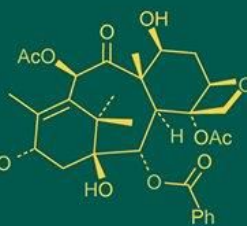
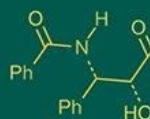


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; SP-8(9): 376-380
www.biochemjournal.com
Received: 22-06-2024
Accepted: 25-07-2024

Anuj Gupta
Ph.D. Scholar, Kisan (P.G.)
College, Simbhaoli, Hapur,
Uttar Pradesh, India

Sugandh Chauhan
Ph.D. Scholar, Kisan (P.G.)
College, Simbhaoli, Hapur,
Uttar Pradesh, India

Sunil Dutt Tyagi
Associate Professor, Kisan
(P.G.) College, Simbhaoli,
Hapur, Uttar Pradesh, India

Satpal Singh
SMS, KVK, Badaun-II,
SVPUA&T, Meerut,
Uttar Pradesh, India

Combining ability analysis for yield and its components in Indian mustard [*Brassica juncea* (L.) Czern & Coss] using half diallel

Anuj Gupta, Sugandh Chauhan, Sunil Dutt Tyagi and Satpal Singh

DOI: <https://doi.org/10.33545/26174693.2024.v8.i9Se.2124>

Abstract

Half diallel analysis excluding reciprocals, comprised of eight parents with two checks was carried out to identify high heterotic crosses and their relationship in terms of general and specific combining ability (GCA and SCA) in Indian mustard in year 2022-23. Analysis of variance for GCA and SCA signify differences for all the traits. Ratio of GCA and SCA variances was below unity for all the characters except days to flowering, plant height and harvest index, which suggested superior role of non-additive genetic variance in the inheritance of these traits. GCA analysis identified specific parental lines with consistently positive effects for various traits. These lines, such as P3, P4, P5, and P7 for early flowering and maturity or P2, P4, and P7 for increased seed weight, can be employed strategically in breeding programs to enhance specific traits in offspring. SCA analysis revealed promising cross combinations exhibiting significant positive effects for several traits. These crosses, like P1 X P7 for earlier flowering, P1 X P4 for increased seed weight, and P4 X P5 for enhanced biological yield, represent valuable breeding material for exploiting heterosis and developing superior mustard varieties.

Keywords: Diallel analysis, combining ability, GCA, SCA, *Brassica juncea*

1. Introduction

India, as the largest agrarian subcontinent, supports 26% of the world's agricultural population on just 12% of the global arable land. It is the fifth largest vegetable oil economy, contributing 7.4% to global oilseed production, 5.8% to oil production, 6.1% to oil meal production, and accounting for 9.3% of the world's edible oil consumption (Jat *et al.*, 2019) [6]. Oilseeds represent the second most significant segment of India's agricultural economy, following cereals, with an annual growth rate of 4.1% over the past three decades. Among oilseeds, brassica species cover 23.5% of the cultivation area and contribute 24.2% to the total oilseed production in the country (Jha *et al.*, 2012) [11]. Despite being the third largest producer of oilseed brassica globally, after Canada and China, India relies on imports for 57% of its domestic edible oil needs and ranks as the seventh largest importer of edible oils. Although oilseed brassica production has seen considerable growth in India, productivity remains low due to extensive rainfed cultivation, biotic and abiotic stresses, and resource limitations (Sharma, 2014) [16].

The regions where mustard is cultivated in India exhibit a vast range of agro-climatic conditions, with different species of rapeseed-mustard grown across various parts of the country (Kumar *et al.*, 2023) [8]. Indian mustard (*Brassica juncea*) is a naturally autogamous species, yet in this crop frequent outcrossing occurs which varies from 5 to 30% depending upon the environmental conditions and frequency of pollinating insects. Cytologically Indian mustard is an amphidiploid (2n=36), derived from interspecific cross of *Brassica rapa* (2n=20) and *Brassica nigra* (2n=16).

Seed quality, seed yield and other yield related parameters of Brassica oil seed crop has been tried to improve by several researchers for international acceptance, erucic acid content should be <2%. As applied different strategies for improving seed yield and quality attributed of Brassica. Gami and Chauhan (2013) [4] and Patel *et al.* (2013) [15] have also reported difference types of gene action and combining abilities in different sets of material studies.

