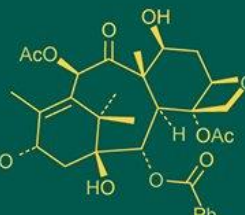


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Study of combining ability and gene action for fruit yield and its component traits in Brinjal [*Solanum melongena* L.]

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Abstract

A half diallel analysis was carried out using nine parental lines and their 36 F_1 hybrids in brinjal (*Solanum melongena* L.), along with a standard check (GJBH-4), to estimate combining ability and the nature of gene action governing fruit yield and its component traits. The experiment was conducted in a randomized block design with three replications during *rabi* 2025-26 at the Vegetable Research Station, College of Agriculture, Junagadh Agricultural University, Junagadh. Observations were recorded on five randomly selected competitive plants per replication for 16 characters.

The analysis of variance for combining ability indicated that mean squares due to general combining ability (GCA) and specific combining ability (SCA) were significant for all traits except number of pickings. The estimates of variance components revealed that SCA variance (σ^2_{sca}) was higher than GCA variance (σ^2_{gca}) for most of the traits, including days to first flowering, days to first picking, number of fruits per plant, fruit length, average fruit weight, fruit girth, number of primary branches per plant, plant height, days to last picking, total fruit yield per plant, total soluble solids, fruit and shoot borer infestation and vitamin-C content, indicating the predominance of non-additive gene action in the inheritance of these traits. Among the parents, GJLB-4, GRB-7, JBR-24-13 and JBR-24-11 were identified as good general combiners for fruit yield per plant. The parent GJLB-4 was also a good general combiner for number of fruits per plant, fruit length, average fruit weight, plant height and resistance to fruit and shoot borer infestation. JBR-24-13 was found to be a good combiner for fruit yield per plant along with plant height and total anthocyanin pigment content, while GRB-7 showed good combining ability for fruit girth, number of primary branches per plant, total soluble solids and fruit and shoot borer infestation. Based on specific combining ability effects and *per se* performance, the cross combinations JBR-24-14 $\times$ JBR-24-11, Pant Rituraj $\times$ Pusa Kranti and JBR-24-12 $\times$ GJLB-4 were identified as superior for fruit yield per plant and its associated traits. High sca effects were observed in crosses involving diverse parental combinations, indicating the importance of non-additive gene interactions.

Keywords: Brinjal, Half-diallel analysis, gene action, combining ability

Introduction

Brinjal (*Solanum melongena* L., $2n = 24$), a key vegetable crop of India belonging to the family *Solanaceae*, is widely known by regional names such as *Ringan*, *Baingan*, *Vangi* and *Katharikai*. It is believed to have originated in the Indo-Burma region and has been cultivated in India since ancient times. Due to its high adaptability, the crop is extensively grown under tropical and subtropical conditions and is often termed the “poor man’s vegetable” because of its affordability and high productivity. Brinjal is nutritionally valuable, containing vitamins like ascorbic acid, niacin and B-complex along with essential minerals such as calcium, magnesium, phosphorus, potassium and iron. The fruits are rich in moisture, fibre and carbohydrates and also possess antioxidant compounds like anthocyanins, especially in purple types. In India, it is widely cultivated in states including West Bengal, Odisha, Bihar, Karnataka, Andhra Pradesh, Maharashtra, Uttar Pradesh and Gujarat and the country ranks among the leading producers globally. The crop shows a high degree of genetic variability in plant growth and fruit traits, which provides good scope for improvement through breeding. Since yield is a complex character controlled by multiple components, effective utilization of this variability is necessary. In this context, heterosis breeding has gained importance as a method to enhance yield and quality traits.

Heterosis, or hybrid vigour, contributes significantly to increased productivity and evaluation of hybrid combinations helps identify superior crosses with better performance than their parents and standard varieties. Therefore, estimation of heterosis for yield and its associated traits is essential for identifying promising hybrids suitable for commercial cultivation and future crop improvement programmes.

