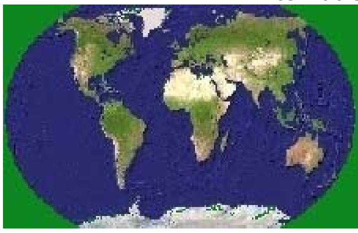
International Journal of Multidisciplinary Research and Development 2014; 1(2): 45-47



International Journal of Multidisciplinary Research and Development

IJMRD 2014; 1(2): 45-47
www.allsubjectjournal.com
Received: 19-07-2014
Accepted: 25-07-2014
e-ISSN: 2349-4182
p-ISSN: 2349-5979

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Combining ability for seed yield and quality components in Indian mustard

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Abstract
A 6 x 6 diallel crosses of Indian Mustard (*Brassica juncea* (L.) Czern & Coss) was evaluated using combining ability analysis. Data were recorded from F_1 generation for quantitative and qualitative traits under study. The variance due to sca was higher than that of due to gca for all the characters except oleic acid. The ratio of variance due to gca and sca was below unity for all the characters except in erucic acid and oleic acid. Based on gca effects of parents, BPR 380-1 and RSK 28 were good general combiners for seed yield. The hybrid SKM 532 x GM 3 had highest sca effects for seed yield followed by RSK 28 x RH(OE)0103 and BPR 380-1 x RSK 28. The parent RH(OE)0103 were found superior for erucic acid, oleic acid and linoleic acid Whereas, for the hybrid, RSK 28 x RH(OE)0103 were found to be superior for erucic acid and high oleic acid.

Keywords: *Indian mustard, general combining ability, specific combining ability.*

1. Introduction
Indian mustard [*Brassica juncea* (L.) Czern & Coss] is an important oil seed crop of the world. Combining ability analysis helps to choose suitable parents for hybridization and provides valuable information regarding cross combinations to be exploited commercially. A high yielding genotype may/may not transmit its superiority to its progeny. Hence, in order to develop high yielding varieties, it would be desirable to identify parents with good combining ability for different traits and the nature of gene action governing yield and their component traits, which could be of great help in selecting parents for the hybridization programme.

2. Material & Methods
From 6 parents (BPR 380-1, RSK 28, RH(OE)0103, SKM 532, GM 3 and GM 1) a set of 15 hybrids were developed in mustard through diallel mating design excluding reciprocals during *Rabi* 2008-09. The trials consisting of 15 hybrids and their 6 parents were raised in randomized block design with three replications at Main Castor & Mustard Research Station, S.D. Agricultural University, Sardarkrushinagar during *Rabi* 2009-10. Each entry was sown in 4.0 m long single row plot at 45 x 10 cm spacing. Observations on five randomly selected competitive plants were recorded for days to 50 percent flowering, days to maturity, plant height, main branch length, number of branches per plant, number of siliquae per plant, number of siliquae on main branch, seed yield per plant, 1000 seed weight, oil content, protein content, erucic acid, oleic acid, linoleic acid and linolenic acid.

3. Results & Discussion
Analysis of variance for combining ability showed the significance of gca and sca variances for all the characters except oleic acid (Table 1). This indicates the additive as well as non additive gene action was important for expression of all the characters studied. The ratio of variance due to gca and sca was below unity for all the characters under study except oleic acid and linolenic acid, indicating the role of non –additive gene action for their expression for above characters. This is in agreement with the studies of Rao & Gulati (2001) and Patel *et al.* (2005).

The gca, sca ratio ($\sigma^2_{gca}/\sigma^2_{sca}$) was less than one for seed yield per plant and it's most of all the characters except in erucic acid and oleic acid. This indicated that non-additive components played greater role in the inheritance of these characters. The presence of predominantly large amount of non-additive gene action would be necessitating the maintenance of heterozygosity in the population.

Breeding methods such as biparental matting followed by reciprocal recurrent selection may increase frequency of genetic recombination and hasten the rate of genetic improvement. The combining ability analysis revealed that, no one parent was superior combiner for all the traits. However, the parent RSK 28 was good combiner for seed yield per plant, days to50 percent flowering, days to maturity, number of branches per plant, total siliquae per plant, protein content and linoleic acid. Therefore, above parents can be considered as a good source of favourable genes for increasing seed yield. It is evident from these results that high gca effects for seed yield per plant in the entries BPR 380-1 and RSK 28 was mainly due to direct yield contributing characters. Therefore, it would be worthwhile to use above lines in the hybridization programme.

