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Combining ability analysis in Indian mustard (*Brassica juncea* L. Czern & Coss)

Mahak Singh*, Lokendra Singh and S.B.L. Srivastava

Department of Genetics and Plant Breeding, C.S. Azad University of Agriculture & Technology, Kanpur 208-002(UP), India
**Corresponding author: drmahak@rediffmail.com*

Abstract

Combining ability analysis of 10 × 10 diallel set of crosses in Indian mustard for ten quantitative traits revealed preponderance of non-additive gene effects for plant height, number of primary branches per plant and seed yield per plant, whereas additive gene effect was found to be predominant for the inheritance of rest of the characters. The parent Durgamani, RLM-198 and Varuna were the good general combiners for seed yield and oil content. Varuna and Durgamani also exhibited desirable general combining ability effect for earliness and dwarfness. Among the cross combinations, cross Kanti × Pusa Agrani exhibited superior specific combining ability effects for seed yield, oil content and other yield attributing traits. Most of the crosses involving high × low general combining parents, exhibited high sca effects for various traits.

Key words: *Brassica juncea, general combining ability, specific combining ability*

Introduction

Indian mustard [*Brassica juncea* L. (Czern & coss)] is an important oil seed crop of the world. It plays a major role in catering edible oil demand of the country. Population of India is increasing rapidly and consequently edible oil demand is also going up day-by-day. Hence, it has become necessary to enhance the present production by developing superior varieties of Indian mustard. Development of superior varieties could be done by reshuffling the genes through hybridization from suitable parents. Moreover, it is also necessary to know about the nature and magnitude of gene action responsible for controlling the inheritance of various yield attributes along with combining ability of the parents and their cross combinations in order to exploit them in further crop improvement programme. The present study was, therefore, undertaken with a view to estimate general and specific combining ability variances and effects in Indian mustard.

Materials and Methods

Ten parents viz, Varuna, Durgamani, RH-30, NDR-8501, Kranti, RLM-198, Pusa Bold, Pusa Basant, Pusa Agrani and RK-9807 were crossed in half diallel fashion to produce 45 F_1s. Ten parents and their 45 F_1s were grown in a randomized block design with three replications. Each parent and F_1s were grown in single row of 5 m length with row to row and plant to plant distance of 45 and 15 cm respectively in each replication during *rabi* (post-rainy) 2006-07 at Oilseeds Research Farm of C.S. Azad University of Agriculture and Technology, Kanpur (U.P.).

Recommended cultural practices were adopted in order to raise a healthy crop. A sample of five representative plants were taken from each plot for recording data on plant height, number of primary branches, number of secondary branches, length of main raceme, number of siliquae on main raceme, seed yield, 1000-seed weight, and oil content in each replication while data on days to 50% flowering, days to maturity were recorded on plot basis. Mean values of sample for various traits were subjected to combining ability analysis method II model I of Griffing (1956).

Results and Discussion

The analysis of variance revealed considerable genetic diversity among the parents, cross combinations as well as between parental group and

cross combination group for all the characters. Analysis of combining ability (table 1) indicated that mean sum of squares due to both general and specific combining ability were significant for all the characters suggesting importance of both additive and non-additive gene effects in the inheritance of these characters. Similar findings were reported by earlier workers (Singh *et al.*, 2008, Singh and Dixit, 2006, Singh *et al.*, 2006, Yadav *et al.*, 2005, Rao and Gulati, 2001). Relative magnitude of non-additive gene effects was predominant in controlling the inheritance of plant height, number of primary branches and seed yield per plant, whereas, additive gene effects were found predominant for controlling the inheritance of rest of the characters.

Table 1: Analysis of variance for combining ability for ten characters in Indian mustard

Source of variation	D.F.	Days to 50% flowering	Days to maturity	Plant height	No. of Primary branches	No. of secondary branches	Length of main raceme	No. of Siliquae on main raceme	Seed yield per plant	1000-seed weight	Oil content
GCA	9	65.45**	25.74**	21.40**	0.28	7.21**	56.30**	54.51**	3.94*	0.23*	2.27**
SCA	45	21.49**	12.82**	32.57**	0.37*	5.36**	28.54**	17.78**	6.10**	0.15*	1.35**
Error	288	2.83	2.41	5.70	0.16	1.54	5.81	5.50	1.94	0.10	0.36

