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Combining ability analysis for yield attributes, yield and quality parameters in brinjal (*Solanum melongena* L.) hybrids

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Abstract
The present investigation was carried out in order to obtained information on combining ability of hybrids developed by following Line x Tester analysis suggested by Kempthorne (1957) at PG student's research farm, College of Horticulture, Rajendranagar, Hyderabad. Analysis of variance for combining ability reveals that the significant effects due to lines were found for only seven characters, whereas, significant tester effects were recorded for 8 characters. However, the interaction effects (line x tester) were found to be significant for all the characters except days to last harvest and fruit width (cm). The analysis for combining ability revealed the predominance of *SCA* variance was greater than *GCA* variance for the characters. Further, the ratio of *GCA* to *SCA* for these characters was less than unity. This indicated the predominance of non-additive gene action governing the inheritance of these characters. The estimates of *GCA* variance were higher than the *SCA* variance with the ratio of *GCA* variance to *SCA* variance more than unity for days to last harvest, which indicates the preponderance of additive gene action involved in the inheritance of this character. Based on *gca* effects, among lines RCBG-2 was the promising general combiner for twelve yield and yield related traits, whereas RCBG-1 for eleven characters. Among testers, Shyamala was the best general combiner for days to first flowering, days to 50% flowering, days to first harvest, fruit width, average fruit weight, fruit yield per plant, marketable yield per plant, total yield per hectare and total marketable yield per hectare and Bhagyamathi for other yield contributing characters. Hence, these parents are recommended for use in breeding programmes to develop precocious and prolific varieties of brinjal. On the basis of specific combining ability effects, the five hybrids RCBG-2 x Bhagyamathi, RCBG-1 x Bhagyamathi, RCBG-4 x Shyamala, RCBG-6 x Shyamala and RCBG-3 x Bhagyamathi were identified as best specific combiners for marketable yield per plant, hence, which may be further tested over locations, seasons and years for commercial release in regions and states.

Keywords: yield attributes, yield, *Solanum melongena* L., hybrids

Introduction
Brinjal (*Solanum melongena* L., 2n = 2x = 24) belonging to the family Solanaceae, is one of the most commonly grown, important and popular vegetable crops in India. It is often referred as poor man's crop (Sharma *et al*., 2004) [22], vegetable of masses (Patel and Sarnaik, 2003) [16] and king of vegetables. The cultivated brinjal is of Indian origin. The region across India and Indo-china is considered the centre of diversity for brinjal (Vavilov, 1951) [28].

India is major producer of brinjal in the world. In India, eggplant occupies an area of 0.73 million hectares with an annual production of 12.515 million tonnes and productivity stands at 18.9 MT/ha. The major brinjal growing states are West Benghal, Odisha, Gujarat, Madhya Pradesh, Bihar, Chhattisgarh, Andhra Pradesh, Maharashta, Karnataka and Telangana. In Telangana, it is grown over an area of 20,176 acres with a production of 2,36,878 tonnes and productivity is 19.46 MT/ha (Dept. of Horticulture, Telangna, 2019-20).

The unripe fruits of brinjal contain carbohydrate, protein, ascorbic acid, Ca, Mg, Fe, P, vitamin B_6, niacin, pantothenic acid, vitamin A and vitamin K. It is very low in calories and fats but rich in soluble fiber content. The peel has significant amounts of phenolic flavonoid phyto-chemicals called anthocyanins. They are also known to have alkaloid solanin in roots and leaves. Copper content, aminoacid content and polyphenol oxidase activity were highest in purple brinjal where as Fe, potassium and chloride content were highest in green cultivars. Brinjal is grown for its immature, tender and unripe fruits which are used in variety of ways as cooked vegetable in curries.

It has got much potential as raw material in pickle making and dehydration industries (Singh *et al*., 1963) [24]. The fruit is employed as cure for toothache. It has also been employed as excellent remedy for those suffering from liver complaints. Fruit is used as cardiotonic, laxative muturant and reliever of inflammation. White brinjals are good for diabetic patients (Singh *et al*., 1963) [24]. Other medicinal uses of brinjal include treatment of diabetes, asthma, cholera, bronchitis and dyspepsia. Fruits and leaves are administered to lower blood cholesterol levels.

Combining ability refers to capacity or ability of a genotype to transmit superior performance to its progenies. The combining ability analysis gives useful information regarding the selection of parents in terms of performance of their hybrids. Selection of parents on the basis of phenotypic performance alone is not a sound procedure, since phenotypically superior lines may not lead to expected degree of heterosis. Therefore, selection of potential parents based on the genetic information (Pidigam *et al*., 2019) [17] and knowledge of their combining ability is very important.

The concept of combining ability was first proposed by Sprague and Tatum (1942) [25] in corn. According to them, the general combining ability (*gca*) was defined as the average performance of parents in a series of hybrid combinations where as the Specific combining ability (*sca*) as the deviation of a particular cross from the average performance in a series of crosses. Griffing (1956) [7] showed the relationship between *GCA* and *SCA* variances. The *GCA* variance is due to additive variances as well as additive inter-allelic interaction (fixable), whereas the *SCA* variance is due to those of dominance and of the three epistatic variances (non- fixable). The study of *gca* helps in selection of superior parents and *sca* in superior hybrids. Hence, *GCA* and *SCA* variances act as diagnostic tools in selection of suitable parents as well as cross combinations. Keeping in view of the above discussed aspects, the present investigation was carried out with an objective of studying the combining ability of hybrids and parents.

Material and Methods

The seven genotypes *viz*., RCBG-1, RCBG-2, RCBG-3, RCBG-4, RCBG-5, RCBG-6 and RCBG-7 having high genetic divergence and desirable characters were selected as lines and three improved locally popular varieties *viz*., Bhagyamathi, Gulabi and Shyamala were selected as testers and were crossed in line x tester mating fashion during *rabi*, 2016. The resultant twenty one single crosses along with ten parents and two standard checks (Arka Anand and Mahy Hari) were evaluated for gene action, *gca* and *sca* effects using Line x Tester analysis by adopting the method suggested by Kempthorne (1957) [10] for twenty yield and yield contributing traits at PG students research farm, College of Horticulture, Rajendranagar, Hyderabad in order to obtained information on the mean performance. Seeds of ten patents, twenty one hybrids and two commercial checks were sown on 25th January, 2017 in plug trays and thirty two days old seedlings were transplanted in the main field. In each replication each genotype was grown in a plot of 1.8 x 3.5 m2 consisting of three rows, accommodating 7 plants in each row. Row-to- row spacing of 60 cm and plant-to-plant spacing of 50 cm was maintained. The recommended package of practices was followed to raise a successful crop and necessary prophylactic plant protection measures were carried out to safeguard the crop from pests and diseases.