For quality components, RH(OE)0103 were found to be good general combiner for the three fatty acid *viz.,* erucic acid, oleic acid and linoleic acid (Table 2). The results of specific combining ability effects revealed that, the crosses, SKM 532 x GM 3, RSK 28 x RH(OE)0103 and BPR 380-1 x RSK 28 were three best cross combinations for seed yield, these crosses also showed moderate standard heterosis Out of three crosses showing high mean and significant positive sca effects for seed yield, one cross (SKM 532 x GM 3) involved average x average gca parents, second cross (RSK 28 x RH(OE)0103) with good x poor and for last cross (BPR 380-1 x RSK 28) with good x good(Table 3). Better performance of hybrids involving poor x poor or average x poor general combiners indicated dominance x dominance (epitasis) type of gene action. The crosses showing high sca effects involving one good general combiner indicated additive x dominance type gene interaction which could produce desirable transgressive segregants in subsequent generations.

The results suggested that the crosses showing high mean performance, positive sca effects for seed yield and their significant response to other related traits had necessarily involved both or at least one parent as good combiner which could be commercially exploited by taking advantage of high degree of natural out crossing in Indian mustard.

Table 1: Analysis of variance (mean square) for combining ability, estimates of components of variance and their ratio for various characters in Indian mustard

Source of variation	df	DF	DM	PH	MBL	NSM	TSP	NBP	SY	OC	EA	OA	LNA	LEA	PC	TSW
GCA	5	29.64**	11.28**	756.64**	23.05**	32.13**	4064.61**	38.85**	39.34**	6.66**	472.62**	264.69**	4.23**	27.56**	**1.7****	**0.47****
SCA	15	5.36**	15.81**	143.89**	72.74**	56.81**	4833.01**	109.98**	22.29**	2.91**	13.53**	8.17**	4.98**	8.13**	**0.9****	**0.32****
Error	40	0.50	1.27	41.51	1.23	4.59	299.27	2.01	1.74	0.31	0.20	0.08	0.08	0.07	**0.0**	**0.02**
σ^2gca		3.64	1.25	89.39	2.73	3.44	470.67	4.60	4.70	0.79	59.0	33.07	0.51	3.43	**0.21**	**0.06**
σ^2sca		4.86	14.54	102.37	71.50	52.22	4533.75	107.97	20.55	2.59	13.33	8.09	4.89	8.06	**0.90**	**0.30**
σ^2gca/σ^2sca		0.75	0.09	0.87	0.04	0.07	0.10	0.04	0.23	0.31	4.42	4.08	0.10	0.42	**0.23**	**0.19**

Table 2: The estimates of general combining ability (gca) effects of the parents for various characters in Indian mustard

Parents	DF	DM	PH	MBL	NSM	TSP	NBP	SY	OC	EA	OA	LNA	LEA	PC	TSW
BPR 380-1	2.03**	0.13	2.47	0.72	0.94	7.29	0.30	2.97**	0.66**	3.97**	-2.96**	0.08	-2.25**	-0.89**	0.09*
RSK 28	-2.97**	-2.13**	-1.34	-0.04	-0.06	27.73**	3.00**	1.20**	-0.61**	3.96**	-2.02**	-0.82**	-0.66**	0.45**	-0.20**
RH (OE) 0103	-1.35**	0.42	-18.80**	-2.92**	3.50**	-5.60	1.47**	-2.53**	-0.01	-15.43**	11.59**	1.03**	3.22**	0.20**	-0.40**
SKM 532	-0.39	0.71	3.67	-0.51	-0.94	-34.53**	-2.66**	0.26	1.44**	1.62**	-0.62**	-0.30**	-0.67**	0.07	0.15**
GM 3	1.24**	-0.42	7.16**	2.19**	-1.99**	-12.96*	-2.42**	-2.69**	-1.05**	4.63**	-3.01**	-0.62**	-0.44**	-0.02	0.24**
GM 1	1.44**	1.29**	6.84**	0.56	-1.46*	18.08**	0.31	0.79	-0.43*	1.25**	-2.97**	0.64**	0.81**	0.18**	0.12**
S.E.(gi) ±	0.23	0.36	2.08	0.36	0.69	5.58	0.46	0.43	0.18	0.14	0.09	0.10	0.09	0.05	0.04

Table 3: Three best specific combiners for seed yield/plant and their performance for other traits in Indian mustard.

Sr. No.	Hybrids	SCA effects	Mean seed yield/plant (g)	GCA status	Significant response in other traits for sca effects
1.	SKM 532 x GM 3	9.70**	19.48	A x P	TSP, NBP, OC, EA, LNA, TSW
2.	RSK 28 x RH(OE)0103	6.39**	13.96	G x P	PH, TSP, EA, OA
3.	BPR 380-1 x RSK 28	4.66**	21.71	G x G	NSM, OC, PC, OA, PC

** Significant at 1 per cent level.

DF = Days to 50% flowering, DM = Days to maturity, PH = Plant height, NBP = No. of branches per plant, TSP = Total Siliquae per plant, TSW = 1000 seed weight, MBL = Main branch length, NSM = No. of siliquae on main branch, OC = Oil content, PC = Protein content, OA = Oleic acid, LEA = Linoleic acid, LNA = Linolenic acid, EA = Erucic acid, SY = Seed yield.

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