Corresponding Author:
Satpal Singh
SMS, KVK, Badaun-II,
SVPUA&T, Meerut,
Uttar Pradesh, India

The limited and steadily declining natural resources (land and water), and competition from agriculture and non-agricultural sector, jeopardized the scope to increase the acreage under oilseeds (Fischer and Connor, 2018) [3]. In such a situation, increase in yield levels through translational scientific interventions is a conceivable alternative to increase the production and edible oil availability (Joshi, 2004; Kumar *et al.*, 2022) [12, 10]. To investigate the inheritance of quantitative traits and evaluate various breeding procedures in the context of heterosis, a comprehensive study of combining ability is crucial (Vaghela *et al.*, 2011; Kumar *et al.*, 2018; Kaur *et al.*, 2019) [22, 9, 19]. Combining ability refers to the capacity of parental genotypes to combine during hybridization and transmit desirable genes to their offspring. It is categorized into general combining ability (GCA) and specific combining ability (SCA). GCA reflects the average performance of a genotype across a series of hybrid combinations, while SCA pertains to cases where certain hybrid combinations perform better or worse than expected based on the average performance of the parental inbred lines. Studies on combining ability have highlighted the predominance of GCA effects on yield and most yield components, underscoring the importance of additive gene action. Conversely, provided evidence for significant SCA effects on yield and yield components, indicating the relevance of non-additive gene action. Singh (2005) [20] noted that both additive and non-additive genetic effects contribute to yield heterosis. The diallel mating design has been extensively utilized to analyze combining ability effects in *B. napus* L. genotypes, offering insights into the genetic mechanisms controlling seed yield and other traits. This approach can be leveraged for hybrid development, and populations can be studied through intensive selection in segregating generations. In light of the described situation, the present study aimed to evaluate: a) the mean performance of parental genotypes and their F1 hybrids, b) the general and specific combining ability effects in parental genotypes and their specific F1 hybrids.

2. Materials and Methods

Breeding material consisted of eight varieties of Indian mustard namely, Rohini, Vardan, PM-22, Pusa Tarak, PM-26, RLM-619, CS-54, and RH-749 along with two checks viz., GM-2 and Vardan. These varieties of Indian mustard were subjected to diallel fashion mating design (excluding reciprocals) during Rabi 2021-22.

The experimental material comprising of 38 treatments viz., (8 parents + 28 F1's and 2 checks) was evaluated in RBD with three replications during Rabi 2022-23. Each parent and F1's planted in one row of 5 m long 45cm apart; plant to plant distance was maintained 15 cm by thinning. All the recommended agronomic practices were adopted for raising a healthy crop. Uniform cultural practices, as recommended, were applied throughout the growing season to all genotypes to minimize field variations and environmental influences.

2.1 Traits Measurement and Statistical Analysis

Data were collected on 10 randomly selected plants from the central two rows on a single plant basis for plant height and yield traits, including main raceme length, 1000-seed weight, and seed yield per plant. All recorded data were subjected to analysis of variance (ANOVA) to test the null hypothesis of no differences between parental means and their F1 populations. Upon finding significant differences among the parental genotypes and their F1 hybrids for

various traits, the data were further analyzed for combining ability as outlined by (Jinks and Hayman, 1953) [22], Griffing's approach- Griffing (1956) [23] Method-I, based on Eisenhart's Model-II, to assess genetic variances due to general combining ability (GCA) and specific combining ability (SCA).

3. Results and Discussion

3.1 Analysis of variance

The analysis of variance was carried out with respect to all the characters to test the significance of differences among various treatments is depicted in Table 1. The mean squares due to treatments were found highly significant for all the thirteen traits. The variance due to replications were found non-significant for all the traits. The results were in accordance with Patel *et al.* (2013) [15] and Arifullah (2013) [1]. Highly significant differences were recorded among the treatments for all the characters namely, days to flowering, days to maturity, plant height, number of siliques per plant, number of branches per plant, seed yield per plant, test weight, harvest index and oil content (Table 1).

