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Research Article

Unveiling the genetic potential of eggplant (*Solanum melongena* L.) genotypes, hybrids for yield and fruit borer resistance

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Abstract
A half-diallel cross involving nine diverse brinjal genotypes, excluding reciprocals, yielded thirty-six combinations for the investigation of combining ability and gene action related to yield components. Varied genetic differences were observed among the genotypes for analyzed features, indicating that both additive and non-additive gene actions are influencing most traits. Examination of the overall combining ability effects highlighted JBR-5, JBR-3, and JBR-4 as effective general combiners for both fruit yield per plant and fruit and shoot borer infestation. Crosses demonstrating substantial specific combining ability effects in fruit yield also displayed noteworthy impacts on one or more components of yield. Promising combinations like JBR-3 X JBR-5, JBL-1 X JBR-5, and JBL-2 X JBL-3 showed potential for varietal improvement, pending multi-location yield trials to confirm their effectiveness. The most favourable cross, JBR-3 X JBR-5 (0.60), demonstrated significantly positive SCA effects for yield per plant, coupled with high and positive effects for fruit length and number of fruits per plant. Further, it also demonstrated enhanced fruit and shoot borer resistance. Most traits exhibited high narrow-sense heritability, suggesting a predominant role of additivity in phenotypic variability. Understanding the genetic mechanisms influencing economically important quantitative traits is crucial for devising successful breeding strategies. Future research should delve into advanced genomic techniques to unravel the genetic architecture of these traits and expedite the development of improved brinjal varieties with enhanced yield and resistance characteristics.

Keywords: Half-diallel analysis, combining ability, Gene action, Yield components.

INTRODUCTION

Vegetables are widely acknowledged as a natural source of nourishing foods and are a relatively economical means of obtaining essential vitamins, minerals, and dietary fibres. Brinjal (*Solanum melongena* L.) is a vegetable plant belonging to the Solanaceae family with a chromosome count of 2n = 24. It has its origins in India and is extensively grown in tropical and subtropical regions, where it thrives in warm climates year-round. Eggplant remains a preferred option for breeders seeking enhancements, attributed to its resilient characteristics, notably hardy nature, sizable flowers, and a substantial quantity of seeds produced through a singular pollination event (Farooq and Delvadiya 2023). Eggplant is renowned for its medicinal attributes and has been suggested as an effective treatment for liver issues and individuals with diabetes (Gangadhara *et al.*, 2021). The growing awareness of eggplant's numerous health advantages has led to a significant and consistent increase in its demand in recent times (Pramila *et al.*, 2020). While brinjal is a commonly grown crop, it is vulnerable to various insect-pest attacks.

One particularly troublesome threat for farmers is fruit and shoot borer, hence there is a need to enhance Fruit and Shoot Borer resistance by effective breeding techniques (Thota *et al*., 2023). Boosting pest resistance in plants is crucial for sustainable agriculture, minimizing dependence on chemical pesticides. This practice fosters robust crops, heightened yields, and environmental preservation, playing a pivotal role in ensuring enduring food security and ecological equilibrium (Kumari *et al*., 2022). In any plant breeding program, whether it's aimed at enhancing varieties or creating hybrids, understanding combining ability is essential. General combining ability and specific combining ability are valuable tools for selecting superior parents and ultimately achieving better hybrid outcomes (Naveen *et al.,* 2022). Plant breeders require a solid grasp of gene action, specifically regarding dominant, additive, and deleterious alleles and how they manifest in homozygous or heterozygous states. The diallel design offers enhanced management of the experimental material, thereby delivering more accurate data on various parameters derived from this particular design (Bhatt *et al.,* 2019). The economic utilization of brinjal has become feasible due to the economical F1 seed production costs and the minimal seed requirement per unit area (Mishra *et al*., 2023). This current study was designed to examine the combining ability effects in eggplant by employing a half-diallel analysis, involving nine different parent plants. Our primary aim is to discover promising parent combinations that can lead to the development of high-yield potential hybrid varieties. Furthermore, comprehending the genetic components of variation aids in creating a genetic profile of quantitative traits, enabling breeders to design effective breeding strategies for variety development. Heritability estimates are crucial for guiding breeders, serving as a cornerstone for selecting individuals based on their phenotypic performance. Hence, a thorough understanding of the genetic mechanisms influencing the heritance of economically significant quantitative traits is essential for devising an effective breeding strategy that facilitates swift enhancement (Barot *et al*., 2014). Moreover, it is imperative to investigate the molecular and genetic foundations of combining ability and gene interactions to enhance the precision of breeding strategies. Subsequent research efforts should focus on employing advanced genomic techniques to uncover the genetic architecture underlying these traits. This will accelerate the development of superior brinjal varieties with heightened yield and improved resistance characteristics (Tiwari *et al*., 2023).

