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 were found to be significant for all the characters except days to last harvest and fruit weight (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, Bhagyamathi was the best general combiner for days to first flowering, days to 50% flowering, days to first harvest, fruit weight, average fruit weight, fruit yield per plant, marketable yield per plant, total yield per hectare and total marketable yield per hectare and Bhagamathi 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, five hybrids RCBG-2 x Bhagyamathi, RCBG-1 x Bhagamathi, RCBG-4 x Shyamala, RCBG-6 x Shyamala and RCBG-3 x Bhagamathi 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) [29].

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 Bengal, Odisha, Gujarat, Madhya Pradesh, Bihar, Chhattisgarh, Andhra Pradesh, Maharashtra, 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, Telangana, 2019-20).

The unripe fruits of brinjal contain carbohydrate, protein, ascorbic acid, Ca, Mg, Fe, P, vitamin B6, 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 phytochemicals 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) [17] 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 (σ²GCA) and SCA variance (σ²SCA) 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 (σ²SCA) are higher than GCA variance (σ²GCA) with the ratio of GCA variance to SCA variance (σ²GCA/σ²SCA) 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).

| S. No. | Character               | σ²GCA | σ²SCA | σ²GCA/σ²SCA |
|--------|------------------------|-------|-------|-------------|
| 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        |
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 combining 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 combining 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*                       | 69.50*                 | 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 hectare (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**                              | 876.26**                            | 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 Bhagymathi (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) [20], 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 |
|---------|------------------|------------------------------|-------------------------------------|-----------------------------|------------------------|------------------------|------------------------|------------------------|-----------------------------|---------------------------|
| 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                       | -1.63**                | -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                      |

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

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), fruit yield per hectare (tons), marketable fruit 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) |
|---------|--------------------------------------|------------------|-----------------|--------------------------|----------------------------|--------------------------------------|-------------------------------|-----------------------------------------|----------------------------------|-------------------------------|
| RCBR-1  | 2.06*                                | 0.98**           | -0.11           | 3.79**                   | 0.30**                     | 0.36**                               | 10.16**                       | 12.14**                                 | 0.92**                           | -6.04**                       |
| RCBG-2  | 2.87**                               | -0.09            | 0.08            | -0.62                    | 0.36**                     | 0.35**                               | 12.16**                       | 11.76**                                 | 0.40**                           | -2.45**                       |
| RCBG-3  | -1.30                                | -0.003           | -0.04           | 2.99**                   | 0.12                      | 0.12                                | 4.01                          | 4.04                                    | 0.03**                           | -2.57**                       |
| RCBG-4  | 3.13**                               | 0.56**           | -0.23**         | -1.89                    | 0.02                      | 0.04                                | 1.46                          | 0.94**                                   | 15.77**                          | -0.38**                       |
| 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                          |

** 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:** 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 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 last flowering | 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                      |
| RCBG-1 x Gulabi       | -11.58**          | -2.35**                     | -0.34                               | -0.40                         | 0.62                    | 0.86                  | 0.51                   | -0.36                    | -0.23                     |
| RCBG-1 x Shyamala     | 8.39**            | 0.44                        | -0.40                               | 0.53*                         | 0.62                    | 0.05                  | 0.60                   | 0.02                     | 0.27*                     |
| RCBG-2 x Bhagyamathi  | -5.11**           | -0.99                       | 0.99                                | -0.40                         | -2.24*                  | -0.24                 | -2.78*                 | -1.43                    | -0.12                     |
| RCBG-2 x Gulabi       | 1.24              | 1.35                        | 0.49                                | -0.10                         | -0.71                   | -0.81                 | -0.16                  | 0.19                     | 0.01                      |
| RCBG-3 x Bhagyamathi  | 3.87**            | -0.76                       | -1.48**                             | 0.50*                         | 2.95**                  | 1.05                  | 2.94*                  | 1.24                     | 0.10                     |
| RCBG-3 x Shyamala     | -10.28**          | -0.73                       | -0.30                               | 0.79**                        | 2.09*                   | 1.21                  | 2.33                   | 1.75                     | 0.25*                     |
| RCBG-3 x Gulabi       | 8.84**            | -0.25                       | 0.44                                | -0.30                         | -0.71                   | 0.97                  | -0.71                  | -0.25                    | 0.09                     |
| RCBG-4 x Bhagyamathi  | 2.70              | 1.01                        | 0.61                                | -0.27                         | 0.60                    | 0.35                  | 0.44                   | 0.23                     | 0.07                      |
| RCBG-4 x Shyamala     | 6.21               | -1.24                       | 0.53                                | 0.44*                         | 0.06                    | 0.00                  | 0.40                   | 0.52                     | 0.29*                     |
| RCBG-5 x Bhagyamathi  | -4.74**           | -0.87                       | 0.65                                | -0.17                         | -0.60                   | 0.94                  | -0.84                  | -0.76                    | -0.67*                    |
| RCBG-5 x Shyamala     | 3.33**            | -0.21*                      | 0.82                                | -0.13                         | -1.90                   | -2.02*                | -1.78                  | 0.43                     | -1.46**                    |
| RCBG-5 x Gulabi       | 3.29              | 1.66                        | -1.56**                             | 0.39                          | 1.95*                   | 1.75*                 | 1.51                   | 0.19                     | -0.15*                    |
| RCBG-6 x Bhagyamathi  | 6.49**            | -1.87                       | 0.74                                | -0.25                         | -0.80                   | 0.25                  | 0.27                   | 0.24                     | 0.28*                     |
| RCBG-6 x Shyamala     | -1.60             | -2.01*                      | -0.71                               | -0.20                         | 0.88                    | 1.09                  | 0.67                   | 1.13                     | -0.25                     |
| RCBG-6 x Gulabi       | 1.18              | 2.37**                      | -0.13                               | 0.02                          | -0.72                   | -1.14                 | -0.38                  | -0.25                    | 0.19                      |
| RCBG-7 x Bhagyamathi  | 4.41              | -0.36                       | 0.84                                | 0.17                          | -0.60                   | 0.05                  | -0.29                  | -0.87                    | 0.06                      |
| RCBG-7 x Shyamala     | 1.50              | -1.26*                      | -0.37                               | 0.33                          | 1.87                    | 1.21                  | 2.22                   | -1.65                    | -0.11                     |
| RCBG-7 x Gulabi       | -0.62             | -1.74*                      | 0.57                                | -0.05                         | -0.94                   | -1.10                 | -0.21                  | -1.06                    | 1.68                       |
| RCBG-8 x Shyamala     | -0.88             | 3.01**                      | -0.20                               | -0.28                         | -0.94                   | -0.17                 | -1.06                  | 1.68*                    | 0.13                      |
| SE (Crosses)          | 1.87              | 0.85                        | 0.50                                | 0.21                          | 1.00                    | 0.83                  | 1.20                   | 1.22                     | 0.13                      |