3.2 GCA and SCA Effects

The analysis of variance for combining ability indicated that variances due to GCA and SCA were highly significant for all the characters. The general combining ability (gca) effects of the parents are presented in Table 2, 3 and 4, which revealed that possibilities to pick out a good general combiner for all the traits was lesser because the combining ability effects of the parents were not consistent for all the yield contributing traits. For days to 50 percent flowering, general combining ability effects (gca) with negative values are desirable. Among parents, P3 (-2.08), P4 (-2.73), P5 (-1.58) and P7 (-3.67) exhibited significant and negative gca effects for days to 50 percent; P3 (-11.46), P4 (-12.00), P5 (-7.66) and P7 (-3.93) found to be a good general combiner for days to maturity; P2 (0.18), P4 (0.69) and P7 (0.48) for 1000 seed weight; P1 (1.16), P5 (1.2), P6 (1.05), P7 (0.43) and P8 (0.67) for biological yield; P2 (2.86) and P8 (2.42) for harvest index; P1 (0.60) and P7 (0.64) for oil content; P4 (0.25), P5 (0.16) and P6 (0.49) for primary branches per plant; P2 (0.07), P4 (0.18), P6 (0.55) and P7 (0.42) for secondary branches per plant; P1 (3.51), P2 (2.68), P6 (4.13) and P8 (3.47) for plant height; P3 (0.28), P5 (0.72) and P6 (1.91) for seeds per silique; P2 (0.33), P4 (35.63), P5 (0.34) and P7 (0.07) for number of silique per plant; P3 (0.34), P7 (2.31) and P8 (3.92) for silique on main raceme and P3 (0.34), P7 (2.31) and P8 (3.92) for seed yield per plant.

The gca and SCA ratio was less than unity for all the traits except days to flowering, plant height and harvest index. This indicated that non-additive component played more roles in inheritance of these characters. The non-additive type of gene action was also found in mustard by Gami and Chauhan (2013) [4]. The parents mentioned above had high general combining ability and fixable component of gene action additive could be successfully exploited by developing homozygous line have 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. In mustard Singh *et al.* (2005) [20], Kirti *et al.*, (2022) [7], Patel *et al.* (2013) [15] and Gami and Chauhan (2013) [4] also reported result in this fashion with different parent.

The promising direct crosses exhibiting significant SCA effects in desirable direction maybe incorporated in future

mustard improvement programme. The specific combining ability is associated with interaction effects, which may be due to dominance and epistatic components of genetic variation that are non-fixable in nature. The maximum significant and positive sca effects in desirable direction are presented in Table 3. SCA effect is an estimate for making selection of best cross combinations. High SCA denotes, undoubtedly a high heterotic response, however this, does not mean high performance of the hybrids as well. However, it can say that in majority of cases, the crosses revealing high sca effects were found to have one or both of the parents as good general combiner for the traits under study.

The results are in agreement with the findings by different authors viz., Vaghela *et al.* (2011)^[22], Maurya *et al.* (2012)^[13], Gami and Chauhan (2014)^[5] and Thanmichon *et al.* (2018)^[20], Singh *et al.* (2019)^[18] and Choudhary *et al.* (2020)^[2]. These hybrids could be further evaluated to exploit the heterosis after identifying suitable hybrid seed production technology and in future breeding programme by utilizing biparental mating or recurrent selection breeding approaches to obtain desirable segregants for development of further superior genotypes for seed yield and its component traits.

Table 1: Analysis of Variance (AVONA) for thirteen different growth and yield parameters in Indian mustard

Source of Variance	DF	DF	DM	TSW	BY	HI	OC	PB	PH	SB	SPS	TSPP	SMR	SY
Replications	2	3.176	2.5835	0.0195	0.32	0.0725	1.6985	0.0095	8.2135	0.0095	0.0095	35.11	0.065	0.0315
Treatments	35	48.447	857.581	1.666	14.888	21.022	2.713	0.951	132.677	1.025	7.453	2,165.36	27.285	1.554
Error	70	1.69	6.974	0.014	0.292	0.19	0.732	0.057	15.353	0.038	0.171	14.283	0.865	0.012
Total	107													