Results and Discussion

Gene action: The components of heritable variation *viz*., *GCA* variance (σ^2GCA) and *SCA* variance (σ^2SCA) and their ratios for all the twenty characters were calculated (Table 1). In the present investigation, combining ability revealed that the estimates of *SCA* variance (σ^2SCA) are higher than *GCA* variance (σ^2GCA) with the ratio of *GCA* variance to *SCA* variance (σ^2GCA/σ^2SCA) lower than unity (<1) for the characters indicating the preponderance of non-additive gene action involved in the inheritance of these traits. Hence, heterosis breeding and recombination breeding with postponement of selection at later generations are ideal to improve these traits. Similar non additive gene action for yield and yield related characters are reported by Aswani and Khandelwal (2005) [2], Nalini *et al*. (2011) [14], Saidaiah *et al*. (2010, 2012) [21, 20], Reddy and Patel (2014) [19], Naresh *et al.* (2015) [15], Vaddoria and Ramani (2015) [27], Kumar and Arumugam (2016) [13], Kumar *et al*. (2016) [13], Kalaiyarasi *et al*. (2017) [9], Hussain *et al*. (2017) [8], Arpita *et al*. (2017) [1] and Chaitanya *et al*. (2018) [4].

The estimates of *GCA* variance were higher than the *SCA* variance with the ratio of *GCA* variance to *SCA* variance more than unity in case of days to last harvest, which indicates the preponderance of additive gene action involving in the inheritance of this character. Hence, direct selection by pureline selection or mass selection or progeny selection or hybridization and selection with pedigree method could be employed to improve this trait. Concurrent results are reported by Enang *et al*. (2015).

Table 1: Combining ability variances and their ratios for twenty characters in brinjal

S. No.	Character	σ^2GCA	σ^2SCA	σ^2GCA/σ^2SCA
1	Plant height (cm)	11.07	12.96	0.85
2	Number of branches per plant	0.90	11.26	0.08
3	Number of flower clusters per plant	0.37	2.40	0.15
4	Number of flowers per cluster	0.27	0.53	0.52
5	Days to first flowering	1.53	7.58	0.20
6	Days to 50% flowering	2.07	4.81	0.43
7	Days to first harvest	2.04	8.29	0.25
8	Days to last harvest	17.51	3.67	4.76
9	Number of fruits per cluster	0.20	0.24	0.84
10	Number of fruits per plant	5.10	48.06	0.11
11	Number of marketable fruits per plant	5.38	43.82	0.12
12	Fruit length (cm)	0.40	0.83	0.48
13	Fruit width (cm)	0.05	0.15	0.32
14	Average fruit weight (g)	5.72	63.03	0.09
15	Fruit yield per plant (kg)	0.06	0.49	0.12
16	Marketable yield per plant (kg)	0.07	0.52	0.13

17	Fruit yield per hectare (tons)	67.03	541.03	0.12
18	Marketable yield per hectare (tons)	77.30	582.93	0.13
19	Ascorbic acid content (mg/100g)	0.73	0.78	0.94
20	Total phenols content (mg/100g)	33.19	51.88	0.64

$\sigma^2 GCA, \sigma^2 SCA$= Additive and nonadditive components of heritable variation, respectively

Combining ability effects

The estimates of analysis of variance for combining ability for all the twenty yield and yield contributing characters were presented in the Table 2, which revealed that there was the presence of significant differences among parents and crosses studied. The significant effects due to lines were found for only seven characters *viz*., number of flowers per cluster, days to 50% flowering, days to last harvest, number of fruits per cluster, fruit length(cm), ascorbic acid content(mg/100gm) and total phenols content(mg/100gm) whereas, significant tester effects were recorded for number of flowers per cluster, days to first flowering, days to 50% flowering, days to first harvest, days to last harvest, number of fruits per cluster, fruit length(cm) and fruit width (cm). However, the interaction effects (line x tester) were found to be significant for all the characters except days to last harvest and fruit width (cm). Combining ability analysis helps in the identification of parents with high *gca* and parental combinations with high *sca*. The *gca* effects include additive and additive x additive components of gene action that can be exploited through hybridization and selection programmes. The specific combing ability effects represents dominance and epistatic gene effects which can be used as an index to determine the usefulness of a particular cross combination for exploitation through heterosis breeding and hybridization programme. The estimates of general combinig ability (*gca*) effects of seven lines and three testers as well as specific combining ability (*sca*) effects of twenty one crosses for all the characters are studied.

Table 2: Analysis of variance for combining ability for yield and yield contributing characters in brinjal

Source of variation	Degrees of freedom	Plant height (cm)	Number of branches per plant	Number of flower clusters per plant	Number of flowers per cluster	Days to first flowering	Days to 50% flowering	Days to first harvest	Days to last harvest	Number of fruits per cluster	Number of fruits per plant
Replicates	2	11.62	1.93	1.01	0.18	8.87	5.76*	8.14	14.90*	0.04	1.16
Crosses	20	174.36**	13.47**	3.56**	1.78**	16.02**	17.45**	19.75**	85.15**	1.26**	67.34**
Line Effect	6	97.63	11.02	5.38	3.71**	14.36	19.80*	19.77	253.69**	2.67**	55.69
Tester Effect	2	478.74	17.12	1.41	2.69*	60.25*	79.00**	76.05**	62.90**	2.76**	145.88
Line * Tester Effect	12	162.00**	14.08**	3.00**	0.66**	9.48**	6.02**	10.36*	4.59	0.30**	60.07**
Error	40	10.27	2.28	0.77	0.12	2.81	1.53	4.11	4.07	0.05	5.10

** Significant at 1% level and * Significant at 5% level

Plant height

***Gca* effects:** For this trait plant height, two lines RCBG-7(5.07) and RCBG-4(3.69) and one tester Gulabi (5.43) exhibited desired positive significant *gca* effects (Table 3). Hence, these three parents are regarded as good general combiners for plant height. The range of *gca* effects among ten parents was found to be -3.65(RCBG-3) to 5.43(Gulabi). These findings are in line with the earlier reports of Ramireddy *et al.* (2011) [18], Bhushan *et al.* (2012) [3], Vaddoria and Ramani (2015) [27], Naresh *et al.* (2015) [15], Kumar and Arumugam (2016) [13] and Kumar *et al.* (2016) [13].