MATERIALS AND METHODS

In the late *Kharif* season of 2022-2023, nine parents *viz*., JBL-1, JBR-1, JBR-2, JBR-3, JBL-2, JBL-3, JBR-4, JBR-5 and JBR-6 which are diverse for the traits *viz*., fruit sizes, shapes, and colours (**Fig.1**.) were raised along with their 36 half diallel hybrids at Research farm of Department of Genetics and Plant Breeding, School of Agriculture, Lovely Professional University, Phagwara, Punjab to understand the combining ability and heterosis. in the crossing block to develop half diallel crosses. Parental genotypes were selected considering the crucial traits for good yield potential and resistance towards the fruit and shoot borer, both of which are paramount for the objectives of this study. The experimental material consisted of a total of 46 entries, including thirty-six hybrids, nine parent plants, and one standard check (Nishant-Advanta), all generated from the mating of nine diverse genotypes in a half-diallel design.

Crosses were made in late *kharif* 2021-22 for the evaluation of F_1 during late *Kharif* 2023. A conventional hybridization method was used, involving emasculation of mature flower buds and pollination using selected male parent pollen following half diallel mating design, which leads to the development of 36 hybrids. Hybrids and parents were transplanted at the spacing of 50 x 50 cm with 2 lines of each genotype and replicated thrice in a Randomized Block Design.

Observation on fruit yield and its associated characteristics *viz.* days to 50% flowering, days to first picking, fruit length (cm), average fruit weight (kg), fruit girth (cm), number of fruits per plant, number of primary branches per plant, plant height (cm), total fruit yield per plant (g) and fruit borer infestation (%) were recorded in five randomly chosen plants. Number of fruit borer damaged and undamaged fruits in each plot was counted and percentage of fruit infestation was then computed. Combining ability was worked out following Griffing's (1956) Method 2, Model I (fixed effect).

RESULTS AND DISCUSSION

The analysis of variance, as presented in **Table 1**, showed that the mean squares related to both general combining ability (GCA) and specific combining ability (SCA) were highly significant for all the traits examined.

Examining the magnitudes of GCA and SCA variances, we observed that for five traits, SCA variances were greater than their corresponding GCA variances. The potence ratio (σ^2GCA/ σ^2 SCA) being less than one confirmed the prevalence of non-additive genetic actions in these five traits. This underscores the potential of a hybrid breeding approach to harness the existing heterosis in eggplant. Thus, these characteristics could potentially be regulated by factors such as dominance, additive-dominance interactions, and/or dominance-dominance epistasis. Similar results were also reported by Santhosha *et al.,* (2017), Chaitanya *et al.,* (2018), Siva *et al*., (2020), Datta *et al*., (2021), Dhaka *et al.,* (2022), Solanki *et al.,* (2022), Nikhila *et al.,* (2023) and Joshi *et al*., (2023).

The paramount characteristic of fruit yield per plant showcased non-additive gene action, as indicated by a general combining ability (GCA) to specific combining ability (SCA) variance ratio that is less than one. Comparable findings were also documented for brinjal in

