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Research Article

COMBINING ABILITY AND VARIANCE ANALYSIS IN INDIAN MUSTARD [*Brassica juncea L. CZERN & COSS*]

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Abstract- The combining ability studies involving 50 hybrids generated through Line x Tester mating of 10 lines and 5 testers was conducted at SKRAU, Bikaner.The combining ability analysis of 15 parents and their 50 F_{1s} revealed the presence of significance differences for general combining ability for all the characters. GCA and SCA variances significant for days to maturity, plant height, number of primary branches per plant and seed yield per plant. The parents RGN-298, RGN-303, RGN-236, were found to be good general combiner for seed yield and some other contributing characters. The cross combination RGN-298 x Kranti showed high per se performance as well high SCA effects for seed yield and yield contributing characters

Keywords- Mustard, Combining ability, lines, testers, GCA, SCA.

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Introduction

The oilseeds occupy significant place in Indian economy next to food grain. India is the third largest producer of oilseeds in the world. Indian mustard [*Brassica juncea* (L.) Czern & Coss] is an important oil seed crop of the world. It is popularly known as *rai*, *raya* or *laha* in India. It plays a major role in catering to edible oil demand of the country. The genus *Brassica*, belongs to cruciferae or brassicaceae family. Indian mustard is a natural amphidiploid (2n=36) of *Brassica campestris* (2n=20) and *Brassica nigra* (2n=16) (Nagaheru, 1935). It originated in Asia with its major center of diversity in China [1]. It was introduced in India from China and from where it spread to Afghanistan and other countries. It is largely a self-pollinated crop (85-90 %). However, owing to insects, especially the honeybees, the extent of cross-pollination varies from 4.0 to 16.6 %.

In India, it covers an area of 6.70 million hectares with 8.00 million tonnes production and 1194 kg/ha productivity [2]. Rajasthan is the largest producer of rapeseed-mustard followed by Uttar Pradesh, Haryana, Madhya Pradesh, West Bengal, Gujarat and Assam. In Rajasthan mustard is cultivated on about 2.78 million hectares with 3.62 MT production and 1301 Kg/ha productivity [3] In Rajasthan It is mostly grown in districts of Alwar, Bharatpur, Sri Ganganagar, Kota, Bikaner and Jaipur.

Mustard seed is largely crushed for edible oil, which is perhaps the cheapest source of oil in our daily diet. Mustard seeds contain about 38-42% oil, which is golden yellow fragrant and considered among the healthiest and most nutritional cooking medium. It is used in the preparation of hair oils, medicines, soap making, mixtures with mineral oils for lubrication and manufacture of greases. Mustard oil has peculiar pungency due to the presence of sulphur compound, thus making it suitable for condiments and for preparation pickles, curries and vegetables. Its leaves are rich in protein, minerals and vitamin A and C after extraction of oil from seeds, the remnant is used as food for milching cattles. Mustard meal or cake is also nutritious and contains about 12% oil and 38 to 42% protein [4].

Ability of a parent to combine well and to produce promising segregations in succeeding generations is an important criterion in selecting parents for a successful hybridization programme. Jenkins and Brunson (1932) advocated the use of open pollinated variety as a tester for preliminary evaluation of lines. Sprague (1939) used top-cross method to estimate the combining ability of inbreds. However, the concept of combining ability was developed by Sprague and Tatum (1942). According to them, general combining ability (GCA) measures the average performance of a line in cross combinations while specific combining ability (SCA) measures the deviation of certain expected combinations on the basis of average performance of the lines involved. Keeping all this in view, the present investigation entitled "Combining ability and variance analysis in Indian mustard [*Brassica juncea* (L.) Czern & Coss]" was undertaken with the objective to estimate the general and specific combining ability effects and variances.

Materials and Methods

The above entitled investigation was carried out at Research farm College of Agriculture, SKRAU, Bikaner during *rabi* 2015-16. This region falls under agro climatic zone Ic of state of Rajasthan. The climate of the region is typically semi arid which is characterized by extremes of temperature during summer and winter with aridity of atmosphere and salinity of rhizosphere.

The experimental material consisted of 10 lines and 5 testers and their 50 combinations of F_{1s}. The crosses were attempted in line x tester fashion to obtained 50 F_1s. Sixty-five genotypes of mustard were sown in randomized block design with three replications at Research farm, College of agriculture, during *rabi* 2015-16. Each genotype was sown in single row plot of 3 m row length. Row to row and plant-to-plant distances were maintained at 45 cm and 20 cm, respectively in each replication. Uniform recommended package of practices were adopted to raise a good crop.

