMM9	38.65	-2.23	104.35	-1.83	150.60	-24.02**	4.52	39.37**	260.56	39.97**	0.79	44.24**	6.28	20.06**	15.38	58.52**
ACNMM27xACNMM29	38.80	-1.85	104.67	-1.53	170.32	-14.08**	3.10	-4.34	172.26	-7.47	0.72	16.97	4.42	-15.54*	12.14	25.12*
ACNMM27XACNMM13	34.97	-11.53**	104.49	-1.69	150.07	-24.29**	2.51	-22.55	251.79	35.26**	0.79	43.64**	5.72	9.36	14.32	47.66**
ACNMM27XACNM52	36.82	-6.85	104.07	-2.09*	173.34	-12.55**	2.79	-13.80	218.33	17.28	0.53	-3.03	5.45	4.08	12.62	30.10*
ACNMM27XACNMM14	35.31	-10.69*	104.00	-2.15*	168.36	-15.06**	3.40	5.02	191.99	3.13	0.57	3.64	4.98	-4.84	12.39	27.70*
ACNMM27x ACNMM9	35.20	-10.95*	103.15	-2.96**	182.44	-7.96	2.73	-15.66	216.67	16.39	0.76	38.79*	4.56	-12.80	10.20	5.19
ACNMM9X ACNMM29	36.00	-8.94*	103.93	-2.22*	184.40	-6.97	3.24	-0.12	230.70	23.93*	0.70	27.27	4.45	-14.97*	11.20	15.50
ACNMM9X ACNMM13	37.33	-5.56	102.10	-3.94**	175.43	-11.50*	3.17	-2.18	198.20	6.47	0.53	-3.64	4.93	-5.80	8.92	-8.04
ACNMM9X ACNM52	39.51	-0.07	102.33	-3.72**	161.97	-18.29**	2.90	-10.51	192.41	3.36	0.47	-15.15	4.94	-5.67	9.59	-1.13
ACNMM9X ACNMM14	37.53	-5.06	104.33	-1.84	168.81	-14.84**	3.20	-1.25	195.67	5.11	0.55	0.01	4.31	-17.64*	12.18	25.57*
ACNMM9XACNMM27	38.83	-1.77	102.00	-4.04**	179.07	-9.66*	3.73	15.00	202.70	8.89	0.82	48.48**	5.20	-0.64	9.05	-6.67
Kranti	39.53		106.29		198.22		3.24		186.16		0.55		5.23		9.70	
CD (5%)	3.34		2.25		17.37		0.78		44.09		0.17		0.70		2.03	

*, ** = Significant at 5% and 1% level respectively

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Rec. on 02.11.2020 & Acc. on 20.11.2020