Table 2(Contd...): Analysis of variance for combining ability for yield and yield contributing characters in brinjal

Source of variation	Degrees of freedom	Number of marketable fruits per plant	Fruit length (cm)	Fruit width (cm)	Average fruit weight (g)	Fruit yield per plant (kg)	Marketable fruit yield per plant (kg)	Fruit yield per hectare (tons)	Marketable fruit yield per hecatre(tons)	Ascorbic acid content (mg/100g)	Total phenols content (mg/100g)
Replicates	2	1.15	0.23	0.18	3.17	0.03	0.03	30.93	30.76	0.01	0.52
Crosses	20	64.26**	3.45**	0.44**	77.09**	0.70**	0.78**	782.66**	866.81**	4.10**	196.99**
Line Effect	6	62.83	3.36*	0.45	75.49	0.74	0.86	817.27	955.13	10.46**	476.15**
Tester Effect	2	125.50	18.22**	1.95**	71.71	1.18	1.29	1317.00	1430.70	3.77	152.33
Line * Tester Effect	12	54.77**	1.03**	0.19	78.78**	0.61**	0.65**	676.29**	728.67**	0.97**	64.85**
Error	40	5.099	0.23	0.13	13.84	0.07	0.07	81.11	81.11	0.03	1.99

****** Significant at 1% level and ***** Significant at 5% level

***Sca* effects:** Among 21 hybrids, four hybrids shown significant positive *sca* effect and five hybrids recorded significant negative *sca* effect (Table 5). Highest *sca* effect was displayed by the cross RCBG-4 x Bhagyamathi (9.10) followed by RCBG-3 x Gulabi (8.84), RCBG-1 x Shyamala (8.39) and RCBG-2 x Shyamala (3.87). This study follows the trend of Umaretiya *et al.* (2008) [26], Bhushan *et al.* (2012) [3], Kumar and Arumugam (2016) [13] and Kumar *et al.* (2016) [13].

Table 3: General combining ability of parents for plant height (cm), number of primary branches per plant, number of flower clusters per plant, number of flowers per cluster, days to first flowering, days to 50% flowering, days to first harvest, days to last harvest, number of fruits per cluster and number of fruits per plant in brinjal

Parents	Plant height (cm)	Number of branches per plant	Number of flower clusters per plant	Number of flowers per cluster	Days to first flowering	Days to 50% flowering	Days to first harvest	Days to last harvest	Number of fruits per cluster	Number of fruits per plant
Lines										
RCBR-1	-0.47	0.36	0.53	0.32*	-0.29	-0.81	-0.41	-3.97**	0.48**	1.92*
RCBG-2	-3.00**	1.67**	1.02**	0.66**	1.05	-0.14	0.25	3.14**	0.64**	3.06**
RCBG-3	-3.65**	-1.36**	-1.13**	-0.21	0.05	2.08**	-0.19	-5.41**	-0.07	-1.76*
RCBG-4	3.69**	0.98	0.42	0.86**	-1.40*	-1.70**	-1.63*	3.48**	0.53**	2.65**
RCBG-5	-1.78	-1.02*	-0.14	-0.13	-1.62**	-1.36**	-1.41*	-6.19**	-0.65**	-2.93**
RCBG-6	0.15	-0.74	-0.88**	-0.71**	1.94**	1.86**	2.81**	7.92**	-0.37**	-2.18**
RCBG-7	5.07**	0.10	0.17	-0.79**	0.27	0.08	0.59	1.03	-0.55**	-0.74
SE (lines)	1.08	0.49	0.29	0.12	0.58	0.48	0.69	0.70	0.07	0.77
Testers										
Bhagyamathi	-1.92**	0.31	0.03	0.36**	0.35	0.24	0.33	0.43	0.33**	2.53**
Gulabi	5.43**	0.71*	-0.27	-0.02	1.49**	1.81**	1.71**	1.48**	0.05	0.19
Shyamala	-3.52**	-1.02**	0.24	-0.35**	-1.84**	-2.05**	-2.05**	-1.90**	-0.39**	-2.73**
SE (testers)	0.70	0.32	0.19	0.08	0.38	0.31	0.45	0.46	0.05	0.51

****** Significant at 1% level and ***** Significant at 5% level

Number of branches per plant

***Gca* effects:** The highest *gca* effect was registered by the line RCBG-2 (1.67) and by the tester Gulabi (0.71) indicating that they are good general combiners for the character number of branches per plant. Among 10 parents, the range of *gca* effect was varied between -1.36 in RCBG-3 to 1.67 in Gulabi and was presented in Table 3. Similar kinds of results are noticed by Umaretiya *et al.* (2008) [26], Shinde *et al.* (2011) [23] and Kumar and Arumugam (2016) [13].

***Sca* effects:** Four cross combinations *viz*., RCBG-4 x Bhagyamathi (3.16), RCBG-7 x Shyamala (3.01), RCBG-6 x Gulabi (2.37) and RCBG-1 x Bhagyamathi manifested significant positive *sca* effect, whereas, lower *sca* effect was shown by the cross RCBG-1 x Gulabi (-2.35) (Table 5). Conformity results are reported by Umaretiya *et al.* (2008) [26], Shinde *et al.* (2011) [23] and Kumar and Arumugam (2016) [13].

Table 4: General combining ability of parents for number of marketable fruits per plant, fruit length (cm), fruit width (cm), average fruit weight (g), fruit yield per plant (kg), marketable fruit yield per plant (kg),yield per hectare (tons), marketable yield per hectare (tons), ascorbic acid content (mg/100g) and total phenols content (mg/100g) in brinjal

Parents	Number of marketable fruits per plant	Fruit length (cm)	Fruit width (cm)	Average fruit weight (g)	Fruit yield per plant (kg)	Marketable fruit yield per plant (kg)	Fruit yield per hectare (tons)	Marketable fruit yield per hectare(tons)	Ascorbic acid content (mg/100g)	Total phenols content (mg/100g)
Lines										
RCBR-1	2.06*	0.98**	-0.11	3.79**	0.30**	0.36**	10.16**	12.14**	1.30**	-0.32
RCBG-2	2.87**	-0.09	0.08	-0.62	0.36**	0.35**	12.16**	11.76**	0.92**	-6.04**
RCBG-3	-1.30	0.003	-0.04	2.99*	0.12	0.12	4.01	4.04	-0.37**	-2.45**
RCBG-4	3.13**	0.56**	-0.23*	-1.89	0.02	0.04	0.64	1.46	0.94**	15.77**
RCBG-5	-3.12**	-0.75**	-0.24*	-4.08**	-0.36**	-0.39**	-11.95**	-12.85**	-0.25**	-0.38
RCBG-6	-2.71**	-0.61**	0.39**	-1.88	-0.32**	-0.36**	-10.80**	-12.15**	-1.52**	-4.75**
RCBG-7	-0.93	-0.10	0.15	1.69	-0.13	-0.13	-4.21	-4.41	-1.03**	-1.80**
SE (lines)	0.77	0.17	0.11	1.17	0.09	0.08	2.95	2.81	0.06	0.41
Testers										
Bhagyamathi	2.20**	-0.22	0.12	-0.20	-0.21**	-0.23***	-7.02**	-7.61**	0.37**	3.10**
Gulabi	0.43	1.02**	-0.35**	-1.74*	-0.05	-0.03	-1.57	-1.16	0.09*	-1.78**
Shyamala	-2.63**	-0.80**	0.23**	1.93*	0.26**	0.26**	8.58**	8.77**	-0.46**	-1.32**
SE (testers)	0.51	0.11	0.07	0.77	0.06	0.05	1.93	1.84	0.04	0.27

****** Significant at 1% level and ***** Significant at 5% level

Number of flower clusters per plant

***Gca* effects:** Among lines, only one line RCBG-2 (1.02) shown positive and significant *gca* effect and two lines *viz*., RCBG-3 (-1.13) and RCBG-6 (0.88) exhibited negative and significant *gca* effect. None of the tester recorded either positive or negative significant effect.