DF- Days to 50% flowering, DM- Days to maturity, TSW- 1000 seed weight (g), BY- Biological yield plant⁻¹ (g), HI- Harvest index (%), OC- Oil content (%), PB- Primary branches/plant, PH-Plant height (cm), SB- Secondary branches/plant, SPS- Seeds/ silique, TSPP- Total number of silique per plant, SMR- Silique on main raceme, SY- Seed yield/plant (g)

Table 2: Analysis of Variance (AVONA) for combining ability for thirteen different parameters in Indian mustard

Source of Variance	DF	DF	DM	TSW	BY	HI	OC	PB	PH	SB	SPS	TSPP	SMR	SY
Due to GCA	7	35.121	1,230.04	1.345	22.327	25.796	5.013	1.019	218.096	0.674	8.714	1,882.27	15.636	2.044
Due to SCA	28	51.779	764.467	1.746	13.029	19.829	2.137	0.934	111.346	1.113	7.138	2,236.14	30.198	1.432
Error	70	1.69	6.974	0.014	0.292	0.19	0.732	0.057	15.353	0.038	0.171	14.283	0.865	0.012

*, ** Significant at 5 and 1 percent level, respectively

DF- Days to 50% flowering, DM- Days to maturity, TSW- 1000 seed weight (g), BY- Biological yield plant⁻¹ (g), HI- Harvest index (%), OC- Oil content (%), PB- Primary branches/plant, PH-Plant height (cm), SB- Secondary branches/plant, SPS- Seeds/ silique, TSPP- Total number of silique per plant, SMR- Silique on main raceme, SY- Seed yield/plant (g)

Table 3: Performance of parents on GCA effect for 13 characters in Indian mustard

Crosses	DF	DM	PH	PB	SB	TSPP
T1×T1	1.87**	8.65**	3.51**	-0.17**	-0.23**	-9.45**
T1×T2	-0.05**	-0.41**	1.70**	0.00**	0.08**	0.35**
T1×T3	0.04**	-2.24**	-0.01**	0.04**	0.07**	-1.37**
T1×T4	0.06**	0.62**	1.17**	0.06**	0.05**	0.35**
T1×T5	0.07**	0.08**	0.62**	-0.04**	0.06**	-0.07**
T1×T6	-0.21**	0.09**	0.54**	-0.02**	-0.83**	-0.70**
T1×T7	-0.09**	12.60**	-0.05**	-0.03**	0.06**	1.86**
T1×T8	-0.08**	-0.74**	2.34**	-0.02**	0.13**	-0.18**
T2×T2	2.91**	5.54**	2.68**	-0.06**	0.07**	0.33**
T2×T3	-0.12**	1.74**	-1.02**	0.02**	0.01**	-0.38**
T2×T4	0.25**	0.31**	-2.53**	0.07**	-0.01**	0.98**
T2×T5	0.29**	1.46**	0.70**	0.00**	-0.10**	0.11**
T2×T6	-0.01**	0.10**	1.98**	-0.01**	0.11**	-0.48**
T2×T7	-0.15**	0.00**	-0.90**	0.00**	0.06**	-0.11**
T2×T8	-2.07**	0.74**	1.62**	-0.01**	-0.05**	-0.56**
T3×T3	0.40**	-11.46**	-4.11**	0.00**	-0.46**	-3.61**
T3×T4	0.02**	-0.07**	0.60**	-0.40**	-0.02**	-0.71**
T3×T5	0.61**	-0.73**	0.28**	0.10**	-0.05**	2.12**
T3×T6	0.31**	-0.88**	-0.46**	0.02**	0.12**	-0.14**
T3×T7	0.55**	-2.74**	-0.85**	0.04**	-0.04**	0.31**
T3×T8	-2.73**	0.57**	1.43**	-0.01**	-0.04**	-0.44**
T4×T4	-0.16**	-12.00**	-1.81**	0.25**	0.18**	3.63**
T4×T5	0.39**	1.96**	0.46**	0.09**	-0.04**	0.76**
T4×T6	0.01**	-0.55**	-0.31**	0.06**	0.10**	0.52**
T4×T7	0.30**	-0.75**	-2.48**	0.05**	0.00**	2.54**
T4×T8	-1.57**	1.40**	1.83**	0.01**	-0.01**	0.77**
T5×T5	-0.20**	-7.66**	-1.92**	0.16**	-0.37**	0.34**
T5×T6	-0.05**	-0.53**	0.28**	0.00**	0.11**	1.57**
T5×T7	0.09**	-3.28**	1.63**	0.01**	-0.03**	0.59**
T5×T8	-1.57**	1.48**	1.31**	0.01**	-0.01**	1.50**
T6×T6	3.62**	14.00**	4.13**	0.49**	0.55**	-16.49**
T6×T7	-0.03**	-0.86**	-0.54**	-0.05**	0.14**	-0.30**
T6×T8	0.05**	-0.38**	-0.01**	-0.02**	0.09**	0.02**
T7×T7	-3.67**	-3.92**	-5.94**	-0.31**	0.42**	-6.82**
T7×T8	-0.04**	-1.35**	0.71**	-0.01**	-0.04**	-0.86**
T8×T8	1.65**	6.85**	3.47**	-0.37**	-0.17**	0.07**