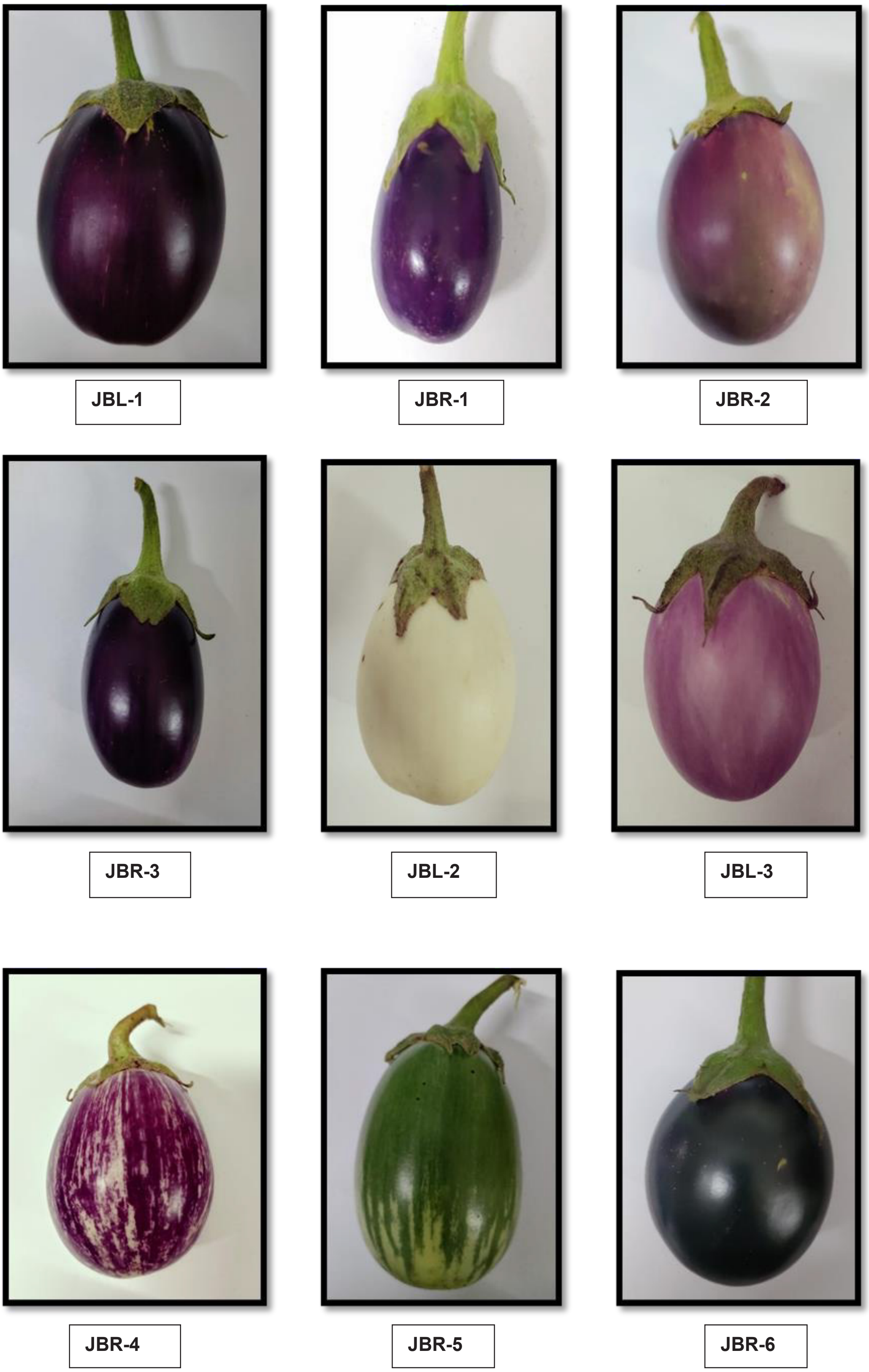

Fig.1. Phenotypic Diversity in Nine Parental Varieties: Exploring Variations in Colour, Size, and Shape

Table 1. Analysis of variance for combining ability for various characters in brinjal

Source of Variation	df	Days to 50%flowering	Days to first picking	Fruit length (cm)	Average fruit weight (gm)	Fruit girth (cm)
GCA	8	46.61**	98.95**	26.35**	4091.58**	28.15**
SCA	36	35.77**	8.91**	1.52**	179.78**	1.65**
Error	88	0.61	0.28	0.03	26.58	0.07
σ^2 GCA		4.18	8.97	2.39	369.54	2.55
σ^2 SCA		35.16	8.63	1.49	153.20	1.57
σ^2 GCA/ σ^2 SCA		0.11	1.03	1.60	2.41	1.62

Source of Variation	df	Number of fruits per plant	Number of primary branches per plant	Plant height (cm)	Total fruit yield per plant (kg)	Fruit borer infestation (%)
GCA	8	51.09**	0.53**	93.71**	0.39**	62.33**
SCA	36	2.87**	0.67**	12.84**	0.04**	9.22**
Error	88	0.06	0.01	0.76	0.01	0.05
σ^2 GCA		4.63	0.04	8.44	0.03	5.66
σ^2 SCA		2.81	0.65	12.08	0.04	9.16
σ^2 GCA/ σ^2 SCA		1.64	0.07	0.69	0.88	0.61

*, ** significant at 5 per cent and 1 per cent levels of significance, respectively

terms of fruit yield per plant by Gangadhara *et al.,* (2021), Timmareddygari *et al.,* (2021), Rajan *et al.,* (2022) and Mishra *et al*., (2023).