***Sca* effects:** Out of 21 crosses, no cross combination displayed the significant positive *sca* effect for number of flower clusters per plant. However, RCBG-2 x Bhagyamathi (0.99) displayed highest positive value among all crosses (Table 5). Negative significant *sca* effects were recorded by three hybrids, RCBG-5 x Gulabi (-1.56), RCBG-2 x Shyamala (-1.48) and RCBG-4 x Bhagyamathi (-1.17).

Table 5: Specific combining ability of crosses for plant height (cm), number of primary branches per plant, number of flower clusters per plant, number of flowers per cluster, days to first flowering, days to 50% flowering, days to first harvest, days to last harvest, number of fruits per cluster and number of fruits per plant in brinjal

Crosses	Plant height (cm)	Number of branches per plant	Number of flower clusters per plant	Number of flowers per cluster	Days to first flowering	Days to 50% flowering	Days to first harvest	Days to last harvest	Number of fruits per cluster	Number of fruits per plant
RCBG-1 x Bhagyamathi	3.19	1.91*	0.75	-0.12	-1.24	-0.90	-1.11	0.35	-0.04	2.40
RCBG-1 x Gulabi	-11.58**	-2.35**	-0.34	-0.40	0.62	0.86	0.51	-0.36	-0.23	0.38
RCBG-1 x Shyamala	8.39**	0.44	-0.40	0.53*	0.62	0.05	0.60	0.02	0.27*	-2.78*
RCBG-2 x Bhagyamathi	-5.11**	-0.59	0.99	-0.40	-2.24*	-0.24	-2.78*	-1.43	-0.12	-0.27
RCBG-2 x Gulabi	1.24	1.35	0.49	-0.10	-0.71	-0.81	-0.16	0.19	0.01	0.61
RCBG-2 x Shyamala	3.87*	-0.76	-1.48**	0.50*	2.95**	1.05	2.94*	1.24	0.10	-0.33
RCBG-3 x Bhagyamathi	-10.28**	-0.73	-0.30	0.79**	2.09*	1.21	2.33	1.75	0.28*	0.61
RCBG-3 x Gulabi	8.84**	-0.05	0.44	-0.30	-0.71	0.97	-0.71	-0.25	-0.09	0.86
RCBG-3 x Shyamala	1.43	0.78	-0.14	-0.50*	-1.38	-2.17*	-1.62	-1.54	-0.19	-1.47
RCBG-4 x Bhagyamathi	9.10**	3.16**	-1.17*	-0.27	0.54	-0.35	0.44	0.24	0.38**	1.58
RCBG-4 x Gulabi	-2.36	-1.24	0.53	0.44*	0.06	-0.59	0.40	0.52	0.29*	-5.91**
RCBG-4 x Shyamala	-6.74**	-1.92*	0.65	-0.17	-0.60	0.94	-0.84	-0.76	-0.67**	4.34**
RCBG-5 x Bhagyamathi	3.20	-0.49	0.82	-0.13	-1.90	-2.02*	-1.78	0.43	-0.13	4.26**
RCBG-5 x Gulabi	3.29	1.66	-1.56**	0.39	1.95	1.75*	1.51	0.19	-0.15	-6.19**
RCBG-5 x Shyamala	-6.49**	-1.17	0.74	-0.25	-0.05	0.27	0.27	0.24	0.28*	1.93
RCBG-6 x Bhagyamathi	-1.60	-2.01*	-0.71	-0.20	0.88	1.09	0.67	1.13	-0.25	-2.60
RCBG-6 x Gulabi	1.18	2.37**	-0.13	0.02	-0.27	-1.14	-0.38	-0.25	0.19	5.63**
RCBG-6 x Shyamala	0.41	-0.36	0.84	0.17	-0.60	0.05	-0.29	-0.87	0.06	-3.03*
RCBG-7 x Bhagyamathi	1.50	-1.26	-0.37	0.33	1.87	1.21	2.22	-1.65	-0.11	-5.96**
RCBG-7 x Gulabi	-0.62	-1.74*	0.57	-0.05	-0.94	-1.03	-1.16	-0.03	-0.02	4.62**
RCBG-7 x Shyamala	-0.88	3.01**	-0.20	-0.28	-0.94	-0.17	-1.06	1.68	0.13	1.34
SE (Crosses)	1.87	0.85	0.50	0.21	1.00	0.83	1.20	1.22	0.13	1.34

****** Significant at 1% level and ***** Significant at 5% level

Number of flowers per cluster

***Gca* effects:** Positive and significant *gca* effects were observed in three lines RCBG-4(0.86), RCBG-2 (0.66), RCBG-1 (0.32) and one tester Bhagyamathi (0.36), whereas, negative significant *gca* effect was found in two lines RCBG-7(-0.79), RCBG-6 (-0.71) and one tester Shyamala (-0.35) (Table 3). Thus, RCBG-4, RCBG-2, RCBG-1 and Bhagyamathi are marked as good general combiners for number of flowers per cluster. Ramireddy *et al.* (2011) [18] also reported similar kind of findings.

***Sca* effects:** The results for number of flowers per cluster are presented in Table 5. Among 21 hybrids, the range of *sca* effects was varied between -0.50 in RCBG-3 x Shyamala to 0.79 in RCBG-3 x Bhagyamathi. Four cross combinations *viz*., RCBG-3 x Bhagyamathi (0.79), RCBG-1 x Shyamala (0.53), RCBG-2 x Shyamala (0.50) and RCBG-4 x Gulabi (0.44) manifested desired significant positive *sca* effects and only one hybrid RCBG-3 x Shyamala exhibited negative significant *sca* effect. These findings are in agreement with the earlier reports of Ramireddy *et al.* (2011) [18] and Kumar *et al.* (2016) [13].

Days to first flowering: The negative estimates of *gca* and *sca* are considered to be favourable for days to first flowering as they give rise to early duration hybrids and results pertaining to this character are given in Table 3 and Table 5 respectively.

***Gca* effects:** Five parents displayed significant effects for days to first flowering, out of which three parents RCBG-5 (-1.62), RCBG-4 (-1.40), Shyamala (-1.84) exhibited desired(negative) significant *gca* effects and two parents RCBG-6 (1.94), Gulabi (1.49) found to be positive and significant effect. Concurrent results are noticed by Umaretiya *et al.* (2008) [26] and Kumar and Arumugam (2016) [13].