Crosses	SMR	SPS	TSW	BY	HI	OC	SY
T1×T1	-0.31**	-0.69	-0.01**	1.16**	-1.16**	0.60**	-0.06**
T1×T2	-0.21**	0.25**	-0.03**	-0.07**	-0.05**	0.34**	-0.01**
T1×T3	0.01**	0.15**	0.00**	0.02**	0.01**	-0.11**	-0.04**
T1×T4	-0.02**	0.02**	-0.04**	-0.02**	0.04**	-0.09**	0.00**
T1×T5	-0.18**	0.09**	-0.01**	-0.15**	0.17**	-0.10**	0.00**
T1×T6	-0.13**	0.05**	0.02**	0.00**	0.01**	0.48**	0.00**
T1×T7	0.39**	0.09**	-0.01**	0.04**	-0.13**	0.01**	0.01**
T1×T8	0.15**	-0.01**	0.00**	0.25**	0.11**	-0.51**	0.05**
T2×T2	-2.48**	-0.71**	0.18**	-0.67**	2.86**	-0.04**	0.40**
T2×T3	0.15**	0.04**	-0.03**	0.24**	-0.06**	0.19**	-0.01**
T2×T4	-0.06**	0.02**	-0.01**	0.14**	0.04**	0.10**	-0.02**
T2×T5	-0.08**	-0.08**	0.02**	0.09**	-0.07**	-0.40**	-0.01**
T2×T6	-0.02**	-0.04**	0.00**	0.06**	0.19**	0.33**	0.05**
T2×T7	-0.03**	-0.15**	-0.01**	0.07**	-0.14**	0.29**	-0.07**
T2×T8	-0.26**	-0.03**	-0.05**	-0.09**	-0.12**	0.27**	-0.03**
T3×T3	0.34**	0.28**	-0.54**	-1.47**	-0.09**	-0.83**	-0.35**
T3×T4	-0.10**	-0.01**	-0.01**	0.08**	-0.14**	0.11**	0.05**
T3×T5	0.12**	0.01**	0.01**	-0.29**	-0.19**	-0.14**	0.01**
T3×T6	-0.04**	-0.09**	-0.01**	-0.26**	-0.09**	0.03**	-0.02**
T3×T7	0.02**	-0.10**	0.04**	0.05**	-0.02**	-0.18**	-0.02**
T3×T8	0.14**	0.23**	0.04**	-0.01**	0.15**	0.13**	0.01**
T4×T4	-0.79**	-0.31**	0.69**	-2.37**	-1.11**	-0.73**	-0.72**
T4×T5	0.41**	-0.12**	0.01**	-0.26**	0.00**	-0.37**	-0.04**
T4×T6	0.11**	-0.03**	0.00**	-0.37**	-0.01**	-0.05**	-0.01**
T4×T7	0.15**	-0.04**	0.00**	0.21**	-0.02**	-0.18**	-0.01**
T4×T8	-0.30**	-0.04**	-0.01**	-0.11**	-0.06**	-0.25**	0.02**
T5×T5	-1.68**	0.72**	-0.32**	1.20**	-0.31**	0.00**	0.28**
T5×T6	0.11**	-0.15**	0.03**	-0.12**	-0.10**	0.49**	-0.01**
T5×T7	0.08**	0.13**	-0.03**	-0.01**	-0.32**	0.02**	-0.03**
T5×T8	0.41**	-0.04**	0.00**	-0.44**	-0.28**	0.07**	0.01**
T6×T6	-1.30**	1.91**	-0.39**	1.05**	-1.97**	0.16**	-0.23**
T6×T7	-0.05**	0.00**	-0.06**	-0.10**	-0.03**	0.44**	0.00**
T6×T8	-0.04**	0.04**	-0.03**	-0.12**	0.05**	-0.13**	0.02**
T7×T7	2.31**	-0.30**	0.48**	0.43**	-0.65**	0.64**	-0.06**
T7×T8	0.05**	0.01**	-0.02**	-0.02**	0.16**	0.11**	0.03**
T8×T8	3.92**	-0.90**	-0.08**	0.67**	2.43**	0.19**	0.74**

