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## Heterotic response analysis for seed yield and its contributing traits in Indian mustard (*Brassica juncea* L. Czern & Coss)

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### Abstract

Highly significant differences were recorded among the treatments, parents,  $F_{1S}$ , parent vs.  $F_{1S}$  for all the characters. The cross combinations namely; Maya x Durgamani, Maya x Urvashi, Jawahar Mustard-1 x Urvashi, Maya x Pusa Agrani, Maya x RLM-198, Durgamani x Urvashi, Urvashi x RLM-198 exhibited significant and positive heterosis over economic parent (Maya) for seed yield per plant.

**Keywords:** *Brassica*, diallele, heterosis and Indian mustard.

### 1. Introduction

Indian mustard [*Brassica juncea* (L.) Czern & Coss] is the dominant species covering around 85 per cent of area under rapeseed mustard in India. The rest of the area is covered by three ecotypes of *Brassica rapa* variety brown sarson, yellow sarson and toria. Among the toria [*Brassica rapa* (L.) spp. Toria] nearly 1.4% area. *Eruca sativa*. *Brassica rapa* L. spp. brown sarson and other occupy nearly 6 percent of the total area. Rapeseed mustard oil is used primarily for edible purposes and is the principal cooking oil in the mustard growing areas of the country. Besides, seeds are used as condiments and in preparations of salad, juices, curries and pickles. The meal cake left after oil extracting forms an important cattle feed and may also be used as organic manure.

### 2. Materials & Methods

The present experiments were carried out using seven diverse genotypes namely; Maya (RK-9902), Pusa agrani, Durgamani, Jawahar mustard-1, Urvashi (RK-9501), Pusa bold and R.L.M.-198. A diallel set (excluding reciprocals) was made to obtain 21 crosses during Rabi, 2009-2010. All the 28 treatments, (7 parents and 21  $F_{1S}$ ) were grown in randomized complete block design with three replications at Oilseed Research Farm, Kalyanpur, C.S. Azad University of Agriculture and Technology, Kanpur during Rabi 2010-2011. The parents and  $F_{1S}$  were grown in single row of five meter length spaced 45 cm apart. The distance of 20 cm between the plants in a row was maintained by thinning. All the recommended agronomic practices were followed for raising the good crop. The following observations were recorded on 5 randomly taken plants in parents and  $F_{1S}$  in each replication namely, days to 50% flowering, days to maturity, plant height (cm), number of siliques per plant, number of secondary branches per plant, length of main raceme (cm), test weight (g), oil content (%) and seed yield per plant (g). Diallel mating design using was proposed by Hayman (1954a) [2]. The combining ability analysis was done by the procedure suggested by Griffing's (1956 b) [1] Method 2, Model I. Oil content was estimated by NMR method.

### 3. Results & Discussion

The results of analysis of variance are given in table-1. Highly significant differences were recorded among the treatments, parents,  $F_{1S}$ , parent vs.  $F_{1S}$  for all the characters. The results of heterosis analysis are given in table-2. Out of 21 crosses the cross combinations namely; Pusa Agrani x Durgamani, Pusa Agrani x Jawahar Mustard-1, Maya x Pusa Agrani, Pusa Agrani x Urvashi, Pusa Agrani x Pusa Bold, Pusa Agrani x R.L.M-198 and Urvashi x Pusa Bold, Durgamani x Pusa Bold, Durgamani x R.L.M-198 showed significant and negative heterosis for early flowering. The cross combinations namely; Pusa Agrani x Urvashi, Pusa Agrani x Jawahar Mustard-1, Pusa Agrani x Pusa Bold, Pusa Agrani x RLM -198, Maya x Pusa Agrani showed negative and significant heterosis for early maturity. The cross combinations namely; Pusa Agrani x Urvashi, Maya x Pusa Agrani, Pusa Agrani x Pusa Bold, Pusa Agrani x R.L.M-

198, Maya x Durgamani, Pusa Agrani x Jawahar Mustard-1, Dugamani x R.L.M-198 showed negative and significant heterosis for dwarf plant height. These results were also similar to Singh *et al.* (2006)<sup>[9]</sup>, Singh *et al.* (2008b)<sup>[8, 10]</sup>, Singh *et al.* (2009c)<sup>[11]</sup>, Singh *et al.* (2010)<sup>[12, 13]</sup>, Singh *et al.* (2010)<sup>[12, 13]</sup> and Tyagi *et al.* (2000)<sup>[14]</sup>.