***Sca* effects:** Negative and significant *sca* effect was observed in only one cross combination *i.e.* RCBG-2 x Bhagyamathi (-2.24) whereas positive and significant *sca* effects were recorded in two hybrids RCBG-2 x Shyamala (2.95) and RCBG-3 x Bhagyamathi (2.09). These results are in accordance with Umaretiya *et al*. (2008) [26] and Kumar and Arumugam (2016) [13].

Days to 50% flowering: Early flowering is highly desirable trait. The days to 50 percent flowering of a particular parent or cross is an indicator of earliness.

***Gca* effects:** Among the lines, RCBG-4 (-1.70) and RCBG-5(-1.36) and among testers, Shyamala (-2.05) registered significant negative *gca* effect. Hence, these three parents can be treated as good general combiners for earliness. Range of *gca* effects among parents was varied from -2.05 in Shyamala to 2.08 in RCBG-3 (Table 3). These findings are in line with the earlier findings of Ramireddy *et al*. (2011) [18], Bhushan *et al*. (2012) [3] and Kumar *et al*. (2016) [13].

***Sca* effects:** Evaluation of hybrids for days to 50% flowering revealed that negative significant *sca* effects were found in two cross combinations RCBG-4 x Bhagyamathi (-2.17) and RCBG-5 x Gulabi (-2.02) indicating their good specific combining ability for early flowering (Table 5). Ramireddy *et al.* (2011) [18], Bhushan *et al.* (2012) [3], Vaddoria and Ramani (2015) [27], Naresh *et al*. (2015) [15] and Kumar *et al.* (2016) [13] also reported similar kind of results.

Days to first harvest

***Gca* effects:** In the present investigation, significant *gca* effects in desirable direction (negative) were manifested by two lines RCBG-4(-1.63) and RCBG-5(-1.41) and one tester Shyamala (-2.05), which are presented in Table 3. Analogues kind of results are noticed by Umaretiya *et al*. (2008) [26],

Bhushan *et al*. (2012) [3], Vaddoria and Ramani (2015) [27] and Khapte *et al*. (2013) [11].

***Sca* effects:** Among hybrids, *sca* effects were ranged from -2.78 in RCBG-2 x Bhagyamathi to 2.94 in RCBG-2 x Shyamala, with only one hybrid showing significant desirable negative *sca* effect (Table 5). The present findings are in conformity with the earlier reports of Umaretiya *et al*. (2008) [26], Bhushan *et al*. (2012) [3], Vaddoria and Ramani (2015) [27] and Khapte *et al*. (2013) [11].

Days to last harvest

***Gca* effects:** Six lines showed significant *gca* effects, of which three lines expressed in positive direction and three lines in negative direction for the character days to last harvest. The line RCBG-6(7.92) showed maximum significant *gca* effect followed by RCBG-4(3.48) and RCBG-2(3.14). Among testers, Gulabi (1.48) recorded positive and significant effect (Table 3).

***Sca* effects:** None of the cross combination exhibited either positive or negative significant effect for this trait. Range of *sca* effects among twenty one hybrids was varied between -1.65 in RCBG-7 x Bhagyamathi to 1.75 in RCBG-3 x Bhagyamathi.

Number of fruits per cluster

***Gca* effects:** The *gca* effects among lines were varied between 0.64(RCBG-2) to -0.65 (RCBG-5) with three lines exhibiting positive significant effects, whereas, in testers it was ranged from -0.39 in Shyamala to 0.33 in Bhagyamathi, with only one tester showing significant positive *gca* effect(Table 3). Conformity results are reported by Kumar *et al*. (2016) [13].

***Sca* effects:** From the Table 5, it was revealed that out of twenty one hybrids, five crosses registered significant positive *sca* effects, of which RCBG-4 x Bhagyamathi (0.38) displayed highest value and remaining four cross combinations *viz*., RCBG-4 x Gulabi (0.29), RCBG-3 x Bhagyamathi (0.28), RCBG-5 x Shyamala (0.28) and RCBG-1 x Shyamala (0.27) are on par with each other. The only one cross combination, RCBG-4 x Shyamala (-0.67) exhibited negative significant *sca* effect. Ramireddy *et al*. (2011) [18] and Kumar *et al*. (2016) [13] also found similar trends of results.

Number of fruits per plant

***Gca* effects:** RCBG-2(3.06), RCBG-4(2.65) and RCBG-1(1.92) among lines, Bhagyamathi(2.53) among testers were marked as good general combiners for number of fruits per plant as they exhibited positive and significant *gca* effects for this trait. Lowest value of *gca* was recorded by RCBG-5(-2.93) among lines and Shyamala (-2.73) among testers (Table 3). The present results are in agreement with the earlier findings of Umaretiya *et al*. (2008) [26], Ramireddy *et al*. (2011) [18], Bhushan *et al*. (2012) [3], Khapte *et al*. (2013) [11], Kumar and Arumugam (2016) [13] and Kumar *et al*. (2016) [13].

***Sca* effects:** Positive and significant *sca* effects were manifested by four cross combinations, RCBG-6 x Gulabi (5.63), RCBG-7 x Gulabi (4.62), RCBG-4 x Shyamala(4.34) and RCBG-5 x Bhagyamathi (4.26) indicating their good specific combinig ability for number of fruits per plant. Umaretiya *et al*. (2008) [26], Bhushan *et al*. (2012) [3], Kumar and Arumugam (2016) [13] and Kumar *et al*. (2016) [13] also found similar kind of results.

Number of marketable fruits per plant

***Gca* effects:** For this character, three lines and one tester expressed significant positive *gca* effects, whereas, two lines and one tester showed significant negative *gca* effect and the values are given in Table 4. Higher values of *gca* effects were recorded by the line RCBG-4 (3.13) and by the tester Bhagyamathi (2.20).

***Sca* effects:** Among hybrids, *sca* effects were ranged from -5.63 in RCBG-7 x Bhagyamathi to 5.58 in RCBG-4 x Shyamala. Positive and significant *sca* effects were exhibited by four hybrids, RCBG-4 x Shyamala (5.58), RCBG-7 x Gulabi (5.39), RCBG-1 x Bhagyamathi (4.39) and RCBG-5 x Bhagyamathi (3.59) (Table 6). Hence these four crosses are identified as good specific combiners for number of marketable fruits per plant.