** 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].

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 Bhagya to 2.94 in RCBG-2 x Shayamala, 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 Bhagya to 1.75 in RCBG-3 x Bhagya.

**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 Shayamala to 0.33 in Bhagya, only with 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 Bhagya (0.38) displayed highest value and remaining four cross combinations viz., RCBG-4 x Gulabi (0.29), RCBG-3 x Bhagya (0.28), RCBG-5 x Shayamala (0.28) and RCBG-1 x Shayamala (0.27) are on par with each other. The only one cross combination, RCBG-4 x Shayamala (-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, Bhagya (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 Shayamala (-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 Shayamala (4.34) and RCBG-5 x Bhagya (4.26) indicating their good specific combing 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 Bhagya (2.20).

**Sca effects:** Among hybrids, *sca* effects were ranged from -5.63 in RCBG-7 x Bhagya to 5.58 in RCBG-4 x Shayamala. Positive and significant *sca* effects were exhibited by four hybrids, RCBG-4 x Shayamala (5.58), RCBG-7 x Gulabi (5.39), RCBG-1 x Bhagya (4.39) and RCBG-5 x Bhagya (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 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) | Marketable fruit yield per hectare (tons) | Marketable yield per hectare (tons) | Ascorbic acid content (mg/100g) | Total phenols content (mg/100g) |
|-----------------------|---------------------------------------|-------------------|-----------------|-------------------------|----------------------------|--------------------------------------|----------------------------------------|----------------------------------|-------------------------------|-----------------------------------|
| RCBG-1 x Bhagya       | 3.49**                                | 0.40*             | 0.40*           | 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                                 | -5.14*                           | -3.82**                         |
| RCBG-1 x Shayamala    | -5.20**                               | -0.97**           | -0.32           | -5.22*                  | -0.15                      | -0.21                               | -5.03                                 | -6.91*                           | -0.50**                         | 7.30**                           |
| RCBG-2 x Bhagya       | -0.05                                | 0.20              | 0.58**          | 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                                | -2.12                                 | 0.06**                           | -3.92**                         |
| RCBG-2 x Shayamala    | -0.43                                | 0.17              | -0.12           | 0.39                    | -0.52**                    | -17.36**                             | -17.90**                              | -0.23**                           | -3.07**                         |
| RCBG-3 x Bhagya       | -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                               | -8.52                                 | -0.20                            | 7.77**                          |
| RCBG-3 x Shayamala    | -0.23                                | -0.35             | -0.05           | -4.62*                  | -0.17                      | -13.56                              | -4.30                                 | -0.005                           | -4.22**                         |
| RCBG-4 x Bhagya       | -0.76                                | -0.19             | -4.01           | -0.47**                 | -0.58**                    | -15.58**                             | -19.37**                              | -0.51**                           | -1.62**                         |
| RCBG-4 x Gulabi       | -4.81**                               | 0.15              | 0.90            | 0.09                    | 0.16                      | 3.10                                 | 5.37                                  | 0.95**                           | 3.63**                         |
| RCBG-4 x Shayamala    | 5.58**                               | 0.09              | 3.11            | 0.37**                  | 12.49**                    | 14.00**                              | -0.44**                               | -2.02**                           |
| RCBG-5 x Bhagya       | 3.59**                               | -0.11             | -0.03           | 3.72                    | -0.03                      | -0.67                               | -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 Shayamala    | 1.84                                 | 0.16              | 0.09            | -2.56                   | -0.22                      | -0.24                               | -7.59                                 | -7.92                            | 0.80**                          | -2.22**                         |
| RCBG-6 x Bhagya       | 0.07                                 | 0.27              | 0.11            | -7.33**                 | -0.31*                     | -0.18                               | -10.35**                              | -6.02                            | 0.10**                          | 2.30**                           |
**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) [19], Khatpe et al. (2013) [10], Naresh et al. (2015) [11] and Kumar et al. (2016) [12].