The cross combinations namely; Pusa Agrani x Urvashi, Pusa Agrani x Durgamani, Pusa Agrani x Pusa bold, Maya x Pusa Bold, Pusa Agrani x R.L.M-198, Maya x Durgamani, Maya x Pusa Agrani, Durgamani x Urvashi, Urvashi x Pusa Bold showed positive and significant heterosis for length of main raceme. The cross combinations namely; Pusa Agrani x Pusa Bold, Pusa Agrani x Urvashi, Pusa Agrani x Jawahar mustard-1, Pusa Agrani x Durgamani, Pusa Agrani x R.L.M-198 showed positive and significant heterosis for more number of siliquae per plant. For number of primary branches per plant only one cross namely; Durgamani x Urvashi showed positive heterosis in F<sub>1</sub> generation over economic parent. The cross combinations namely; Maya x Urvashi, Maya x Pusa Bold, Maya x Pusa Agrani, Maya x Durgamani,

Maya x Jawahar Mustard-1, Maya x RLM-198, Urvashi x RLM-198, Pusa Bold x RLM-198, Jawahar Mustard-1 x Urvashi showed positive and significant heterosis for oil content. The cross combinations namely; Maya x Pusa Bold, Maya x Urvashi, Maya x Jawahar Mustard-1, Pusa Bold x RLM-198, Jawahar Mustard-1 x Pusa Bold, Pusa Agrani x Urvashi, Maya x Durgamani, Jawahar Mustard-1 x Urvashi, Jawahar Mustard-1 x RLM-198, Durgamani x Urvashi, Urvashi x RLM-198, Durgamani x Pusa Bold, Maya x Pusa Agrani showed positive and significant heterosis for test weight and the cross combinations namely; Maya x Durgamani, Maya x Urvashi, Jawahar Mustard-1 x Urvashi, Maya x Pusa Agrani, Maya x RLM-198, Durgamani x Urvashi, Urvashi x RLM-198 exhibited significant and positive heterosis over standard variety (Maya) for seed yield per plant. These results were also similar to Setyendra *et al.* (2009), Sheikh & Singh (2001)<sup>[4]</sup>, Singh *et al.* (2009)<sup>[5]</sup>, Singh & Lallu (2004)<sup>[6]</sup>, Singh *et al.* (2007) and Singh *et al.* (2008)<sup>[10, 8]</sup>,

**Table 1:** ANOVA of parents, F<sub>1</sub>s for 9 characters in a 7 x 7 parental diallel cross analysis in Indian mustard: mean sum of squares.

Source of variation	d.f.	Days to 50% flowering	Days to maturity	Plant height (cm)	Length of main raceme (cm)	No. of Siliquae/plant
Replications	02	04.08	06.25	10.36	0.01	06.58
Treatments	27	49.93**	78.01**	167.16**	106.92**	1169.86**
Parents	06	102.98**	112.15**	340.76**	175.53**	2280.65**
F <sub>1</sub> s	20	33.56**	68.66**	105.71**	70.46**	894.90**
Parents Vs. F <sub>1</sub> s	01	59.06**	60.04**	354.75**	424.32**	04.34
Error	54	2.03	2.02	05.13	3.56	16.44

**Table 1:** Continue.....

Sources of variation	d.f.	No. of secondary branches/plant	Oil content (%)	Test weight (g)	Seed yield /plant (g)
Replications	02	3.32	0.17	0.09	4.00
Treatments	27	09.81**	5.57**	0.85**	42.57**
Parents	06	22.52**	3.40**	1.09**	60.09**
F <sub>1</sub> s	20	06.16	3.97**	0.07*	33.09**
Parents Vs. F <sub>1</sub> s	01	06.67	50.97**	2.10**	127.14**
Error	54	3.51	0.13	0.03	05.71