Conversely, for the other five traits, the magnitude of GCA exceeded their corresponding SCA variances. The potence ratio (σ^2 GCA/ σ^2 SCA) being greater than one confirmed the predominance of additive genetic effects in these traits, specifically, days to first picking, average fruit weight, fruit length, fruit girth, and the number of fruits per plant. The prevalence of additive gene action for fruit yield and its component traits has also been documented by Arpita *et al*., (2017), Kachouli *et al.,* (2019), Kaushik, P (2019), Siva *et al.,* (2020), Mondal *et al*., (2021) and Joshi *et al*., (2023).

The findings suggested that both additive and non-additive types of gene effects play a crucial role in the inheritance of all the traits examined in the current study. The results, are in accordance with the findings of Singh and Chaudhary (2018), Patil *et al.,* (2019), Mondal *et al*., (2021), Joshi *et al*., (2023), Mishra *et al*., (2023) and Gami *et al*., (2023).

Combining ability effects: The parent's general combining ability effects (denoted as gca) can be employed to assess the relative capabilities and qualities of the parents and their hybrids. In addition to this, the specific combining ability of the hybrids (represented by sca) can be harnessed, utilizing their inherent potential, in order to incorporate them effectively into a suitable breeding program.

General combining ability effects: The summary of general combining ability effects of the parents (**Table 2**) indicated that no single parent exhibited excellent general combining ability for all traits. However, upon overall evaluation, it was observed that parents JBR-5, JBR-3, and JBR-4 demonstrated strong general combining abilities, particularly in relation to fruit yield per plant and some of its components. Each of these parent plants demonstrated successful resistance against fruit borers, with JBR-4 (-1.306) exhibiting particularly strong resistance.

The parent JBR-5 ranked first in gca effects for fruit yield per plant (0.420), days to 50 % flowering, fruit length, average fruit weight, and fruit girth. JBR-3, as a parent, attained the second position in general combining ability (GCA) effect for both fruit yield per plant and plant height. However, it claimed the top spot in terms of GCA effect for the number of primary branches per plant. The parent JBR-4 secured fourth position for fruit yield per plant, average fruit weight, fruit girth, plant height and fruit borer infestation. Therefore, JBR-5, JBR-3, and JBR-4 proved to be effective general combiners for fruit yield and its components. The results are in accordance with findings of Chaitanya *et al*., (2018), Siva *et al.,* (2020), Datta *et al.,* (2021), Mondal *et al*., (2021), Dhaka *et al.,* (2022), and Nikhila *et al.,* (2023).

High general combining ability effects are frequently linked to additive gene effects or interactions involving additive x additive effects (Griffing, 1956a and 1956b). This indicates the heritable component of genetic variation that

Table 2. Estimates of general combining ability effects for different characters in brinjal

Parents	Days to 50% flowering	Days to first picking	Fruit length (cm)	Average fruit weight (gm)	Fruit girth (cm)	Number of fruits per plant	Number of primary branches per plant	Plant height (cm)	Total fruit yield per plant (Kg)	Fruit borer infestation (%)
JBL-1	-0.709*	-2.979*	-0.220*	-13.680*	-0.304*	1.435*	-0.028	-0.350	-0.081*	0.700*
JBR-1	1.191*	**-3.755***	**-1.587***	-16.316*	-2.111*	2.225*	0.245*	-1.416*	-0.139*	-1.052*
JBR-2	**2.322***	0.981*	-1.164*	-5.596*	-0.844*	-0.674*	**-0.352***	-3.129*	-0.159*	-2.573*
JBR-3	1.588*	1.078*	-0.715*	1.783	0.398*	-0.068	**0.321***	1.520*	0.092*	-0.431*
JBL-2	-2.342*	**4.881***	1.728*	10.578*	1.412*	**-3.369***	0.075*	**5.090***	**-0.160***	**-2.985***
JBL-3	-1.357*	3.924*	-0.894*	**-21.073***	**-2.424***	**3.140***	-0.216*	1.504*	-0.122*	**4.635***
JBR-4	0.846*	-0.415*	-1.056*	5.519*	1.060*	-0.735*	-0.195*	1.518*	0.077*	-1.306*
JBR-5	**-3.494***	-1.325*	**3.002***	**43.364***	**2.431***	-2.714*	0.075*	0.105	**0.420***	1.891*
JBR-6	1.955*	-2.391*	0.907*	-4.579*	0.383*	0.759*	0.075*	**-4.842***	0.072*	1.121*
S.E.(gi)	0.22	0.15	0.05	1.46	0.08	0.06	0.03	0.24	0.01	0.06
S.E.(gi-gj)	0.33	0.22	0.08	2.19	0.12	0.10	0.05	0.37	0.02	0.09

