



ISSN Print: 2394-7500
ISSN Online: 2394-5869
Impact Factor: 5.2
IJAR 2017; 3(8): 719-724
www.allresearchjournal.com
Received: 08-06-2017
Accepted: 10-07-2017

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Combining ability (gca & sca) and heterotic response analysis in Indian mustard (*Brassica juncea* L. Czern & Coss)

Rajendra Kumar, Mahak Singh and Amit Tomar

Abstract

Highly significant differences were recorded among the treatments for all the characters. Analysis of variance further indicated highly significant differences among the parents, F₁s and parent vs. F₁s for all the characters. The estimated variance of general combining ability (σ^2_{gca}) were higher than variance of specific combining ability (σ^2_{sca}) for Days to flowering, days to maturity, plant height, number of siliquae per plant. The parents namely, Parent Urvashi and Maya are found good general combiners for seed yield per plant. The cross combinations Maya x Pusa Agrani and Jawahar mustard-1 x Urvashi are found good specific combiners for seed yield per plant. The cross combinations 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 are exhibited positive and significant heterotic effects.

Keywords: combining ability (gca & sca), heterosis & 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. In spite of fact that Indian mustard plays such a prominent role in agricultural economy.

2. Materials and Methods

The material for the present investigation consisted seven varieties/ genotypes of Indian mustard, [*Brassica juncea* (L.) Czern & Coss] which were selected on the basis of variation for various characters from available genetic material maintained in the section of Oil Seeds, Department of Genetics and Plant Breeding, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur. Using seven diverse genotypes, a diallel set (excluding reciprocals) was made to obtain 21 crosses during Rabi, 2009-2010. All the 28 treatments, (7 parents and 21 F₁s) 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 F₁s 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 F₁s in each replication namely, days to 50% flowering, days to maturity, plant height (cm), number of siliquae 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).

The combining ability analysis was done by the procedure suggested by Griffing's (1956 b) Method 2, Model I. Oil content was estimated by NMR method.

3. Results and Discussion

The results of present investigation indicated that the analysis of variance are presented in table-1. Highly significant differences were recorded among the treatments for all the characters. Analysis of variance further indicated highly significant differences among the parents, F_1 s and parents vs F_1 s for all characters except plant height, length of main raceme per plant, number of siliquae per plant. The analysis of variance for combining ability are presented in table-2. The mean sum of square due to gca were highly significant for all the characters. The mean sum of square due to sca was highly significant for all the characters except number of siliquae per plant, length of main raceme, plant height and seed yield per plant. The estimated variance of general combining ability (σ^2_{gca}) were higher than variance of specific combining ability (σ^2_{sca}) for Days to flowering, days to maturity, plant height, number of siliquae per plant and where as the estimated σ^2_{sca} were higher than of σ^2_{gca} for length of main raceme, number of secondary branches per plant, oil content, test weight, seed yield per plant. Similar findings were also observed by Oshastidar *et al.* (2002)^[6] and Singh *et al.* (2009c)^[11].

The estimated values of general combining ability effect of parent for all the characters are presented in table-3. The parents namely, Pusa Agrani, Durgamani are desirable for early flowering, Pusa Agrani for early maturity, Pusa Agrani, and while Urvashi, R.L.M-198, Pusa bold for dwarf plant height, Urvashi, Maya, Durgamani, and Pusa bold. Maya, Urvashi, RLM-198, Durgamani for length of main raceme, Maya, Urvashi, Durgamani, and Pusa bold for number of siliquae per plant, Urvashi, Maya, Jawahar mustard-1 for number of secondary branches per plant, Maya and Urvashi for high oil content, Pusa bold, Urvashi for test weight and Urvashi and Maya for high seed yield per plant. The estimated values of specific combining ability effect of crosses for all the characters are presented in table-4. The crosses namely, Urvashi x Pusa bold, Jawahar Mustard-1 x R.L.M-198, Durgamani x Pusa bold, Pusa Agrani x Jawahar Mustard-1, Durgamani x RLM-198, Pusa bold x RLM-198 are shown early flowering, Maya x R.L.M-198, Pusa Agrani x Urvashi, Pusa Agrani x R.L.M-198, Pusa Agrani x Durgamani for early maturity, Jawahar mustard-1 x R.L.M-198, Jawahar mustard-1 x Pusa bold, Jawahar mustard-1 x Urvashi, Durgamani x R.L.M-198, Maya x Durgamani, Maya x Pusa Agrani, Durgamani x R.L.M-198, Maya x Urvashi for dwarf plant height, Jawahar Mustard-1 x Pusa Bold, Jawahar Mustard-1 x R.L.M-198, Durgamani x Jawahar Mustard-1, Maya x Pusa Agrani, Durgamani x Pusa Bold, Jawahar Mustard-1 x Urvashi for length of main raceme, Maya x Pusa Agrani, Jawahar Mustard -1 x R.L.M-198, Jawahar Mustard-1 x Urvashi,