Observations were recorded on the following traits:

Days to 50 % flowering, Days to maturity, Plant height (cm), Number of primary branches per plant, Number of secondary branches per plant, Number of siliquae per plant, Number of seeds per siliqua, Test weight (g), Biological yield per plant, Harvest index, Seed yield per plant (g).

Results and Discussion

The analysis of variance for parents, crosses and parents vs. crosses computed for different characters under study revealed highly significant difference due to genotype for all the characters indicating sufficient genetic variability present in the materials for all the characters. Whereas parents (testers) were significant for all the characters except number of seeds per siliqua and biological yield, per plant [Table-1]. The gca, sca ratio ($\sigma^2_{gca}/\ \sigma^2_{sca}$) was less than one for all the characters except days to maturity [Table-1]. 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. These results were in accordance with the findings of [5-6] for seed yield per plant and number of siliquae per plant; and [7] also for days to maturity. Under such conditions, conventional method of breeding may not be very efficient in capitalizing the available genetic variability. The most efficient way for utilizing the non-additive genetic variability is either through the exploitation of heterosis or special breeding method like diallel selective mating.

An overall appraisal of general combining ability effects indicated that the parent RGN-303 was good combiner for days to maturity, plant height, test weight, biological yield per plant and seed yield per plant; RGN-298 for plant height, test weight, biological yield per plant and seed yield per plant and RGN-236 for plant height and seed yield [Table-2]. The parents discussed above had high general combining ability and fixable component of gene action additive and additive x additive types of epistasis. Theses could be successfully exploited by developing homozygous lines having used for improved character for which improvement was desired. These parental lines might be utilized for producing the intermating population in order to get desirable recombinants in Indian mustard. [8-9] also observed various lines and testers having good combining ability behaviour.

The seven cross combinations showed correspondence of mean performance of top three crosses with best specific cross combinations for plant height (RGN-303 x RGN-145); number of primary branches per plant (RGN-73 x Geeta); number of seeds per siliqua (RGN-298 x RGN-145) and (RGN-303 x RB-50); test weight (RGN-303 x Kranti); harvest index (Bio-902 x RB-50) and for seed yield (RGN-298 x Kranti). The examination of the data revealed that the crosses, which expressed high *per se performance* and desirable SCA effects for various characters involved either good x good, good x average, good x poor, average x good and average x average combining parents. This suggesting that intra-allelic interactions were also important for these traits. The crosses showing high SCA effects involving one good general combiner, indicated additive x dominance type intra-allelic interactions, which could produce desirable transgressive segregants in subsequent generations. These results were also supported by [10-12].

Table-1 *Analysis of variance (mean square) for combining ability, eatimate of components of variance and their ratio for yield and its components in mustard*

Source of variation	d.f.	Days to maturity	Plant height (cm)	No. of primary branches per plant	No. of seeds per siliqua	Test weight (g)	Biological yield per plant (g)	Harvest index (%)	Seed yield per plant (g)
Replications	2	13.89	137.15	2.80	11.16	0.50	329.31	4.30	25.38
genotype	64	109.73**	781.83**	5.10**	17.81**	1.20**	3901.52**	219.61**	38.29**
Parents	14	73.41**	762.28**	8.69**	12.43**	1.60**	2102.67**	336.71**	51.09**
Parents vs Crosses	1	762.48**	6078.79**	28.73**	252.18**	5.17**	43180.06**	3783.44**	324.93**
Crosses	49	106.79**	679.32**	3.59**	14.56**	1.00**	3613.87**	113.42**	28.79**
Parents (lines)	9	99.68**	589.01**	9.38**	16.11**	2.02**	3101.82**	497.12**	69.64**
Parents (testers)	4	24.56**	848.04**	6.41**	3.26	0.65*	376.19	48.35**	21.99*
Error	128	4.58	45.67	1.34	4.09	0.21	169.27	13.26	8.39
σ^2_{gca}		10.36**	36.82**	0.13*	0.43	0.02	-21.44	0.22	1.50**
σ^2_{sca}		5.95**	103.33**	0.40*	2.36**	0.20**	1205.02*	35.72**	2.99**
$\sigma^2_{gca}/\ \sigma^2_{sca}$		1.74	0.35	0.32	0.18	0.10	-0.01	0.01	0.65

*and ** indicate significant at 5 and 1 percent levels, respectively.