Materials and Methods

The experimental material comprised of parents and their F_1 derived by crossing among nine parents viz., JBR-24-14, JBR-24-13, JBR-24-12, JBR-24-11, GJB-3, GJLB-4, GRB-7, Pant Rituraj and Pusa Kranti in a half-diallel fashion. (Table 1) Row to row and plant to plant spacing was 60 cm $\times$ 30 cm. To produce a better crop, the region's recommended agronomic practices were followed. Nine parental types were selected on the basis of morphological variability for growth, maturity, fruit size, fruit shape, fruit yield and yield contributing trait in brinjal. The experiment was laid out in a randomized block design with three replications during rabi-2025-26 at Vegetable Research Station, Junagadh Agricultural University, Junagadh. The observations were recorded on sixteen characters viz., days to first flowering, days to first picking, number of fruits per plant, fruit length (cm), average fruit weight (g), fruit girth (cm), number of branches per plant, plant height (cm), days to last picking, number of pickings, total fruit yield per plant (kg), total soluble solids, fruit borer infestation (%), shoot borer infestation (%), Vitamin-C (100 mg) and total anthocyanin pigment (100 mg) and Mean data were used for statistical analysis. The total variation among F_1 hybrids was partitioned further into variance due to parents, hybrids and their interaction effects, which were used for combining ability analysis (Griffing 1956b) [6].

Results and Discussion

The analysis of variance for combining ability revealed that mean squares due to general combining ability (GCA) (except number of picking) and specific combining ability (SCA) were significant/highly significant for all the sixteen characters. The magnitude of GCA and SCA variances exhibited that the SCA variances were higher than their respective GCA variances (except total anthocyanin pigment) for all the traits. Thus, non-additive gene action was found for inheritance of traits in this investigation. The gca and sca ratio ($\sigma^2_{gca}/\sigma^2_{sca}$) was less than unity,

indicating that non-additive components play a comparatively larger role in inheritance. For the attributes, Total anthocyanin pigment the gca and sca ratio ($\sigma^2_{gca}/\sigma^2_{sca}$) was greater than unity, indicating that additive components are comparatively more important in the inheritance of these traits. (Table 1)

These findings are in concurrence with results of These findings are in concurrence with results of Akpan *et al.* (2016) [1], Viradiya (2016) [15], Dishri and Mishra (2017) [4], Kumar *et al.* (2017) [9], Chaurasia *et al.* (2018) [3], Singh *et al.* (2018) [13], Siva *et al.* (2020) [14], Joshi *et al.* (2023) [7], Mishra *et al.* (2023b) [11], Patel *et al.* (2023) [12], Dudhatra *et al.* (2024) [5], Keerthana *et al.* (2025) [8], Lokesh *et al.* (2025) [10].

The preponderance of additive gene actions for total anthocyanin pigment has been akin to Akpan *et al.* (2016) [1], Kumar *et al.* (2017) [6], Siva *et al.* (2020) [14], Joshi *et al.* (2023) [7], Mishra *et al.* (2023b) [11], Patel *et al.* (2023) [12], Dudhatra *et al.* (2024) [5], Lokesh *et al.* (2025) [10] in brinjal.

The general combining ability effects of the parents showed that parent GJLB-4 was a good general combiner for number fruits per plant, fruit length, average fruit weight, plant height, fruit borer infestation, shoot borer infestation and total fruits yield per plant. The parent JBR-24-13 was good combiners for fruit yield per plant and also good combiners for yield attributing traits for plant height. (Table 2)

Among 36 crosses, the estimation of sca effects found that the best three crosses combinations; JBR-24-14 $\times$ JBR-24-11, Pant Rituraj $\times$ Pusa Kranti and JBR-24-12 $\times$ GJLB-4 identified for fruit yield per plant and some of its related traits. Crosses with high sca effects for fruit yield evolved from good $\times$ poor, average $\times$ average and good $\times$ poor general combiners. The JBR-24-14 $\times$ JBR-24-11 exhibited specific combining ability. Hence, such cross combinations should be used for commercial exploitation of heterosis for fruit yield improvement in brinjal. (Table 3)

However, Chaudhary *et al.* (1976) [2] stated that high sca effect would not necessarily mean a high performance by the cross and the estimation of sca effect seemed to be superfluous, as no additional information was obtained by doing so. Therefore, it is suggested that the selection of parents for further breeding programme should be based on gca effect and due consideration should be given to mean value of the cross combination while selecting crosses for specific combining ability effect.