*, ** Significant at 5 and 1 per cent levels, respectively

General combining ability

A perusal of general combining ability (gca) effects of parents indicated that none of the parent was found to be good general combiner for all the traits (table 2). However, one of the parents Varuna was found to be a good general combiner for five characters viz., days to 50% flowering, plant height, length of main raceme, number of siliquae on main raceme and oil content by exhibiting desirable significant negative and positive gca effect. Parent Durgamani, RH-30 (for plant height, number of secondary branches and length of main raceme) and RLM-198 were observed to be good general combiners for four characters each viz., days to 50% flowering, plant height, number of siliquae on main raceme and seed yield/plant, plant height, number of secondary branches, length of main raceme, number of siliquae on main raceme and number of secondary branches, length of main raceme, number of siliquae on main raceme and seed yield/plant,

Table 2: Estimates of GCA effects of ten parents for ten characters in Indian mustard

Parent	Days to 50% flowering	Days to maturity	Plant height	No. of Primary branches	No. of secondary branches	Length of main raceme	Siliquae / main raceme	Seed yield / plant	1000-seed weight	Oil content
Varuna	-3.97**	1.26**	-1.65**	-0.03	0.44	1.99**	1.50**	-0.06	-0.06	0.67**
Durgamani	-3.19**	0.87**	-0.94**	-0.24	-1.63**	-0.76**	1.70**	0.97**	0.01	-0.76**
NDR-8501	-0.47	-0.10	0.68*	-0.13	-0.07	-0.67*	0.48*	0.20	0.14	-0.13
RH-30	0.73**	1.04**	-1.31**	0.22	0.58*	2.13**	0.58*	-0.42	-0.08	0.39
RLM-198	1.26**	-0.54**	0.35	0.13	0.66*	0.57*	1.56**	0.70**	-0.1	-0.21
Kranti	3.17**	2.37**	1.15**	0.01	-0.16	2.10**	0.09	-0.80**	-0.13	-0.13
Pusa Bold	0.81**	-1.32**	-0.11	-0.06	0.16	1.74**	0.10	-0.26	0.13	-0.49
Pusa Basant	3.01**	0.29	1.30**	0.24	0.66*	-0.04	1.41**	0.41	0.03	0.19
Pusa Agrani	-0.99**	-1.35**	2.13**	-0.04	-1.04**	-3.54**	-4.97**	-0.65*	-0.22	0.41
RK-9807	-0.36	-2.52**	-1.61**	-0.11	0.47	-3.52**	-2.45**	-0.09	0.20	0.06
SE±(gi)	0.312	0.180	0.428	0.012	0.115	0.436	0.412	0.146	0.008	0.027
SE±(gi-gi)	0.472	0.401	0.951	0.027	0.256	0.969	0.916	0.324	0.017	0.061

*, ** Significant at 5 and 1 per cent levels, respectively

Table 3: Estimates of sca effects of top three combinations for ten characters in Indian mustard

Cross combination	Specific combining ability effects	General combining ability effect of parents
Days to 50% flowering		
Varuna ´ Pusa Basant	-6.03**	H ´ L
RH 30 ´ RLM 198	-5.64**	H ´ L
RH 30 ´ Pusa Basant	-7.06**	H ´ L
Days to maturity		
RLM-198 ´ Pusa Basant	-6.67**	H ´ H
NDR-8501 ´ Kranti	-5.87**	H ´ H
Kranti ´ RK-9807	-4.78**	H ´ L
Plant height		
RH 30 ´ Pusa Agrami	-16.31**	H ´ L
Durgamani ´ Pusa Agrami	-4.55**	L ´ H
Durgamani ´ NDR-8501	-4.23**	H ´ H
No. of primary branches		
Kranti ´ Pusa Agrami	1.63	H ´ H
RH-30 ´ RLM-198	1.98	H ´ L
Durgamani ´ Pusa Agrami	0.94	H ´ H
No. of secondary branches		
Kranti ´ Pusa Agrani	3.35*	L ´ H
RLM-198 ´Pusa Agrani	2.93	L ´ H
NDR-8501 ´ Pusa Agrani	2.53	L ´ H
Length of main raceme		
Varuna ´RK-9807	10.36**	H ´ L
NDR-8501 ´ RK-9807	7.52**	H ´ L
Varuna ´ Pusa Basant	5.78**	L ´ H
No. of siliquae on main raceme		
Durgamani ´ RK-9807	7.69**	H ´ H
Pusa Basant ´ Pusa Agrani	6.84**	H ´ H
Varuna ´ RK-9807	5.16**	H ´ L
Seed yield per Plant		
Pusa Basant ´ RK-9807	5.52**	H ´ L
RLM-198 ´RK-9807	4.65**	H ´ L
Pusa Bold ´ RK-9807	5.78**	L ´ H
1000-seed weight		
Varuna ´ Pusa Agrani	0.50	H ´ H
NDR 8501 ´ RH-30	1.02	H ´ L
Pusa Bold ´RK-9807	1.12	H ´ L
Oil content		
Durgamani ´ RH-30	2.06	L ´ H
Durgamani ´ Pusa Bold	2.19	L ´ H
Kranti ´ Pusa Agrani	2.91	H ´ H