Table 6: Specific combining ability of crosses for number of marketable fruits per plant, fruit length (cm), fruit width (cm), average fruit weight (g), fruit yield per plant (kg), marketable fruit yield per plant (kg),yield per hectare (tons), marketable yield per hectare (tons), ascorbic acid content (mg/100g) and total phenols content (mg/100g) in brinjal

Crosses	Number of marketable fruits per plant	Fruit length (cm)	Fruit width (cm)	Average fruit weight (g)	Fruit yield per plant (kg)	Marketable fruit yield per plant (kg)	Fruit yield per hectare(tons)	Marketable fruit yield per hectare (tons)	Ascorbic acid content (mg/100g)	Total phenols content (mg/100g)
RCBG-1 x Bhagyamathi	4.39**	-0.25	0.40*	5.85**	0.43**	0.49**	14.46**	16.46**	0.69**	-3.57**
RCBG-1 x Gulabi	0.81	1.23**	-0.08	-0.63	-0.28	-0.27	-9.43	-9.54	-0.18	-3.82**
RCBG-1 x Shyamala	-5.20**	-0.97**	-0.32	-5.22*	-0.15	-0.21	-5.03	-6.91	-0.50**	7.39**
RCBG-2 x Bhagyamathi	-0.94	0.04	0.20	3.58	0.56**	0.53**	18.57**	17.85**	-0.30**	4.29**
RCBG-2 x Gulabi	1.37	-0.21	-0.08	-3.98	-0.04	0.01	-1.21	0.06	0.53**	-3.92**
RCBG-2 x Shyamala	-0.43	0.17	-0.12	0.39	-0.52**	-0.54**	-17.36**	-17.90**	-0.23*	-0.37
RCBG-3 x Bhagyamathi	-0.73	0.04	-0.11	3.99	0.43**	0.38*	14.50**	12.82*	0.21*	-3.54**
RCBG-3 x Gulabi	0.95	0.31	0.16	0.63	-0.26	-0.26	-8.83	-8.52	-0.20	7.77**
RCBG-3 x Shyamala	-0.23	-0.35	-0.05	-4.62*	-0.17	-0.13	-5.66	-4.30	-0.005	-4.22**
RCBG-4 x Bhagyamathi	-0.76	0.31	-0.19	-4.01	-0.47**	-0.58**	-15.58**	-19.37**	-0.51**	-1.62*
RCBG-4 x Gulabi	-4.81**	-0.40	0.15	0.90	0.09	0.16	3.10	5.37	0.95**	3.63**
RCBG-4 x Shyamala	5.58**	0.09	0.04	3.11	0.37*	0.42**	12.49*	14.00**	-0.44**	-2.02**
RCBG-5 x Bhagyamathi	3.59*	-0.11	-0.03	3.72	-0.03	-0.06	-0.98	-2.10	-0.29**	0.63
RCBG-5 x Gulabi	-5.43**	-0.04	-0.05	-1.17	0.26	0.30*	8.57	10.01*	-0.51**	1.60*
RCBG-5 x Shyamala	1.84	0.16	0.09	-2.56	-0.22	-0.24	-7.59	-7.92	0.80**	-2.22**
RCBG-6 x Bhagyamathi	0.07	0.27	0.11	-7.33**	-0.31*	-0.18	-10.35*	-6.02	0.10	2.39**

RCBG-6 x Gulabi	1.72	-0.54	-0.27	3.22	-0.02	-0.22	-0.69	-7.24	-0.26*	-2.11**
RCBG-6 x Shyamala	-1.79	0.27	0.16	4.11*	0.33*	0.40**	11.04*	13.26**	0.17	-0.28
RCBG-7 x Bhagyamathi	-5.63**	-0.29	-0.37	-5.80**	-0.62**	-0.59**	-20.61**	-19.64**	0.11	1.42
RCBG-7 x Gulabi	5.39**	-0.33	0.17	1.01	0.25	0.30*	8.50	9.86*	-0.32**	-3.15**
RCBG-7 x Shyamala	0.24	0.62*	0.19	4.78*	0.36*	0.29	12.12*	9.78	-0.21*	1.73*
SE (Crosses)	1.34	0.29	0.19	2.03	0.15	0.15	5.11	4.86	0.10	0.71

****** Significant at 1% level and ***** Significant at 5% level

Fruit length

The *gca* effects for fruit length are presented in Table 4 and *sca* effects were given in Table 6.

***Gca* effects:** Among lines, *gca* effects for fruit length was varied between -0.75(RCBG-5) to 0.98(RCBG-1) and among testers it was ranged from -0.80(Shyamala) to 1.02(Gulabi). Therefore, RCBG-1 among the lines and Gulabi among the testers were considered as good general combiners for fruit length. These results are in consonance with earlier findings of Umaretiya *et al*. (2008) [26], Ramireddy *et al*. (2011) [18], Bhushan *et al*. (2012) [3], Khapte *et al*. (2013) [11], Naresh *et al*. (2015) [15] and Kumar *et al*. (2016) [13].

***Sca* effects:** The *sca* effects among hybrids have a range of -0.97 in RCBG-1 x Shyamala to 1.23 in RCBG-1 x Gulabi. Only two cross combinations exhibited significant positive *sca* effects while only one hybrid shown significant negative effect. Thus the two crosses *viz*., RCBG-1 x Shyamala and RCBG-7 x Gulabi were treated as good specific combiners for fruit length. Umaretiya *et al*. (2008) [26], Bhushan *et al*. (2012) [3], Vaddoria and Ramani (2015) [27], Naresh *et al*. (2015) [15], Khapte *et al*. (2013) [11], Kumar and Arumugam (2016) [13] and Kumar *et al*. (2017) also reported similar results.

Fruit width

***Gca* effects:** The *gca* effects of lines and testers were presented in Table 4. Among ten parents, *gca* effects were ranged from -0.35(Gulabi) to 0.39(RCBG-6). RCBG-6 and Shyamala exhibited positive and significant *gca* effects among lines and testers respectively.

***Sca* effects:** RCBG-1 x Bhagyamathi(0.40) was the only one cross combination which manifested significant and positive *sca* effect among twenty one hybrids and the range was varied from -0.37(RCBG-7 x Bhagyamathi) to 0.40 (RCBG-1 x Bhagyamathi).

The present results with respect to the *gca* and *sca* effects are in line with the earlier reports of Aswani and Khandelwal (2005) [2] and Chaitanya *et al*. (2018) [4].

Average fruit weight

***Gca* effects:** For average fruit weight, two lines RCBG-1(3.79) and RCBG-3 (2.99) and one tester Shyamala (1.93) expressed significant *gca* effects in desirable direction. Hence, these three parents are regarded as good general combiners for this character. The range of *gca* effects among ten parents was found to be -4.08(RCBG-5) to 3.79(RCBG-1) (Table 4). These findings are in line with the earlier reports of Naresh *et al*. (2015) [15], Khapte *et al*. (2013) [11], Kumar and Arumugam (2016) [13] and Chaitanya *et al*. (2018) [4].