Table 1: Analysis of variance showing mean square for combining ability and variance components for different characters in brinjal

Source of variation	d.f.	Days to First flowering	Days to first picking	Number of fruits per plant	Fruit length (cm)	Average fruit weight (g)	Fruit girth (cm)	Number of primary branches per plant	Plant height (cm)
GCA	8	4.55**	5.22**	10.89**	1.31**	275.68**	0.24**	0.56**	336.57**
SCA	36	2.57**	4.95**	30.31**	1.79**	108.59**	0.30**	1.12**	167.71**
Error	88	0.59	1.43	1.42	0.08	9.03	0.03	0.05	7.12
σ^2_{gca}	-	0.36	0.34	0.86	0.11	24.24	0.02	0.05	29.95
σ^2_{sca}	-	1.99	3.53	28.88	1.72	99.56	0.27	1.07	160.59
$\sigma^2_{gca}/\sigma^2_{sca}$	-	0.18	0.10	0.03	0.07	0.24	0.07	0.04	0.19

Source of variation	d.f.	Days to last picking	Number of pickings	Total fruit yield per plant (kg)	Total Soluble Solids% (TSS)	Fruit borer infestation (%)	Shoot borer infestation (%)	Vitamin-C (100 mg)	Total anthocyanin pigment (100 mg)
GCA	8	36.65**	0.49	0.72**	0.90**	7.28**	1.80**	0.36**	595.67**
SCA	36	32.42**	0.70**	0.94**	0.33**	2.68**	0.66**	1.20**	47.22**
Error	88	6.09	0.24	0.04	0.01	0.24	0.07	0.11	1.26
σ^2_{gca}	-	2.78	0.02	0.06	0.08	0.64	0.16	0.02	54.04
σ^2_{sca}	-	26.33	0.46	0.90	0.32	2.44	0.59	1.09	45.95
$\sigma^2_{gca}/\sigma^2_{sca}$	-	0.11	0.05	0.07	0.25	0.26	0.27	0.02	1.18

*, ** Significant at P = 0.05 and P = 0.01 levels of probability, respectively

Table 2: Estimates of general combining ability effect of parents for different characters in brinjal

Sr. No.	Parents	Days to First flowering	Days to first picking	Number of fruits per plant	Fruit length (cm)	Average fruit weight(g)	Fruit girth (cm)	Number of primary branches per plant	Plant height (cm)
1	JBR-24-14	0.16	0.75*	0.07	-0.21*	1.05	-0.23**	-0.16*	12.68**
2	JBR-24-13	0.10	0.26	0.50	-0.28**	0.16	-0.07	-0.12	2.09**
3	JBR-24-12	-0.71**	-0.16	1.08**	-0.65**	-9.05**	-0.13**	-0.22**	-1.71*
4	JBR-24-11	0.92**	0.08	0.09	0.16*	-2.30**	0.15**	0.26**	0.17
5	GJB-3	0.89**	1.20**	-0.18	0.36**	-2.66**	0.22**	-0.24**	-1.23
6	GJLB-4	0.07	-0.43	1.35**	0.17*	3.36**	0.04	-0.03	1.90*
7	GRB-7	-0.05	0.02	-0.27	0.06	0.34	0.10	0.28**	-4.82**
8	Pant Rituraj	-0.96**	-0.98**	-2.05**	-0.09	-0.55	-0.12*	-0.09	-6.41**
9	Pusa Kranti	-0.44*	-0.74*	-0.59	0.47**	9.66**	0.05	0.32**	-2.68**
	SE (gi)	0.21	0.33	0.33	0.07	0.85	0.05	0.06	0.75
	SE (gi-gj)	0.10	0.16	0.16	0.03	0.42	0.02	0.03	0.37
Range	Min.	-0.96	-0.98	-2.05	-0.65	-9.05	-0.23	-0.24	-6.41
	Max.	0.92	1.20	1.35	0.47	9.66	0.22	0.32	12.68
Significant and desirable parents		3	2	2	4	2	2	3	3

*, ** significant at 5% and 1% levels, respectively.