\*Significant at P = 0.05; \*\*Significant at P = 0.01

**Table 2:** Estimates of heterosis over economic parent for 9 characters in 21 F<sub>1</sub>s derived from a 7 x 7 diallel cross in Indian mustard (*Brassica juncea* L. Czern & Coss): EP= Maya

Cross combinations	Days to flowering		Days to maturity		Plant height (cm)		Length of main raceme (cm)		No. of siliquae/plant	
	EP	SCA	EP	SCA	EP	SCA	EP	SCA	EP	SCA
Maya x Pusa agrani	-7.01**	-0.24	-6.59**	0.23	-9.98**	-2.84*	-7.01**	5.18**	-3.39	21.49**
Maya x Durgamani	0.00	0.39	1.52	1.82*	-5.08**	-3.73*	-7.59**	-1.05	-0.84	1.82
Maya x Jawahar mustard-1	1.75	-1.24	-0.25	-0.55	-2.90	-3.25**	-19.87**	-5.82**	-4.71	-1.88
Maya x Urvashi	3.06*	2.39**	0.00	-0.29	-3.63	-2.62*	-1.17	0.21	-5.56	-16.29**
Maya x Pusa bold	2.63	0.09	0.25	-0.21	-0.36	2.01	-18.12**	-5.64**	-2.07	-1.51
Maya x R.L.M.-198	3.51**	0.87	-1.01	-2.21**	-0.90	1.16	0.00	3.29**	-2.07	3.53
Pusa Agrani x Durgamani	-10.96**	-1.72*	-7.35**	-1.55*	-6.35**	4.79**	-19.87**	-0.79	-11.22**	2.23
Pusa Agrani x Jawahar mustard-1	-7.89**	-2.35**	-6.85**	-0.92	-4.54*	4.60**	-18.12**	2.44**	-16.03**	-4.81*
Pusa Agrani x Urvashi	-6.57**	0.128	-7.61**	-1.99**	-10.70**	-4.77**	-20.47**	-3.53**	-16.41**	-17.55**
Pusa Agrani x Pusa bold	-6.14**	-0.35	-6.85**	-1.25	-9.25**	-3.47*	-19.87**	0.62	-17.83**	-20.10**
Pusa Agrani x R.L.M.-198	-4.82**	0.76	-6.85**	-1.58*	-7.26**	0.34	-17.54**	0.55	-10.65**	10.27**
Durgamani x Jawahar mustard-1	1.31	-0.06	0.51	-0.32	-2.17	-0.95	-0.57	6.55**	-5.94	02.19
Durgamani x Urvashi	-1.31	0.57	0.25	-0.73	-3.63	-1.66	-5.26**	-0.75	-5.37	-7.21**
Durgamani x Pusa bold	-2.63*	-2.39**	0.51	-0.66	-3.26	-2.36*	-1.17	5.40**	-4.62	-2.10
Durgamani x R.L.M.-198	-2.19	-1.94**	1.27	0.01	-4.17*	-3.88**	-2.33	3.32**	-4.71	2.60
Jawahar mustard-1 x Urvashi	3.51**	1.28	0.76	-0.10	-3.08	-4.18*	-0.57	4.14**	-2.83	11.75**
Jawahar mustard-1 x Pusa bold	4.82**	0.31	0.00	-1.36	-2.54	-4.55**	-1.17	7.62**	-5.56	4.53**
Jawahar mustard-1 x R.L.M.-198	0.88	-2.57**	1.27	-0.03	-3.08	-5.40**	0.00	6.88**	-4.71	12.56**
Urvashi x Pusa bold	-3.06*	-3.06**	1.27	0.23	0.00	2.08	-4.08*	1.32	-5.09	-5.21*
Urvashi x R.L.M.-198	0.43	-0.28	1.27	-0.10	0.00	2.23	-1.17	1.58	-4.71	1.16

Pusa bold x R.L.M.-198	0.88	-1.91**	2.54*	1.31	0.35	1.53	-18.12**	-4.27**	-4.24	5.27*
SE (EP) ±	1.16		1.16		1.84		1.54		3.30	
SE (Sij) ±		0.73		0.73		1.17		0.97		2.09
SE (Sij - Sik) ±		1.09		1.09		1.74		1.45		3.11

Table 2: Continue.....