x R.L.M-198, Jawahar Mustard-1 X Pusa Bold for number of siliquae per plant, Pusa Agrani x Durgamani and Durgamani x Urvashi for number of secondary branches per plant, Urvashi x Pusa Bold, Pusa Bold x R.L.M-198, Urvashi x R.L.M-198, Maya x Pusa Agrani, Maya x Durgamani, Pusa Agrani x Durgamani, Maya x R.L.M-198, Jawahar Mustard-1 x Urvashi, Pusa Agrani x R.L.M-198 for high oil content, Jawahar Mustard-1 x R.L.M-198, Maya x Durgamani, Maya x Pusa Bold, Pusa Agrani x Urvashi, Durgamani x Jawahar Mustard-1, Maya x Urvashi for test weight and Maya x Pusa Agrani and Jawahar mustard-1 x Urvashi are shown high sca effect for seed yield. Similar findings were also observed by Dixit *et al.* (2007)^[1], Gupta *et al.* (2010)^[2], Kerkhi *et al.* (2007)^[3], Kumar & Srivastava (2010)^[19], Kumar *et al.* (2007)^[5], Parmar *et al.* (2004)^[7] and Prajapati *et al.* (2009)^[8].

The estimated values of heterosis over economic parent (Maya) for all the characters are presented in table-5. 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 are shown early flowering, Pusa Agrani x Urvashi, Pusa Agrani x Jawahar Mustard-1, Pusa Agrani x Pusa Bold, Pusa Agrani x RLM -198, Maya x Pusa Agrani for early maturity, 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 for dwarf plant height, 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 for length of main raceme, 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 for number of siliquae per plant, Durgamani x Urvashi for number of secondary branches per plant, 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 for high oil content, 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 for test weight and 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 for high seed yield per plant. Similar findings were also observed by Setyendra *et al.* (2009), Sheikh & Singh (2001)^[10], Singh *et al.* (2009)^[11], Singh & Dixit (2009)^[18], Singh & Lallu (2004)^[13], Singh *et al.* (2007)^[14], Singh *et al.* (2008)^[15], Singh *et al.* (2006)^[12], Singh *et al.* (2008b)^[17], Singh *et al.* (2009c)^[11], Singh *et al.* (2010)^[19], Singh *et al.* (2010)^[20] and Tyagi *et al.* (2000)^[21].

Table-1: ANOVA of parents F₁'s for 9 characters in a 7 x 7 parental diallel cross of Indian mustard mean sum of squares.

Source of variation	d.f.	Days to flowering	Days to maturity	Plant height	Length of main raceme	No. of Silique/ 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 ₁ 's	20	33.56**	68.66**	105.71**	70.46**	894.90**
Parents Vs. F ₁ 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.....

Source of variation	d.f.	No. of secondary branches / plant	Oil content	Test weight	Seed yield /plant
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 ₁ s	20	06.16	3.97**	0.07*	33.09**
Parents Vs. F ₁ 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: ANOVA for combining ability and related statistics of 9 characters in a 7 x 7 parental diallel cross of F₁'s in Indian mustard.

Source of variation	d.f.	Days to flowering	Days to maturity	Plant height	Length of main raceme	No. of Silique/ plant
GCA	6	60.53**	109.44**	193.95**	66.84**	1272.06**
SCA	21	04.10**	02.16**	16.23**	26.72**	137.93**
Error	54	0.67	0.67	01.71	01.18	05.47
□ ² gca		8.33	12.08	21.36	07.29	140.73
□ ² sca		3.43	1.49	14.52	25.54	132.46
GPR		0.82	0.94	0.74	0.36	0.67

Table 2: Continue.....

Source of variation	d.f.	No. of secondary branches / plant	Oil content	Test weight	Seed yield /plant
GCA	6	7.24**	3.43**	0.87**	40.40**
SCA	21	2.13	1.40**	0.11**	6.70**
Error	54	1.17	0.04	0.09	1.90
□ ² gca		0.67	0.37	0.09	4.27
□ ² sca		0.96	1.36	0.10	4.80
GPR		0.58	0.35	0.64	0.64

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

GCA = General combining ability, SCA = Specific combining ability
GPR = General productivity ratio

Table 3: Estimates of gca effects for 7 parent alongwith their mean performance for 9 characters in F₁'s of a dillel cross in Indian mustard.