*, ** Significant 5 and 1 per cent levels, respectively

respectively; parents Pusa Agrani, RK-9807, Pusa Bold, Pusa Basant and NDR- 8501 for two characters each; parent Kranti was found to be good general combiner only for no. of silique on main raceme. It can be concluded that parent Varuna, Durgamani, RH-30 and RLM-198 possess desirable alleles for most of the characters. Hence, these parents could be used in future breeding programme for improvement of respective characters.

Formation of new heterotic group

Out of 45 crosses only six crosses viz; Pusa Basant × RK-9807, RLM-198 × RK-9807, Pusa Bold × RK-9807, Pusa Bold × Pusa Basant, RH-30 × Pusa

Bold and Durgamani × RH-30 were found better crosses for seed yield and other characters (table 4). This new group of crosses justified the development of commercial hybrids in Indian mustard in order to exploit hybrid vigour at commercial level. These results are in agreement with earlier findings of Singh *et al.* (2009) and Srivastav *et al.* (2009).

Specific combining ability

None of the cross combination was found to be a common combiner for all the characters under study (table 3). Cross combination RH-30 × Pusa Basant showed highly significant desirable negative specific combining ability (sca) effects for days to 50% flowering and cross combination. RLM-198 x Pusa Basant exhibited highly significant negative sca effect for days to maturity. These cross combinations can be exploited to isolate early maturing genotype in later generations. Cross combination Kranti × Pusa Agrani was good specific combiner for early maturity, number of primary branches, number of secondary branches, length of main raceme, seed yield and oil content. Cross combination Pusa Bold × RK-9807 was proved to be a good specific combiner for early maturity, taller plant type, length of main raceme and number of siliquae on main raceme. Cross combination Pusa Basant × RK-9807 followed by RLM-198 × RK-9807, Pusa Bold × Pusa Basant, RH-30 × Pusa Bold and Durgamani × RH-30 showed significant positive sca effects for seed yield (table-4).

It was observed for most of the characters that there was close association between mean performance and gca effects of the parents. However, combinations having high mean did not exhibit high sca effects for all the characters suggested that only good general combiner on the basis of mean performance may be reliable but not good specific combiner. Parents involved in these crosses were HxH, HxL, LxH and LxL combiners. The cross combinations involving either both or one parent with high gca effect indicated additive gene action in controlling the expression of respective trait. These cross combinations would give rise to transgressive segregants in later generations. While cross combinations involving L x L combiners reflected non-additive gene action, which is non-fixable in nature and could be exploited only through heterosis breeding for further improvement of the respective trait. Similar findings were reported by earlier workers Srivastava *et al.* (2009); Singh *et al.* (2009); Singh *et al.* (2008a, b).

Table 4: Top ranking crosses for seed yield per plant and other characters in Indian mustard

Crosses	*Per se* performance	Specific combining ability effect	General combining ability effect		Other characters with same specific combining ability effect
			P_1	P_2	
Pusa Basant × RH-9807	29.53	5.52**	-0.41	-0.09	Days to 50% flowering, days to maturity and plant height
RLM-198 × RK-9807	17.93	5.78**	-0.21	-0.09	Number of siliquae on main raceme and length of main raceme
Pusa Bold × RK-9807	29.34	4.65**	-0.70	-0.09	Plant height
Pusa Bold × Pusa Basant	27.80	3.56*	-0.26	-0.41	Days to 50% flowering
RH – 30 × Pusa Bold	26.80	3.39*	-0.42	-0.26	Days to 50% flowering
Durgamani × RH - 30	27.89	3.25*	-0.97	-0.42	Days to 50% flowering

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