*, ** Significant at 5 and 1 percent level, respectively

DF- Days to 50% flowering, DM- Days to maturity, TSW- 1000 seed weight (g), BY- Biological yield plant⁻¹ (g), HI- Harvest index (%), OC- Oil content (%), PB- Primary branches/plant, PH-Plant height (cm), SB- Secondary branches/plant, SPS- Seeds/ silique, TSPP- Total number of silique per plant, SMR- Silique on main raceme, SY- Seed yield/plant (g)

Table 4: Performance of cross on SCA effect for 13 characters in Indian mustard

Crosses	DF	DM	PH	PB	SB	TSPP	SMR	SPS	BY	TSW	HI	OC	SY
P1XP2	-0.06*	-0.39*	1.7*	0	0.08 *	0.35*	-0.2*	0.25*	-0.07*	-0.03*	-0.05*	0.34*	-0.01*
P1XP3	0.04*	-2.25**	0	0.04*	0.07*	-1.37*	0.01*	0.17*	0.02	0	0.01*	-0.11*	-0.04*
P1XP4	0.09	0.62*	1.17**	0.05*	0.05*	0.35**	-0.02*	-0.01*	-0.01*	-0.04*	0.04*	-0.09	-0.01*
P1XP5	0.01*	0.08*	0.62	-0.04*	0.06*	-0.08*	-0.14	0.09*	-0.15*	-0.01*	0.17*	-0.1*	0
P1XP6	-0.22*	0.11 *	0.55*	-0.02*	-0.83 *	-0.7*	-0.15*	0.03	0	0.02*	0.01*	0.48*	0
P1XP7	-0.1*	12.61**	-0.05*	-0.03*	0.07*	1.86	0.38	0.11*	0.04**	-0.01*	-0.13*	0.01*	0.2*
P1XP8	-0.09	-0.76*	2.34*	-0.03*	0.13 **	-0.17*	0.13*	0	0.24*	0	0.11*	-0.51*	0.06*
P2XP3	-0.12**	1.75*	-1.02*	0.02*	0.01*	-0.38*	0.12*	0.05*	0.24	-0.03*	-0.06*	0.19*	-0.01*
P2XP4	0.26	0.29*	-2.53*	0.07**	-0.01	0.99*	-0.05*	0.04*	0.15*	-0.01	0.04*	0.1*	-0.02*
P2XP5	0.32*	1.45*	0.7*	0	-0.09 *	0.11*	-0.10	-0.09*	0.09**	0.02*	-0.07*	-0.4*	-0.01*
P2XP6	-0.02*	0.12*	1.98*	-0.01	0.11 **	-0.48	-0.01	-0.02*	0.06	0	0.19*	0.33*	0.06*
P2XP7	-0.16*	-0.01*	-0.9*	0	0.05**	-0.11*	-0.02**	-0.14*	0.07**	-0.01*	-0.14*	0.29*	-0.07*
P2XP8	0.02*	0.74*	1.62*	0	-0.05*	-0.56*	-0.27*	-0.05	-0.09*	-0.05	-0.11*	0.27*	-0.03*
P3XP4	0.41*	-0.07*	0.6*	-0.4**	-0.02*	-0.71*	-0.10*	-0.01*	0.09*	-0.01*	-0.14*	0.11*	0.05
P3XP5	0.02*	-0.72**	0.28**	0.1**	-0.05	2.12*	0.12*	0.03*	-0.28*	0.01*	-0.19*	-0.14*	0.01*
P3XP6	0.62*	-0.91*	-0.46	0.02*	0.13 **	-0.14	-0.03*	-0.1*	-0.27*	-0.01*	-0.09	0.03*	-0.03*
P3XP7	0.31*	-2.74**	-0.85*	0.04	-0.04**	0.31*	0.03	-0.13*	0.02	0.04*	-0.02*	-0.18*	-0.01*
P3XP8	0.56*	0.58*	1.43*	-0.01	-0.04*	-0.44*	0.12	0.24**	0.02*	0.04*	0.15*	0.13*	0.01*
P4XP5	-0.16*	1.99*	0.46*	0.09**	-0.04*	0.76*	0.42	-0.12*	-0.28*	0.01*	0	-0.37	-0.04
P4XP6	0.4	-0.54*	-0.31*	0.06	0.09 **	0.52*	0.14*	-0.05*	-0.36*	0.01*	-0.01*	-0.05*	-0.01
P4XP7	0	-0.77*	-2.48*	0.05**	0.00	2.54*	0.13*	-0.04*	0.19*	-0.01*	-0.03	-0.18*	-0.01*
P4XP8	0.3*	1.42*	1.83*	0.01*	-0.01*	0.77*	-0.32*	-0.01*	-0.12*	-0.01*	-0.06*	-0.25*	0.02**
P5XP6	-0.2*	-0.52*	0.29*	0	0.11 **	1.57*	0.09*	-0.14*	-0.14*	0.03*	-0.1*	0.49*	-0.02*
P5XP7	-0.05*	-3.28**	1.63*	0	-0.03*	0.59*	0.11*	0.13*	0.01*	-0.03*	-0.32*	0.02*	-0.03
P5XP8	0.1*	1.44*	1.31*	0.01*	-0.02*	1.5*	0.43**	-0.07*	-0.46*	0	-0.28*	0.07*	0
P6XP7	-0.3*	-0.84*	-0.54*	-0.05*	0.14 **	-0.3*	-0.06*	0.01*	-0.07	-0.07*	-0.03*	0.44*	0.01*
P6XP8	0.06*	-0.39*	-0.01	-0.02	0.09 *	0.02	-0.01*	0.04*	-0.11*	-0.03	0.05	-0.13	0.01*