Hybrid combination	Days to flowering		Days to maturity		Plant height		Length of main raceme		No. of silique/plant	
	gca effect	Mean	gca effect	Mean	gca effect	Mean	gca effect	Mean	gca effect	Mean
Maya	0.86**	76.00	0.46	131.33	0.70	183.67	2.19**	57.00	13.52**	353.33
Pusa Agrani	-5.36**	66.00	-7.84**	117.67	-10.15**	158.00	-5.07**	38.33	-23.55**	287.00
Durgamani	-0.66**	76.67	1.23**	133.00	-0.26	181.00	0.82*	46.00	05.12**	340.33
Jawahar mustard-1	2.31**	82.33	1.27**	134.00	3.25**	191.00	-1.40**	37.00	-4.85**	308.00
Urvashi	-0.32	73.67	1.34**	134.00	1.29**	184.67	3.23**	55.67	6.56**	359.67
Pusa bold	1.64**	82.33	1.60**	134.00	2.66**	185.33	-0.59	47.00	4.12**	347.67
R.L.M.-198	1.53**	81.00	1.94**	135.00	2.51**	184.67	0.82*	46.67	-0.92	310.33
\bar{X}_p		76.85		131.28		181.19		46.81		329.47
SE (g _i) ±	0.24		0.24		0.40		0.33		0.72	
SE (g _i - g _j) ±	0.38		0.38		0.61		0.50		1.10	

Table 3: Continue.....

Hybrid combination	No. of secondary branches/ plant		Oil content		Test weight		Seed yield / plant	
	gca effect	Mean	gca effect	Mean	gca effect	Mean	gca effect	Mean
Maya	0.85**	26.33	1.17**	38.97	0.22**	5.04	2.16**	36.00
Pusa Agrani	-1.15**	18.00	-0.38**	37.28	-0.33**	4.66	-3.77**	26.33
Durgamani	0.11	22.67	-0.63**	36.61	-0.29**	4.54	-0.51	31.00
Jawahar mustard-1	-0.85**	22.00	-0.15*	38.54	-0.10**	4.55	-0.54	31.33
Urvashi	01.37**	25.67	0.44**	38.29	0.36**	5.61	2.68**	40.33
Pusa bold	0.07	22.67	-0.07	36.45	0.39**	5.92	0.42	35.35
R.L.M.-198	-0.41	22.00	-0.39**	36.50	-0.24**	4.34	-0.43	32.00
\bar{X}_p		22.76		37.52		4.95		33.18
SE (g _i) ±	0.33		0.06		0.03		0.42	
SE (g _i - g _j) ±	0.50		0.10		0.04		0.64	

Table 4: Estimates of sca effects and mean performance for 9 characters of 21 F₁'s derived from a 7 parent dillel cross in Indian mustard.