Tablep-2 *General and specific combining ability variance and per cent contribution of line, testers and their interaction for yield and yield component traits in mustard*

S. No.	Characters	Variance (Random effect)			Per cent contribution		
		σ^2_{gca}	σ^2_{sca}	$\sigma^2_{gca}/\ \sigma^2_{sca}$	Line	Testers	Line x testers
1	Days to 50 % flowering	4.09	8.12	0.50	55.15	8.35	36.48
2	Days to maturity	10.36**	5.95**	1.74	82.75	2.22	15.02
3	Plant height(cm)	36.82**	103.33**	0.35	58.86	2.36	38.76
4	No. of primary branches per plant	0.13*	0.40*	0.32	31.99	12.27	55.73
5	No. of secondary branches per plant	1.28**	3.38**	0.39	57.45	2.41	40.13
6	No. of siliquae per plant	3371.06	24577.10**	0.13	26.65	13.15	60.19
7	No. of seeds per siliqua	0.43	2.36**	0.18	38.82	5.99	55.17
8	Test weight (g)	0.02	0.20**	0.10	36.94	5.27	57.78
9	Biological yield per plant (g)	-21.44	1205.02**	-0.01	13.93	8.77	77.24

Table-3 *Correspondence of per se performance of top crosses and best specific cross combinations*

S. No.	Characters	Top three best cross on the mean basis	1st, 2nd, 3rd, best specific cross combinations
1	Days to maturity	RGN-236 x RL-1359, RGN-236 x Kranti RGn-236 x Kranti	RGN-303 x RL-1359, RGN-73 x RGN-145, RGN-303 x Kranti
2	Plant height	RGN-303 x RGN-145, RGN-303 x Geeta RGN-303 x Geeta	RGN-303 x RGN-145, RGN-298 x RB-50, RGN-229 x Kranti
3	No. of primary branch	RGN-48 x RGN-145, RGN-73 x Geeta Bio-902 x RL-1359	GM-3 x RL-1359, RGN-73 x Geeta, RGN-48 x RB-50
4	No. of seeds per siliqua	RGN-298 x RGN-145, RGN-303 x RB-50 Rohini x Kranti	RGN-298 x RGN-145, RGN-13 x Geeta, RGN-303 x RB-50
5	Test weight	RGN-303 x Kranti, RGN-303 x RL-1359 GM-3 x Kranti	RGN-303 x Kranti, RGN-73 x RL-1359, RGN-229 x RGN-145
6	Biological yield per plant	RGN-303 x RGN-145, RGN-13 x Rl-1359 RGN-298 x RB-50	RGN-303 x RB-50, Rohini x RB-50, RGN-73 x Kranti
7	Harvest index	Bio-902 x RB-50, Rohini x RGN-145 RGN-303 x RB-50	Bio-902 x RB-50, RGN-229 x RGN-145, RGN-303 x RL-1359
8	Seed yield per plant	Rohini x RGN-145, RGN-298 x Kranti RGN-303 x RL-1359	RGN-236 x Geeta,RGN-48 x Geeta, RGN-298 x Kranti

Conclusion

The analysis of general and specific combining ability variances were significant for days to maturity, plant height, number of primary branches per plant, number of secondary branches per plant and seed yield per plant. Whereas SCA was also significant for number of siliquae per plant, number of seeds per siliqua, test weight, biological yield per plant and harvest index. The GCA/SCA ratio lesser than one for all the characters except days to maturity. This expressed that non-additive gene action played greater role in the inheritance of these characters.

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Author Contributions

1. Heeralal Barual- This paper is being the part of his study for M.Sc. thesis.
2. A.K.Sharma-Professor in the Plant breeding and Genetics department and supervised the M.Sc. thesis.
3. Harsh.V.S.Shekhawat- Ph.D scholar in the Plant breeding and Genetics department provided F_1 seeds for carrying out this study.
4. Manoj Kumar, .M S Bhinda, Rajesh Kumar and R P Jakhar- Ph.D scholar and M.Sc. students in the same department and helped in collection of data from the field.

Abbreviations

SKRAU- Swami Keshwan and Rajasthan Agricultural University.
GCA- General combining ability
SCA- Specific combining ability
g- Gram
cm.- Centimeter.

Ethical approval:

This article does not contain any studies with human participants or animals performed by any of the authors.

Conflict of Interest: None declared

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