4. Conclusion

The present investigation employed a half-diallel crossing design to explore the potential for improving yield and related traits in Indian mustard (*Brassica juncea* L.). The analysis of variance revealed significant variations among treatments for all studied traits, highlighting the presence of substantial genetic diversity within the parental lines. The mean performance data further emphasized this point, demonstrating a wide range of variation for each trait across parents and their hybrids. GCA analysis identified specific parental lines with consistently positive effects for various traits. These lines, such as P3, P4, P5, and P7 for early flowering and maturity or P2, P4, and P7 for increased seed weight, can be employed strategically in breeding programs to enhance specific traits in offspring. SCA analysis revealed promising cross combinations exhibiting significant positive effects for several traits. These crosses, like P1 X P7 for earlier flowering, P1 X P4 for increased seed weight, and P4 X P5 for enhanced biological yield, represent valuable breeding material for exploiting heterosis and developing superior mustard varieties.

5. References

- Arifullah M, Munir M, Mahmood A, Ajmal KS, Hassan-ul-F. Genetic analysis of some yield attributes in Indian Mustard (*Brassica juncea* L.). Afr J Plant Sci. 2013;7(6):219-226.
- Choudhary P, Sharma H, Sanadya SK, Dodiya NS, Bishnoi V. Combining ability for agronomic and quality traits in Indian mustard. Int J Chem Stud. 2020;8(5):720-724.
- Fischer RA, Connor DJ. Issues for cropping and agricultural science in the next 20 years. Field Crops Res. 2018;222:121-142.
- Gami RA, Chauhan RM. Heterosis and combining ability analysis for seed yield and its attributes in Indian mustard [*Brassica juncea* (L.) Czern and Coss]. Int J Agric Res. 2013;47(6):535-539.
- Gami RA, Chauhan RM. Genetic analysis for oil content and oil quality traits in Indian mustard [*Brassica juncea* (L.) Czern and Coss]. Int J Agric Sci. 2014;10(1):146-150.
- Jat RS, Singh VV, Sharma P, Rai PK. Oilseed brassica in India: Demand, supply, policy perspective and future potential. OCL. 2019;26:8.
- Kirti S, Kumar A, Sharma VK. Combining ability analysis for yield and component traits in baby corn. Pharma Innov J. 2022;11(9):2383-2386.
- Kumar P, Kumar P, Suniti, Kumar U, Avni, Mann A. Transcriptional regulatory network involved in drought and salt stress response in rice. In: Salinity and Drought Tolerance in Plants: Physiological Perspectives. Singapore: Springer Nature Singapore; c2023. p. 237-274.