Hybrid combination	Days to flowering		Days to maturity		Plant height		Length of main raceme		No. of siliquae/plant	
	sca effect	Mean	sca effect	Mean	sca effect	Mean	sca effect	Mean	sca effect	Mean
Maya x Pusa Agrani	-0.24	70.67	0.23	122.67	-2.84*	165.33	5.18**	53.00	21.49**	341.33
Maya x Durgamani	0.39	76.00	1.82*	133.33	-3.73*	174.33	-1.05	52.67	1.82	350.33
Maya x Jawahar mustard-1	-1.24	77.33	-0.55	131.00	-3.25**	178.33	-5.82**	45.67	-1.88	336.67
Maya x Urvashi	2.39**	78.33	-0.29	131.33	-2.62*	177.00	0.21	56.33	-16.29**	333.67
Maya x Pusa bold	0.09	78.00	-0.21	131.67	2.01	183.00	-5.64**	46.67	-1.51	346.00
Maya x R.L.M.-198	0.87	78.67	-2.21**	130.00	1.16	182.00	3.29**	57.00	3.53	346.00
Pusa Agrani x Durgamani	-1.72*	67.67	-1.55*	121.67	4.79**	172.00	-0.79	45.67	2.23	313.67
Pusa Agrani x Jawahar mustard -1	-2.35**	70.00	-0.92	122.33	4.60**	175.33	2.44**	46.67	-4.81*	296.67
Pusa Agrani x Urvashi	01.28	71.00	-1.99**	121.33	-4.77**	164.00	-3.53**	45.33	-17.55**	295.33
Pusa Agrani x Pusa bold	-0.35	71.33	-1.25	122.33	-3.47*	166.67	0.62	45.67	-20.10**	290.33
Pusa Agrani x R.L.M. -198	0.76	72.33	-1.58*	122.33	0.34	170.33	0.55	47.00	10.27**	315.67
Durgamani x Jawahar mustard-1	-0.06	77.00	-0.32	132.00	-0.95	179.67	6.55**	56.67	02.19	332.33
Durgamani x Urvashi	0.57	75.00	-0.73	131.67	-1.66	177.00	-0.75	54.00	-7.21**	334.33
Durgamani x Pusa bold	-2.39**	74.00	-0.66	132.00	-2.36*	177.67	5.40**	56.33	-2.10	337.00
Durgamani x R.L.M.-198	-1.94**	74.33	0.01	133.00	-3.88**	176.00	3.32**	55.67	2.60	336.67
Jawahar mustard-1 x Urvashi	1.28	78.67	-0.10	132.33	-4.18*	178.00	4.14**	56.67	11.75**	343.33
Jawahar mustard-1 x Pusa bold	0.31	79.67	-1.36	131.33	-4.55**	179.00	7.62**	56.33	4.53**	333.67
Jawahar mustard-1 x R.L.M.-198	-2.57**	76.67	-0.03	133.00	-5.40**	178.00	6.88**	57.00	12.56**	336.67
Urvashi x Pusa bold	-3.06**	73.67	0.23	133.00	2.08	183.67	1.32	54.67	-5.21*	335.33
Urvashi x R.L.M.-198	-0.28	76.33	-0.10	133.00	2.23	183.67	1.58	56.33	1.16	336.67
Pusa bold x R.L.M.-198	-1.91**	76.67	1.31	134.67	1.53	184.33	-4.27**	46.67	5.27*	338.33
\bar{X}		74.92		129.33		176.44		52.00		330.00
SE (S _{ij}) ±	0.73		0.73		1.17		0.97		2.09	
SE (S _{ij} - S _{ik}) ±	1.09		1.09		1.74		1.45		3.11	

Table 4: Continue.....

Hybrid combination	No. of secondary branches / plant		Oil content		Test weight		Seed yield / plant	
	sca effect	Mean	sca effect	Mean	sca effect	Mean	sca effect	Mean
Maya x Pusa Agrani	-0.29	22.67	1.31**	40.78	-0.06	5.06	5.29**	39.00
Maya x Durgamani	-0.55	23.67	0.89**	40.30	0.36**	5.52	4.69**	41.67
Maya x Jawahar mustard-1	0.42	23.67	0.27	40.17	0.61**	5.95	-0.94	36.00
Maya x Urvashi	-2.14*	23.33	0.72**	41.20	0.18*	5.97	0.18	40.33
Maya x Pusa bold	0.16	24.33	0.98**	40.94	0.32**	6.14	-2.90*	35.00
Maya x R.L.M.-198	-0.36	23.33	0.48**	40.13	-0.16	5.04	0.95	38.00
Pusa Agrani x Durgamani	3.45**	25.67	0.84**	38.70	0.03	4.64	-2.38	28.67
Pusa Agrani x Jawahar mustard -1	1.42	22.67	0.13	38.47	-0.20*	4.60	-0.68	30.33
Pusa Agrani x Urvashi	0.53	24.00	-0.99**	37.94	0.31**	5.57	-0.23	34.00
Pusa Agrani x Pusa bold	-0.18	22.00	0.16	38.57	-0.47**	4.82	02.36	34.33
Pusa Agrani x R.L.M. -198	0.97	22.67	0.37*	38.47	0.20*	4.86	-1.45	29.67
Durgamani x Jawahar mustard-1	-2.18*	20.33	-0.19	37.90	-0.12	4.72	1.06	35.33
Durgamani x Urvashi	1.94*	26.67	-0.21	38.47	0.12	5.41	0.18	37.67
Durgamani x Pusa bold	-0.77	22.67	0.27	38.44	-0.16	5.17	1.10	36.33
Durgamani x R.L.M.-198	-0.29	22.67	0.39*	38.23	-0.03	4.66	1.95	36.33
Jawahar mustard-1 x Urvashi	-0.77	23.00	0.55**	39.71	0.02	5.50	2.55**	40.00
Jawahar mustard-1 x Pusa bold	0.19	22.67	0.03	38.67	0.10	5.62	1.47	36.67
Jawahar mustard-1 x R.L.M.-198	0.01	22.00	-0.72**	37.61	0.55**	5.43	2.32	36.67
Urvashi x Pusa bold	1.31	26.00	1.64**	40.87	0.07	6.03	-1.75	36.67
Urvashi x R.L.M.-198	-0.21	24.00	1.20**	40.11	-0.04	5.30	-0.23	37.33
Pusa bold x R.L.M.-198	0.75	23.67	1.46**	39.86	0.28**	5.65	1.36	36.67
\bar{X}		23.41		39.31		5.31		36.03
SE (S _{ij}) ±	0.96		0.17		0.1		1.23	
SE (S _{ij} - S _{ik}) ±	1.44		0.28		0.14		1.83	