*, ** significant at 5 per cent and 1 per cent levels of significance, respectively Continue…

is amenable to enhancement. Therefore, JBR-5, JBR-3, and JBR-4 hold significant potential for the development of improved eggplant lines with increased yield capacity. Additionally, for specific components, varieties or lines demonstrating strong general combining ability can be employed in component breeding programs to effectively enhance those particular aspects, ultimately leading to improvements in overall fruit yield.

Specific combining ability effects: The analysis of specific combining ability (SCA) effects, as presented in **Table 3** indicated that none of the crosses consistently outperformed all the traits across the board.Positive significant specific combining ability (sca) effects were observed in 11 crosses for fruit length (cm), 7 crosses for average fruit weight (gm), 13 crosses for fruit girth (cm), 15 crosses for the number of fruits per plant, 12 crosses for the number of primary branches per plant, 13 crosses for plant height, and 10 crosses for total fruit yield per plant. On the other hand, significantly negative sca effects were noted in 4 crosses for days to 50% flowering, 12 crosses for days to the first picking, and in 16 crosses for fruit infestation by brinjal fruit and shoot borer.

The top-yielding hybrid, JBR-3 X JBR-5 (0.60), showed the highest SCA effect for fruit length, ranked second for the number of fruits per plant, and ranked fourth for fruit borer infestation, but it did not excel in other traits. This observation could be attributed to the combination of a less effective general combiner parent with a more effective one. Notably, the substantial specific combining ability (SCA) effect for this specific trait was accompanied by significant heterosis and robust individual performance. The hybrid JBR-3 x JBR-5 ranked first by expressing the highest standard heterosis for yield per plant, also exhibited significant and desirable heterosis for other one or more traits. The results are in compliance with the findings of Kaushik *et al*., (2018), Valadares *et al*., (2019), Solanki *et al.,* (2022), and Nikhila *et al*., (2023).

Conversely, in the case of the cross JBL-1 X JBR-5 (0.44), it displayed the second highest specific combining ability (SCA) effect for fruit yield per plant. This outcome can be attributed to the combination of a less effective general combiner parent with a more effective one, suggesting the influence of dominant gene action. These variations may be associated with genetic diversity in the presence of heterozygous loci. The results are in compliance with Patil *et al.,* (2019), Datta *et al.,* (2021) and Dhaka *et al.,* (2022).

In case of the cross JBL-2 X JBL-3 (0.29), it displayed the third highest specific combining ability (SCA) effect for fruit yield per plant and fruit borer infestation, but it did not excel in other traits. his observation may be explained by the pairing of a parent with strong general combining abilities for certain traits with another parent that is less effective in those specific traits.

A condensed summary of the most effective general combiners and significant specific combining effects (**Table 3**) suggested that, for the majority of the traits under investigation, the top general combiners might not consistently yield the most favourable cross combinations. Given this scenario, it is advisable to explore promising transgressive segregants in subsequent generations for integration into breeding programs.