Sr. No.	Parents	Days to last picking	Number of pickings	Total fruit yield per plant (kg)	Total Soluble Solids (%) (TSS)	Fruit borer infestation (%)	Shoot borer infestation (%)	Vitamin-C (100 mg)	Total anthocyanin pigment (100 mg)
1	JBR-24-14	-2.48**	-0.37**	-0.33**	-0.29**	1.33**	0.45**	0.31**	13.08**
2	JBR-24-13	-1.30	0.08	0.23**	-0.18**	-0.11	0.16*	0.12	4.06**
3	JBR-24-12	2.15**	0.18	-0.34**	-0.19**	1.01**	0.62**	-0.24*	7.57**
4	JBR-24-11	0.76	-0.25	0.15**	-0.24**	-0.07	-0.36**	-0.01	0.13
5	GJB-3	-2.03**	0.11	-0.28**	-0.03	0.36*	0.25**	0.05	-11.47**
6	GJLB-4	1.15	-0.04	0.34**	-0.11**	-0.42**	-0.18*	-0.09	-0.68*
7	GRB-7	-1.55*	0.24	0.16**	0.54**	-0.94**	-0.47**	-0.27**	-3.02**
8	Pant Rituraj	2.03**	-0.13	0.01	0.15**	-0.03	0.04	0.05	-4.31**
9	Pusa Kranti	1.27	0.18	0.06	0.33**	-1.13**	-0.50**	0.08	-5.35**
	SE (gi)	0.70	0.14	0.05	0.03	0.14	0.07	0.09	0.31
	SE (gi-gj)	0.35	0.07	0.02	0.01	0.07	0.03	0.04	0.15
Range	Min.	-2.48	-0.37	-0.34	-0.29	-1.13	-0.50	-0.27	-11.47
	Max.	2.15	0.24	0.34	0.54	1.33	0.62	0.31	13.08
Significant and desirable parents		2	0	4	3	3	4	1	3

*, ** significant at 5% and 1% levels, respectively.

Table 3: Top three best specific cross combinations of sca effect for fruit yield per plant along with their desirable sca effect of component characters including gca effect of their parents in brinjal

Crosses	sca effect for fruit yield per plant	fruit yield per plant (kg)	Heterosis (%) over		Significant desirable sca effects for component traits
			Better parent	Standard check (GJBH-4)	
JBR-24-14 × JBR-24-11	2.53**	5.40	17.31**	18.16**	2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 16
Pant Rituraj × Pusa Kranti	2.14**	5.25	35.63**	14.95*	2, 3, 4, 5, 6, 7, 8, 11, 12, 13, 14
JBR-24-12 × GJLB-4	1.53**	4.59	37.11**	0.51	1, 2, 3, 6, 7, 8, 11, 13, 16

*, ** significant at 5% and 1% levels, respectively.

1	=	Days to first flowering	2	=	Days first picking	3	=	Number of fruits per plant
4	=	Fruit length (cm)	5	=	Average fruit weight (g)	6	=	Fruit girth (cm)
7	=	Number of primary branches per plant	8	=	Plant height (cm)	9	=	Days to last picking
10	=	Number of pickings	11	=	Total fruit yield per plant (kg)	12	=	Total soluble solids (%)
13	=	Fruit borer infestation (%)	14	=	Shoot borer infestation (%)	15	=	Vitamin-C (100 mg)
16	=	Total anthocyanin pigment (100 mg)						

Conclusion

On the basis of the gca effect, GJLB-4, JBR-24-13 and GRB-7 also exhibited high gca effect for fruit yield per plant, Some desirable traits like fruit length, fruit girth, average fruit weight, number of fruits per plant, plant height, fruit and shoot borer infestation, total anthocyanin pigment and total soluble solids. Therefore, these parents were identified as good general combiners and could be preferred in breeding programme as these parents upon crossing, are expected to give desirable segregants in the succeeding

generations. On the basis of the sca effect, crosses JBR-24-14 × JBR-24-11, Pant Rituraj × Pusa Kranti and JBR-24-12 × GJLB-4 displayed high sca effect for fruit yield per plant. The high sca status of the hybrids suggested that significant role was also played by dominance effect. Overall, present investigation suggested that non-additive gene action was important for most of the characters. Therefore, heterosis breeding is the most suitable breeding method for enhancing the fruit yield potential of brinjal.

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