Table 5: Estimates of heterosis over economic parent for 9 characters in 21 F₁s derived from a 7 x 7 diallel cross in Indian mustard EP= Maya

Source of variation	Days to flowering	Days to maturity	Plant height	Length of main raceme	No. of Siliquae/plant	No. of secondary branches/plant	Oil content	Test weight	Seed yield/plant
	EH	EH	EH	EH	EH	EH	EH	EH	EH
Maya x pusa agrani	-7.01**	-6.59**	-9.98**	-7.01**	-3.39	-13.90**	4.64**	0.39**	8.33**
Maya x Durgamani	0.00	1.52	-5.08**	-7.59**	-0.84	-10.10**	3.41**	9.52**	15.75**
Maya x Jawahar mustard-1	1.75	-0.25	-2.90	-19.87**	-4.71	-10.10**	3.07**	18.05**	0.00
Maya x Urvashi	3.06*	0.00	-3.63	-1.17	-5.56	-11.39**	5.72**	18.45**	12.02**
Maya x Pusa bold	2.63	0.25	-0.36	-18.12**	-2.07	-7.59**	5.05**	21.82**	-2.77
Maya x R.L.M.-198	3.51**	-1.01	-0.90	0.00	-2.07	-11.39**	2.97**	0.00	05.55**
Pusa Agrani x Durgamani	-10.96**	-7.35**	-6.35**	-19.87**	-11.22**	-2.50	-0.69*	-07.93**	-20.36**
Pusa Agrani x Jawahar mustard-1	-7.89**	-6.85**	-4.54*	-18.12**	-16.03**	-13.90**	-01.28**	-08.73**	-15.75**
Pusa Agrani x Urvashi	-6.57**	-7.61**	-10.70**	-20.47**	-16.41**	-8.84**	-2.64**	10.51**	-5.55**
Pusa Agrani x Pusa bold	-6.14**	-6.85**	-9.25**	-19.87**	-17.83**	-16.44**	-01.02**	-04.36**	-4.63*
Pusa Agrani x R.L.M.-198	-4.82**	-6.85**	-7.26**	-17.54**	-10.65**	-13.90**	-01.28**	-03.57**	-17.58**
SE (EP) =	1.16	1.16	1.84	1.54	3.30	1.52	0.30	0.14	1.95

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

Table 5: Continue..... EP = Maya

Source of variation	Days to flowering	Days to maturity	Plant height	Length of main raceme	No. of Siliquae/plant	No. of secondary branches/plant	Oil content	Test weight	Seed yield/plant
	EH	EH	EH	EH	EH	EH	EH	EH	EH
Durgamani x Jawahar mustard-1	1.31	0.51	-2.17	-0.57	-5.94	-22.78**	-2.74**	-6.34**	-1.86
Durgamani x Urvashi	-1.31	0.25	-3.63	-5.26**	-5.37	01.29	-01.28**	7.34**	4.63**
Durgamani x Pusa bold	-2.63*	0.51	-3.26	-1.17	-4.62	-13.90**	-01.36**	2.57*	0.91
Durgamani x R.L.M.-198	-2.19	1.27	-4.17*	-2.33	-4.71	-13.90**	-01.89**	-7.53**	0.91
Jawahar mustard-1 x Urvashi	3.51**	0.76	-3.08	-0.57	-2.83	-12.64**	01.89**	9.12**	11.11**
Jawahar mustard-1 x pusa bold	4.82**	0.00	-2.54	-1.17	-5.56	-13.90**	-0.76*	11.50**	01.86
Jawahar mustard-1 x R.L.M.-198	0.88	1.27	-3.08	0.00	-4.71	-16.44**	-03.48**	7.73**	01.86
Urvashi x Pusa bold	-3.06*	1.27	0.00	-4.08*	-5.09	-1.25	04.87**	19.64**	01.86
Urvashi x R.L.M.-198	0.43	1.27	0.00	-1.17	-4.71	-8.84**	02.92**	5.15**	3.69**
Pusa bold x R.L.M.-198	0.88	2.54*	0.35	-18.12**	-4.24	-10.10**	02.28**	12.10**	01.86
SE (EP) =	1.16	1.16	1.84	1.54	3.30	1.52	0.30	0.14	1.95

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

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