Hence, it is essential to prioritize the individual performance (per se performance) when selecting cross combinations. Specific combining ability (SCA) effects primarily indicate how the F1 performance deviates, and

Table 3. Ranking of top three genotypes as per GCA and SCA performance

S.No.	Characters	Best general combiners	Best specific combiners
1.	Days to 50% flowering	JBR-5, JBL-2, JBL-3	JBR-3 x JBR-4 JBL-1 X JBR-3 JBL-1 X JBR-3
2.	Days to first picking	JBR-1, JBL-1, JBR-6	JBL-2 X JBR-4 JBR-1 X JBR-5 JBR-2 X JBR-6
3.	Fruit length (cm)	JBR-5, JBL-2, JBR-6	JBR-3 X JBR-5 JBL-2 X JBR-6 JBL-1 X JBR-4
4.	Average fruit weight (gm)	JBR-5, JBL-2, JBR-4	JBL-1 X JBR-5 JBR-2 X JBL-2 JBR-1 X JBR-5
5.	Fruit girth (cm)	JBR-5, JBL-2, JBR-4	JBL-3 X JBR-5 JBL-3 X JBR-4 JBL-3 X JBR-6
6.	Number of fruits per plant	JBL-3, JBR-1, JBL-1	JBL-2 X JBR-4 JBR-3 X JBR-5 JBL-1 X JBL-2
7.	No. of primary branches per plant	JBR-3, JBR-1, JBL-2	JBR-4 X JBR-6 JBL-2 X JBR-6 JBL-2 X JBR-4
8.	Plant height (cm)	JBL-2, JBR-3, JBR-4	JBR-5 X JBR-6 JBR-4 X JBR-6 JBL-2 X JBL-3
9.	Total fruit yield per plant (kg)	JBR-5, JBR-3, JBR-4	JBR-3 X JBR-5 JBL-1 X JBR-5 JBL-2 X JBL-3
10.	Fruit borer infestation (%)	JBL-2, JBR-2, JBR-4	JBL-2 X JBR-5 JBR-3 X JBL-3 JBL-2 X JBL-3

its magnitude can vary based on the performance of the parent lines. Therefore, a high SCA effect does not always guarantee high performance in the hybrid. Consequently, estimating SCA effects appears to have limited utility in the selection process

Furthermore, it has been observed that an enhanced resistance to fruit and shoot borers contributes to a natural increase in yield (Praneetha *et al*., 2022). Looking ahead, the exploration of Fruit and Shoot Borer (FSB) resistance, a complex trait influenced by multiple genes, can be enhanced through the application of Quantitative Trait Loci (QTL) mapping. This approach involves the identification of major QTLs associated with broad-spectrum resistance against FSB, providing valuable insights for future breeding strategies (Tiwari *et al*., 2023). The hybrid combination of JBR-3 crossed with JBR-5 demonstrated larger fruit size with favorable shape and size characteristics. Notably, both parent varieties, JBR-3 and JBR-5, exhibited high individual yields, contributing to the significant Specific Combining Ability (SCA) observed in the hybrid for yield per plant. Additionally, the hybrid displayed noteworthy resistance to fruit borer, further enhancing its economic viability in alignment with consumer preferences.

Genetic components of variation : Comparative analysis has been a longstanding approach to exploring the genetic influences on the expression of quantitative traits. In order to devise effective breeding programs, it is crucial to gain a comprehensive understanding of the nature and extent of genetic diversity within a specific population, as emphasized by Debnath (1988). We utilized the t^2 test, originally proposed by Hayman (1954), to assess the suitability of our research material for conducting diallel analysis on each of the ten traits. The non-significant 't^2' values across all the characteristics in our study affirm that they conform to the fundamental assumptions of diallel analysis.

Genetic components of variances *viz*., D, H_1, H_2, h^2, E, F along with value of t^2 for fifteen characters in brinjal are presented in **Table 4.** Furthermore, the table includes supplementary data, encompassing the mean degree of