- Kumar P, Kirti S, Pankaj YK, Kumar R. Climate change takes down crop yield potential regarding abiotic stress- An overview. In: Pant H, Singh MK, Srivastava DK, Mathur V, editors. New Approaches in Agricultural, Environmental and Nutritional Technology. India. 2018;2:9-17.
- Kumar P, Kumar P, Vashali SS, Tomar A. Evaluation of drought resistance indices and grain yield in basmati and non-basmati rice under water stress at reproductive stage. Pharma Innov J. 2022;11(9):2081-2085.
- Jha GK, Pal S, Mathur VC, Bisaria G, Anbukkani P, Burman RR, et al. Edible oilseeds supply and demand scenario in India: Implications for policy. New Delhi: Division of Agricultural Economics, Indian Agricultural Research Institute; c2012.
- Joshi PK. Diversification of agriculture in a more competitive environment. In: Agricultural Diversification and International Competitiveness. Tokyo: Asian Productivity Organization; c2004.
- Maurya N, Singh AK, Singh SK. Analysis of combining ability in Indian mustard (*Brassica juncea* (L.) Czern and Coss). Indian J Plant Sci. 2012;1:2-3.
- Patel A, Prajapati KP, Patel PJ, Shah SK, Patel PS. Genetic studies of yield and quality traits in Indian mustard (*Brassica juncea* L.). J Oilseed Brassica. 2015;6(2):289-295.
- Patel AM, Arha MD, Khule AA. Combining ability analysis for seed yield and its attributes in Indian mustard [*Brassica juncea* (L.) Czern & Coss]. Asian J Bio Sci. 2013;8(1):11-12.
- Sharma VP. Problems and prospects of oilseeds production in India. Ahmedabad: Centre for Management in Agriculture (CMA), Indian Institute of Management (IIM); c2014. p. 236.
- Shrimali TM, Chauhan RM, Gami RA, Patel PT. Diallel analysis in Indian mustard (*Brassica juncea* L. Czern & Coss.). Electron J Plant Breed. 2016;7(4):919-924.
- Singh I, Kumar R, Kaur S, Singh H, Kaur R. Combining ability studies using diallel mating design in Indian mustard [*Brassica juncea* (L.) Czern & Coss.]. Indian J Agric Res. 2019;53(3):366-369.
- Singh SK, Haider ZA, Ram S. Combining ability and heterosis for seed yield and its components in Indian mustard (*Brassica juncea*). Indian J Agric Sci. 2005;75(4):228-229.
- Thanmichon S, Ullah Z, Baruah PK. Combining ability and heterobelt iosis for yield and yield-attributing traits in Indian mustard (*Brassica juncea* L.). J Oilseed Brassica. 2018;9(2):132-138.
- Vaghela PO, Thakkar DA, Bhadauria HS, Sutariya DA, Parmar SK, Prajapati DV. Heterosis and combining ability for yield and its component traits in Indian mustard [*Brassica juncea* (L.) Czern & Coss]. J Oilseed Brassica. 2011;2(1):39-43.
- Jinks JL, BI Hayman. The analysis of diallel crosses. Maize Genetics News Letter. 1953;27:48-54.
- Griffing BR. Concept of general and specific combining ability in relation to diallel crossing systems. Australian journal of biological sciences. 1956;9(4):463-493.