Source of variation	No. of secondary branches/ plant		Oil content (%)		Test weight (g)		Seed yield/ plant (g)	
	EP	SCA	EP	SCA	EP	SCA	EP	SCA
Maya x Pusa agrani	-13.90**	-0.29	4.64**	1.31**	0.39**	-0.06	8.33**	5.29**
Maya x Durgamani	-10.10**	-0.55	3.41**	0.89**	9.52**	0.36**	15.75**	4.69**
Maya x Jawahar mustard-1	-10.10**	0.42	3.07**	0.27	18.05**	0.61**	0.00	-0.94
Maya x Urvashi	-11.39**	-2.14*	5.72**	0.72**	18.45**	0.18*	12.02**	0.18
Maya x Pusa bold	-7.59**	0.16	5.05**	0.98**	21.82**	0.32**	-2.77	-2.90*
Maya x R.L.M.-198	-11.39**	-0.36	2.97**	0.48**	0.00	-0.16	05.55**	0.95
Pusa Agrani x Durgamani	-2.50	3.45**	-0.69*	0.84**	-07.93**	0.03	-20.36**	-2.38
Pusa Agrani x Jawhar mustard-1	-13.90**	1.42	-01.28**	0.13	-08.73**	-0.20*	-15.75**	-0.68
Pusa Agrani x Urvashi	-8.84**	0.53	-2.64**	-0.99**	10.51**	0.31**	-5.55**	-0.23
Pusa Agrani x Pusa bold	-16.44**	-0.18	-01.02**	0.16	-04.36**	-0.47**	-4.63*	02.36
Pusa Agrani x R.L.M.-198	-13.90**	0.97	-01.28**	0.37*	-03.57**	0.20*	-17.58**	-1.45
Durgamani x Jawahar mustard-1	-22.78**	-2.18*	-2.74**	-0.19	-6.34**	-0.12	-1.86	1.06
Durgamani x Urvashi	01.29	1.94*	-01.28**	-0.21	7.34**	0.12	4.63**	0.18
Durgamani x Pusa bold	-13.90**	-0.77	-01.36**	0.27	2.57*	-0.16	0.91	1.10
Durgamani x R.L.M.-198	-13.90**	-0.29	-01.89**	0.39*	-7.53**	-0.03	0.91	1.95
Jawahar mustard-1 x Urvashi	-12.64**	-0.77	01.89**	0.55**	9.12**	0.02	11.11**	2.55**
Jawahar mustard-1 x Pusa bold	-13.90**	0.19	-0.76*	0.03	11.50**	0.10	01.86	1.47
Jawahar mustard-1 x R.L.M.-198	-16.44**	0.01	-03.48**	-0.72**	7.73**	0.55**	01.86	2.32
Urvashi x Pusa bold	-1.25	1.31	04.87**	1.64**	19.64**	0.07	01.86	-1.75
Urvashi x R.L.M.-198	-8.84**	-0.21	02.92**	1.20**	5.15**	-0.04	3.69**	-0.23
Pusa bold x R.L.M.-198	-10.10**	0.75	02.28**	1.46**	12.10**	0.28**	01.86	1.36
SE (EP) ±	1.52		0.30		0.14		1.95	
SE (Sij) ±		0.96		0.17		0.1		1.23
SE (Sij - Sik) ±		1.44		0.28		0.14		1.83

\*Significant at P = 0.05; \*\*Significant at P = 0.01

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