***Sca* effects:** Three cross combinations *viz*., RCBG-1 x Bhagyamathi (5.85), RCBG-7 x Shyamala (4.78) and RCBG-6 x Shyamala (4.11) manifested significant positive *sca* effect and thus considered as best specific combiners for average fruit weight. The range was varied from -7.33 in RCBG-6 x Bhagyamathi to 5.85 in RCBG-1 x Bhagyamathi (Table 6). Conformity results are reported by Vaddoria and Ramani (2015) [27], Naresh *et al*. (2015) [15], Kumar and Arumugam (2016) [13] and Chaitanya *et al*. (2018) [4].

Fruit yield per plant

***Gca* effects:** The highest *gca* effect was registered by the line RCBG-2(0.36) and by the tester Shyamala (0.26) (Table 4), which indicates their good general combining ability for the trait fruit yield per plant. Among lines, the range of *gca* effect was varied between -0.36 in RCBG-5 to 0.36 in RCBG-2 whereas, in testers it shown a range of -0.21(Bhagyamathi) to 0.26(Shyamala). Similar kind of results are noticed by Naresh *et al*. (2015) [15] and Kumar and Arumugam (2016) [13].

***Sca* effects:** From the Table 6, it was analysed that among 21 hybrids, six hybrids shown significant positive *sca* effect and four hybrids recorded significant negative *sca* effect. Highest *sca* effect was displayed by the cross RCBG-2 x Bhagyamathi (0.56) followed by RCBG-1 x Bhagyamathi (0.43), RCBG-3 x Bhagyamathi (0.43), RCBG-4 x Shyamala (0.37), RCBG-7 x Shyamala (0.36) and RCBG-6 x Shyamala (0.33). Hence, these six cross combinations were considered as promising specific combiners for fruit yield per plant. This study follows the trend of Khapte *et al*. (2013) [11], Naresh *et al*. (2015) [15] and Kumar and Arumugam (2016) [13].

Marketable yield per plant

The *gca* effects for marketable fruit yield per plant (kg) are presented in Table 4 and *sca* effects are given in Table 6.

***Gca* effects:** Out of seven lines, only two lines RCBG-1(0.36) and RCBG-2(0.35) exhibited significant *gca* effects in positive (desirable) direction and they were found to be equally superior combiners for marketable yield per plant. Among testers, Shyamala (0.26) was the best general combiner.

***Sca* effects:** Among 21 hybrids, the range of *sca* effects were varied between -0.59 in RCBG-7 x Bhagyamathi to 0.53 in RCBG-2 x Bhagyamathi. Seven cross combinations *viz*., RCBG-2 x Bhagyamathi (0.53), RCBG-1 x Bhagyamathi (0.49), RCBG-4 x Shyamala (0.42), RCBG-6 x Shyamala (0.40), RCBG-3 x Bhagyamathi (0.38), RCBG-5 x Gulabi (0.30) and RCBG-7 x Gulabi (0.30) manifested desired significant positive *sca* effects and three hybrids exhibited negative significant *sca* effect.

Total yield per hectare

***Gca* effects:** For this character, two lines and one tester expressed significant positive *gca* effects whereas, two lines and one tester showed significant negative *gca* effect (Table 4). Higher values of *gca* effect were recorded by the line RCBG-2(12.16) and by the tester Shyamala (8.58).

***Sca* effects:** The *sca* effects among the hybrids were varied between -20.61(RCBG-7 x Bhagyamathi) to 18.57(RCBG-2 x

Bhagyamathi) with six crosses exhibiting positive and significant effects and four crosses with negative significant effects and are presented in Table 6. The crosses RCBG-2 x Bhagyamathi(18.57), RCBG-3 x Bhagyamathi(14.50), RCBG-1 x Bhagyamathi(14.46), RCBG-4 x Shyamala(12.49), RCBG-4 x Shyamala(12.49) were the top five good specific combiners identified in this study for total yield per hectare (tons) which further may utilized to improve the yield in brinjal.

Table 7: Number of parents and crosses showing significant positive and negative *gca* and *sca* effects respectively for twenty yield and yield contributing characters in brinjal

S. No.	Character	Number of parents with significant *gca* effects		Number of crosses with significant *sca* effects	
		+Ve	-Ve	+Ve	-Ve
1	Plant height (cm)	3	4	4	5
2	Number of branches per plant	2	3	4	4
3	Number of flower clusters per plant	1	2	-	3
4	Number of flowers per cluster	4	3	4	1
5	Days to first flowering	2	3	2	1
6	Days to 50% flowering	3	3	1	2
7	Days to first harvest	2	3	1	1
8	Days to last harvest	4	4	-	-
9	Number of fruits per cluster	4	4	5	1
10	Number of fruits per plant	4	4	4	5
11	Number of marketable fruits per plant	4	3	4	4
12	Fruit length (cm)	3	3	2	1
13	Fruit width (cm)	2	3	1	-
14	Average fruit weight (g)	3	2	3	4
15	Fruit yield per plant (kg)	3	3	6	4
16	Marketable yield per plant (kg)	3	3	7	3
17	Fruit yield per hectare (tons)	3	3	6	4
18	Marketable yield per hectare (tons)	3	3	7	3
19	Ascorbic acid content (mg/100g)	4	5	6	9
20	Total phenols content (mg/100g)	2	6	7	10

Total marketable yield per hectare

***Gca* effects:** Positive and significant *gca* effects were recorded by two lines RCBG-1(12.14) and RCBG-2(11.76) and one tester Shyamala(8.77) and the range was varied from -12.85(RCBG-5) to 12.14(RCBG-1) among parents.

***Sca* effects:** The highest *sca* value among all hybrids was displayed by the cross RCBG-2 x Bhagyamathi(17.85) followed by RCBG-1 x Bhagyamathi(16.46) whose parents have high x low *gca* effects indicating the additive and dominance type of gene action whereas, lowest value was shown by the hybrid RCBG-7 x Bhagyamathi(-19.64).

Ascorbic acid content

***Gca* effects:** All lines and testers exhibited significant *gca* effects for ascorbic acid content. However, the desirable significant positive effects were observed in three lines *viz*., RCBG-1(1.30), RCBG-4(0.94) and RCBG-2(0.92). In testers, Bhagyamathi (0.37) and Gulabi showed significantly positive *gca* effect. Kumar and Arumugam (2016) [13] also reported similar results.

***Sca* effects:** Positive and significant *sca* effects were registered by five hybrids Table 6, of which RCBG-4 x Gulabi(0.95) showed highest value followed by RCBG-5 x Shyamala(0.80), RCBG-1 x Bhagyamathi(0.69), RCBG-2 x Gulabi(0.53) and RCBG-3 x Bhagyamathi(0.21). The *sca* effects among hybrids have a range of -0.51 to 0.95, which are in line with the earlier reports of Kumar and Arumugam (2016) [13].