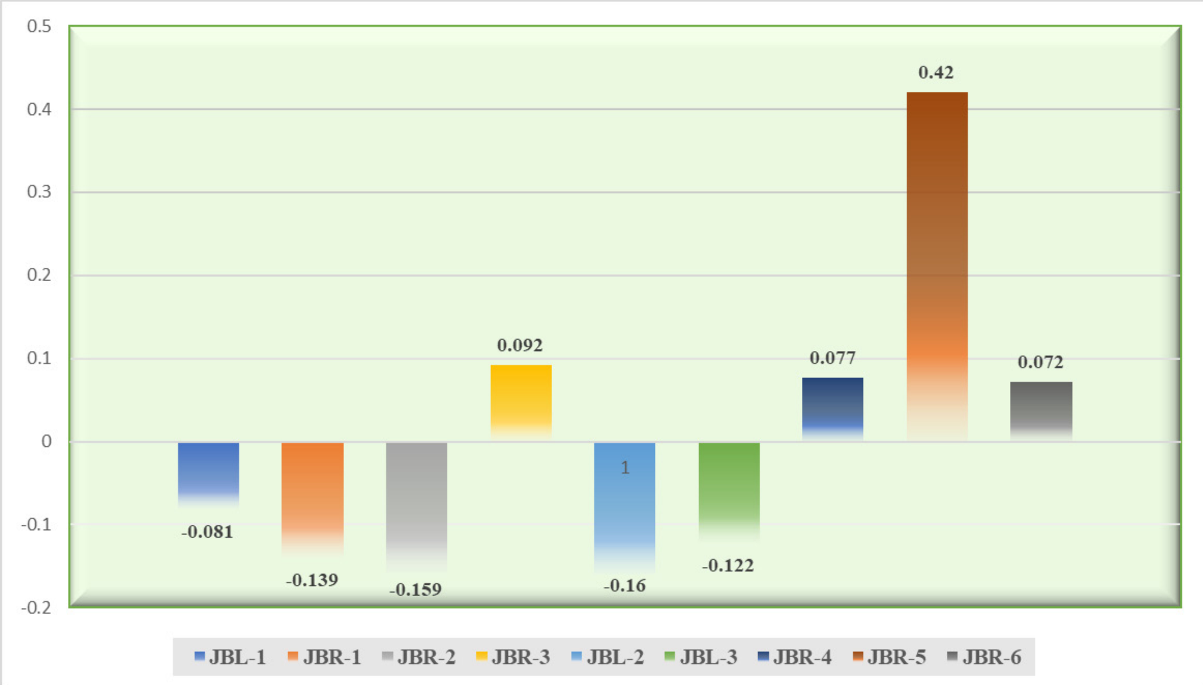

Fig. 2. Estimation of General Combining Ability for Fruit yield.

dominance represented as $(H_1/D)^{1/2}$, the ratio of positive and negative genes within the parental lines ($H_2/4H_1$), the proportion of dominant and recessive genes within the parental lines (K_D/K_R), the count of gene groups regulating each trait and displaying dominance (h^2/H_2), and the narrow sense heritability expressed as a percentage for all the examined characteristics.

In case of total fruit yield per plant, the genetic elements, namely D, H_1, and H_2, demonstrated statistical significance in **Table 4.** This underscores the significance of both additive and dominance factors in influencing the inheritance of this particular trait. The substantial predominance of the additive component (D) over the dominance component (H_1) suggests that the gene action primarily follows an additive pattern for this trait. Notably, the overall dominance effect of heterozygous loci (h^2) did not reach statistical significance, indicating ambidirectional dominance. The environmental influence, as indicated by the non-significant 'E' component in appeared to play a minor role in shaping the trait's expression.

The degree of dominance, expressed as $(H_1/D)^{1/2}$, stood at 1.73, suggesting a case of overdominance. Furthermore, the $H_2/4H_1$ ratio, at 0.21, revealed an asymmetrical distribution of negative and positive alleles among the parental lines. With a K_D/K_R ratio of 0.49, it was apparent that recessive genes were more prevalent than dominant ones, a conclusion supported by the negative F value (-0.07). The h^2/H_2 ratio, at 0.04, indicated that estimating the number of gene groups controlling the trait was challenging. Importantly, the narrow-sense heritability estimate for this trait was notably high at 65.8%.

The assessment of variation components yielded noteworthy findings, demonstrating the significance of both additive (D) and dominance effects (H_1 and H_2) across all the traits. However, in the majority of these traits, except for days to first picking, average fruit weight, and fruit girth, H_1 surpassed D, indicating the pivotal role of dominance components in shaping the inheritance of fruit yield and its associated characteristics. Similarly reported by Yadav *et al.,* (2017) and Mondal *et al.*, (2021). The average degree of dominance, represented as $(H_1/D)^{1/2}$, exceeded one for all traits, except days to first picking, average fruit weight, fruit girth, and the number of fruits per plant. This pattern indicates an overdominance gene action, suggesting that employing heterosis breeding methods could yield significant improvements in brinjal. The non-significant 'E' estimates for all traits imply minimal environmental influences altering their expression. The equitable distribution of positive and negative genes among parental lines streamlines breeders' choices for desirable traits without compromising other pertinent characteristics. In the present investigation, the unequal distribution of positive and negative genes among the parental lines became apparent through the $H_2/4H_1$ estimate for all the assessed traits.