**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 showed 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) [19], Vaddoria and Ramani (2015) [27], Naresh et al. (2015) [11], Khatpe et al. (2013) [10], Kumar and Arumugam (2016) [12] 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 Bhagayamathi(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 Bhagayamathi) to 0.40 (RCBG-1 x Bhagayamathi).

The present results with respect to the *gca* and *sca* effects are in line with the earlier reports of Aswani and Khandelwal (2005) [12] 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) [13], Khatpe et al. (2013) [10], Kumar and Arumugam (2016) [12] and Chaitanya et al. (2018) [4].

**Sca effects:** Three cross combinations viz., RCBG-1 x Bhagayamathi (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 Bhagayamathi to 5.85 in RCBG-1 x Bhagayamathi (Table 6). Conformity results are reported by Vaddoria and Ramani (2015) [27], Naresh et al. (2015) [11], Kumar and Arumugam (2016) [12] 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(Bhagayamathi) to 0.26(Shyamala). Similar kind of results are noticed by Naresh et al. (2015) [11] and Kumar and Arumugam (2016) [12].

**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 Bhagayamathi (0.56) followed by RCBG-1 x Bhagayamathi (0.43), RCBG-3 x Bhagayamathi (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 Khatpe et al. (2013) [10], Naresh et al. (2015) [11] and Kumar and Arumugam (2016) [12].

** 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 Bhagayamathi to 0.53 in RCBG-2 x Bhagayamathi. Seven cross combinations viz., RCBG-2 x Bhagayamathi (0.53), RCBG-1 x Bhagayamathi (0.49), RCBG-4 x Shyamala (0.42), RCBG-6 x Shyamala (0.40), RCBG-3 x Bhagayamathi (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 Bhagayamathi) to 18.57(RCBG-2 x Bhagayamathi) to 5.85 in RCBG-1 x Bhagayamathi (Table 6). Conformity results are reported by Vaddoria and Ramani (2015) [27], Naresh et al. (2015) [11], Kumar and Arumugam (2016) [12] and Chaitanya et al. (2018) [4].
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                                           |
| 1      | Plant height (cm) | 3                                             | 4                                             |
| 2      | Number of branches per plant | 4                                             | -                                             |
| 3      | Number of flower clusters per plant | 1                                             | 2                                             |
| 4      | Number of flowers per cluster | 4                                             | 3                                             |
| 5      | Days to first flowering | 2                                             | 3                                             |
| 6      | Days to 50% flowering | 3                                             | 2                                             |
| 7      | Days to first harvest | 2                                             | 1                                             |
| 8      | Days to last harvest | 2                                             | 1                                             |
| 9      | Number of fruits per cluster | 4                                             | 1                                             |
| 10     | Number of fruits per plant | 4                                             | 1                                             |
| 11     | Number of marketable fruits per plant | 4                                             | 1                                             |
| 12     | Fruit length (cm) | 2                                             | 3                                             |
| 13     | Fruit width (cm) | 3                                             | 2                                             |
| 14     | Average fruit weight (g) | 3                                             | 2                                             |
| 15     | Fruit yield per plant (kg) | 3                                             | 3                                             |
| 16     | Marketable yield per plant (kg) | 3                                             | 3                                             |
| 17     | Fruit yield per hectare (tons) | 3                                             | 3                                             |
| 18     | Marketable yield per hectare (tons) | 3                                             | 3                                             |
| 19     | Ascorbic acid content (mg/100g) | 4                                             | 5                                             |
| 20     | Total phenols content (mg/100g) | 2                                             | 6                                             |

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) 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).

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) and Kumar and Arumugam (2016) 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, 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 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 F1 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 (%) |
|----------------|--------------------|---------------|-----------------------|-----------------------|--------------|---------------|
| RCBG-1 x Bhagyamathi | 2.63               | 0.49**        | 0.36**                | -0.23**               | H x L        | 89.17**       |
| RCBG-2 x Bhagyamathi | 2.66               | 0.53**        | 0.35**                | -0.23**               | H x L        | 93.67**       |
| RCBG-4 x Shyamala   | 2.73               | 0.42**        | 0.04                  | 0.26**                | M x H        | 145.95**      |

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

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