Total phenols content

***Gca* effects:** With respect to the total phenols content where negative significant *gca* effects are desirable, four lines and two testers registered significant *gca* effects. The range of *gca* effect among lines was varied from -6.04(RCBG-2) to 15.77(RCBG-4) and among testers it was ranged from -1.78(Gulabi) to 3.10(Bhagyamathi) (Table 4). Conformity results are observed by Bhushan *et al*. (2012) [3] and Kumar and Arumugam (2016) [13].

***Sca* effects:** As many as seventeen hybrids exhibited significant *sca* effects, of which seven were positive in direction and ten were in the negative direction. The range of *sca* effect was varied from -4.22(RCBG-3 x Shyamala) to 7.77(RCBG-3 x Gulabi) among hybrids. The top three crosses with desirable negative *sca* effects were RCBG-3 x Shyamala (-4.22), RCBG-2 x Gulabi (-3.92) and RCBG-2 x Gulabi (-3.82) for total phenols content. Kumar and Arumugam (2016) [13] also reported similar type of results.

In the present investigation the high estimates of *gca* effects was observed for different attributes of economic importance which may be useful for sorting out outstanding parents with favourable alleles for different components of yield. The number of parents and crosses with significantly positive and negative *gca* and *sca* effects for twenty characters are given in Table 7. The *gca* effect of the lines for various characters revealed that none of the parents excelled for all characters in positive direction. With respect to marketable fruit yield per plant (kg), the lines RCBG-1(0.36) and RCBG-2(0.35) possessed significant desirable *gca* values. However, these lines also shown positive significant effects for other yield contributing characters like number of flowers per cluster, number of fruits per cluster, number of fruits per plant, number of marketable fruits per plant, fruit length, average fruit weight, yield per plant and number of branches per plant, number of flower clusters per plant, number of flowers per cluster, days to last harvest, number of fruits per cluster, number of fruits per plant, number of marketable fruits per plant, yield per plant, respectively.

The *gca* effects of the lines for various characters also revealed that the line RCBG-4 excelled positive significant *gca* values for the characters *viz*., Plant height, number of flowers per cluster, days to first flowering, days to 50% flowering, days to first harvest, days to last harvest, number of fruits per cluster, number of fruits per plant, number of marketable fruits per plant, fruit length and ascorbic acid content and RCBG-5 for days to first flowering, days to 50% flowering, days to first harvest (earliness).

Among the testers, Shyamala (0.26) possessed significant positive *gca* effect for marketable fruit yield per plant (kg). Besides, the marketable yield per plant (kg), it also shown desirable *gca* values for its component characters like fruit width, average fruit weight, yield per plant and earliness characters *viz*., days to first flowering, days to 50% flowering, days to first harvest. The tester Bhagyamathi also shown desirable *gca* effects for characters *i.e.* number of flowers per cluster, number of fruits per cluster, number of fruits per plant, number of marketable fruits per plant and ascorbic acid content. Thus these parents could be utilized extensively in hybridization followed by selection to accelerate the pace of genetic improvement of fruit yield and its component traits.

On the basis of specific combining ability effects, it can be concluded that desirable *sca* effects were not revealed by any of the cross for all the traits. RCBG-2 x Bhagyamathi, RCBG-1 x Bhagyamathi, RCBG-4 x Shyamala, RCBG-6 x Shyamala, RCBG-3 x Bhagyamathi, RCBG-7 x Gulabi and RCBG-5 x Gulabi were the identified crosses, on the basis of higher and significant specific combining ability effects for marketable yield per plant. From study, it is evident that, besides marketable yield per plant, RCBG-2 x Bhagyamathi for days to first flowering, days to first harvest, fruit yield per plant, fruit yield per hectare and marketable yield per hectare; RCBG-1 x Bhagyamathi for number of branches per plant, number of marketable fruits per plant, fruit width, average fruit weight, fruit yield per plant, fruit yield per hectare, marketable yield per hectare, ascorbic acid content and total phenols content; RCBG-4 x Shyamala for number of fruits per plant, number of marketable fruits per plant, fruit yield per plant, fruit yield per hectare, marketable yield per hectare and total phenols content; RCBG-3 x Bhagyamathi for number of flowers per cluster, number of fruits per cluster, fruit yield per plant, fruit yield per hectare, marketable yield per hectare, ascorbic acid content and total phenols content; RCBG-6 x Shyamala for average fruit weight, fruit yield per plant, fruit yield per hectare and marketable yield per hectare also shown significant *sca* effects.

It was concluding that, the lines RCBG-1, RCBG-2, RCBG-4 and the testers Shyamala, Bhagyamathi were identified as top general combiners while, the cross combinations RCBG-1 x Bhagyamathi, RCBG-2 x Bhagyamathi, RCBG-3 x Bhagyamathi, RCBG-4 x Shyamala and RCBG-6 x Shyamala were identified as top specific combiners for fruit yield and its contributing characters in brinjal.

The top three crosses with high *sca* effect along with their *per se* performance and *gca* effects of their parents for all the twenty yield and its contributing characters are presented (Table 8). In majority of the crosses, high *sca* was either due to high x low or medium x high or medium x medium combining parents, which further substantiate the operation of non-additive gene action (additive x dominance and dominance x dominance epistatic interaction). An ideal cross combination to be explored is the one where high magnitude of *sca* is present (Saidaiah *et al.*, 2010) [21], in addition to high *gca* in both or at least one of the parent. It is evident from the different studies, the predominance of non additive gene action over the additive component, which is ideal for exploitation through heterosis breeding. In few cases, crosses with both good general combiner parents had also exhibited high *sca* effects, indicating the role of additive x additive type of gene action and hence, a good scope for fixation of the heterotic effects through the isolation of high yielding homozygous lines in advanced generations (Saidaiah *et al.*, 2010) [21].

Based *sca* effects for marketable fruit yield and its attributes, three cross combinations *viz*., RCBG-1 x Bhagyamathi, RCBG-2 x Bhagyamathi and RCBG-4 x Shyamala were proved to be promising heterotic crosses for yield and its contributing traits (Table 4.27). These hybrids may be further tested over locations, seasons and years and recommended for commercial release.

Table 8: *Per se* performance, *sca* effects, *gca* effects of the parents and heterosis of F_1 crosses for marketable fruit yield per plant (kg) in brinjal

Hybrids	*Per se* performance	*sca* effects	*gca* effects of male	*gca* effect of female	*gca* status	Heterosis (%)		
						RH	HB	SH
RCBG-1 x Bhagyamathi	2.63	0.49**	0.36**	-0.23**	H x L	89.17**	78.69**	39.05**
RCBG-2 x Bhagyamathi	2.66	0.53**	0.35**	-0.23**	H x L	93.67**	80.75**	40.65**
RCBG-4 x Shyamala	2.73	0.42**	0.04	0.26**	M x H	145.95**	95.93**	44.19**

****** Significant at 1% level. RH = Relative heterosis, HB = Heterobeltiosis, SH = Standard heterosis, H = High, L = Low, M = Medium

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