The negative indication of 'F' and a K_D/K_R ratio below one for traits such as fruit length, average fruit weight, plant height, and total fruit yield pointed to an excess of

Table 4. Estimation of genetic components of variation for different characters in brinjal.

Components/ Ratios	Days to 50% flowering	Days to first picking	Fruit length (cm)	Average fruit weight (gm)	Fruit girth (cm)	No. of fruits/ plant	No. of primary branches/ plant	Plant height (cm)	Total fruit yield/plant (kg)	Fruit borer infestation (%)
D	13.21	39.41*	7.28*	1002.68*	13.60*	20.73*	0.11	24.86*	0.06*	24.85*
H_1	148.20*	36.77*	7.80*	714.47*	7.22*	11.19*	2.36*	51.39*	0.18*	42.64*
H_2	133.31*	33.99*	4.98*	625.06*	5.99*	10.20*	2.22*	46.46*	0.15*	33.07*
h^2	25.65	0.19	0.12	1.56	-0.03	7.00	3.37*	11.64	0.01	1.88
F	7.80	6.55	-0.49	-511.83	5.14*	3.47*	0.01	-6.98	-0.07	10.51
E	0.64	0.27	0.03	26.39	0.08	0.06	0.02	0.79	0.004	0.05
$(H_1/D)^{1/2}$	3.39	0.96	1.03	0.84	0.73	0.73	4.58	1.44	1.73	1.31
$H_2/4H_1$	0.22	0.23	0.16	0.22	0.21	0.23	0.24	0.23	0.21	0.19
K_D/K_R	1.19	1.18	0.94	0.54	1.70	1.26	1.02	0.82	0.49	1.38
h^2/H_2	0.19	0.01	0.03	0.002	-0.005	0.69	1.52	0.25	0.04	0.06
Heritability (ns) %	23	67	80.5	81.4	75.5	77.8	16.8	59.7	65.8	59
t^2	21.42	0.60	2.51	4.79	0.03	0.94	37.13	6.93	8.14	0.16

*,**significant at 5 per cent and 1 per cent levels of significance

recessive genes in the parents. Conversely, the positive indication of 'F' and a K_D/K_R ratio exceeding one for traits like days to 50% flowering, days to first picking, fruit girth, number of fruits per plant, number of primary branches per plant, and fruit borer infestation suggested a higher proportion of dominant genes compared to recessive genes. The present results are, in agreement with Yadav *et al*., (2017) and Mondal *et al*., (2021) and Gami *et al*., (2023).

Understanding the number of gene groups expressing dominance and influencing specific traits is crucial for genetic advancements through selection. In the current study, the value of h^2/H_2 was low in most of the cases except number of primary branches indicating that number of gene groups could not be estimated properly.
Significant heritability estimates in the narrow sense were noted for days to first picking, fruit length, average fruit weight, fruit girth, number of fruits per plant, plant height, and total fruit yield per plant, as well as fruit borer infestation. This suggests that selecting based on these characteristics would result in swift improvement. In contrast, days to 50% flowering and the number of primary branches exhibited low heritability.

In general, most of the traits are showing high narrow sense heritability (except days to 50% flowering and number of primary branches) indicated that major part of phenotypic variability was due to additiveness and there is possibility of fixing these traits by simple selection.

In summary, the study underscores the potential of JBR-5, JBR-3, and JBR-4, which exhibited significant general combining ability and performed well in most traits. These parent plants hold promise for future breeding programs, especially in selecting superior segregants to improve fruit yield and related characteristics. Crosses that exhibited notable specific combining ability effects for fruit yield also demonstrated significant effects on fruit and shoot borer infestation and also for other yield components, such as JBR-3 X JBR-5, JBL-1 X JBR-5, and JBL-2 X JBL-3. These crosses have the potential for varietal improvement, pending multi-location testing to identify promising recombinants. Interestingly, it was observed that crosses with high specific combining ability effects did not always involve parents with high general combining ability effects, suggesting the importance of interallelic interactions in shaping the traits.

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