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# GENE ACTION AND COMBINING ABILITY ANALYSIS FOR YIELD AND YIELD ATTRIBUTING CHARACTERS IN BRINJAL (*SOLANUM MELONGENA* L.)

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**ABSTRACT**

The present investigation was carried out at Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal, to obtained information on combining ability of brinjal hybrids developed by diallel mating system (Griffin, 1956). Analysis of variance for combining ability reveals that the significant effects were found for only thirteen characters. The analysis for combining ability revealed that the predominance of GCA variance was greater than SCA variance for all the characters except number of flowers cluster$^{-1}$and number of fruits plant$^{-1}$. This indicated the predominance of non- additive gene action governing the inheritance of these characters. Based on *gca* effects, among the parents Kashi Taru, PLR 2 and Udumalai Samba were the promising general combiners for yield and yield attributing traits. 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 four hybridsKashi Tarux PLR 2, Kashi Taru x PLR 1, Kashi Taru x CO 2 and Purple Round x PLR 1were identified as best specific combiners for fruit yield plant$^{-1}$ and hence may be further tested over locations, seasons and years for commercial release in regions and states.

***Keywords***: *Solanum melongena L.,* Brinjal, full diallel, qualitative and quantitative traits, *gca*, *sca*

## Introduction

Brinjal (*Solanum melongena* L.), known as eggplant, aubergine or Guinea squash is one of the most popular and major vegetable crops in India and also in other parts of the world. It has a chromosome number of 2n = 24. It is an often cross pollinated annual herbaceous plant, originated in India and shows secondary diversity in South East Asia (Bhatt *et al.*, 2020). Eggplant is ranked among the top ten vegetables that provide the healthiest food with low calories and also contains higher phenol content that is helpful in radical absorbing capacity. Brinjal is known of its excellent nutritional pharmaceutical properties *viz.*, moisture, crude fibre, ash, protein, fat, carbohydrate, energy, sugar, ascorbic acid and anthocyanin. Significant amount of minerals *viz.*, K,Na, Ca, P, Mg, Fe, Zn, Mn and Cu are also reported from 100 g$^{-1}$ of fruit on fresh weight basis. The available local cultivars of present brinjal cultivation suffer from low productivity.Therefore, it's imperative to enhance the current cultivars or create superior hybrids that have great yield and quality. Keeping the preceding information in mind, the current inquiry entitled "Diallel analysis in Brinjal (*Solanum melongena* L.)" was carried out at Pandit Jawaharlal Nehru College of Agriculture & Research Institute, Karaikal with the objectives to estimate the *gca* and *sca* for parents and hybrids respectively.

## Materials and Methods

The experiment was carried out at the college Eastern farm, Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal, U. T. Puducherry, India. The experimental material consisted of six parents (CO 2, PLR 1, PLR 2, Kashi Taru, Udumalai Samba and Pusa Purple Round) and their 30 hybrids derived from 6 x 6 full diallel (including reciprocal) mating design. The hybrids and parents were evaluated in a randomized block design with two replications. Each plot consisted of 12 plants in a row

at 90 cm x 60 cm. All the recommended package of practices were adopted for growing a healthy crop. Five randomly selected plants, from each plot in each replication were tagged and used for recording the observations. The data was recorded for fifteen biometrical traits namely, plant height, number of primary branches plant$^{-1}$, days to first flowering, days to 50% flowering, number of flowers cluster$^{-1}$, number of clusters plant$^{-1}$,number of fruits cluster$^{-1}$, fruit length, fruit girth, individual fruit weight, days to first harvest, number of fruits plant$^{-1}$, fruit yield plant$^{-1}$, total phenol and ascorbic acid content. Characters representing earliness were calculated from the date of transplanting. Observations on plant height, number of primary branches plant$^{-1}$, were recorded at the last picking and in contrast, other characters were obtained from each picking and the total was computed. The observations on total phenol and ascorbic acid were recorded on five random fresh fruits, taken from each genotype in each replication and the mean values were calculated.

## Results and Discussion

The variance due to general combining ability (*gca*) of parents and specific combining ability (*sca*) of crosses was significant for all the traits under study (Table 1). Based on pooled analysis of the *gca* effects of the parents Kashi Taru, PLR 2 and Udumalai Sambawere found to be promising general combiners for fruit yield and other yield contributing traits. All these parents might be contributing positive alleles for yield and yield attributes. Among the parents, Kashi Taru was found to be good general combiner for fruit yield, plant height, days to first flowering, days to 50 % flowering, number of flowers cluster$^{-1}$, number of fruits cluster$^{-1}$, fruit length, fruit girth, individual fruit weight, days to first harvest, number of fruits plant$^{-1}$, fruit yield plant$^{-1}$, total phenol and ascorbic acid and PLR 2 was a good general combiner for plant height, number of primary branches, fruit girth, individual fruit weight,days to first harvest and total phenol in general. Udumalai Samba was found good general combiner for number of flowerscluster$^{-1}$, number of clustersplant$^{-1}$, number of fruits plant$^{-1}$ and fruit yield plant$^{-1}$. The parents with good general combining ability for the above trait also exhibited high *per se* performance for respective trait. This is true with the parents Kashi Taru, PLR 2 and Udumalai Samba for most of the characters (Table 2). Therefore, these parents were noted as good source of favourable genes for increasing fruit yield plant$^{-1}$ through various yield contributing characters and use of these parental lines would be more rewarding for boosting fruit yield in brinjal. It was further noted that improvement of these parents had resulted into $F_1$ hybrids expressing useful heterosis for various traits.

Out of 30 crosses, significant *sca* effects in favourable direction were exhibited by 11 crosses for plant height, seven crosses for number of primary branches plant$^{-1}$, four crosses for days to first flowering, seven crosses for days to 50 % flowering, 11 crosses for number of flowers cluster$^{-1}$, six for number of clusters plant$^{-1}$, 15 for number of fruits cluster$^{-1}$, eight crosses for fruit length, 11 crosses for fruit girth, five crosses for individulal fruit weight, six crosses for days to first harvest, nine crosses for number of fruits plant$^{-1}$, 11 crosses fruit yield plant$^{-1}$, eight crosses for total phenol and 13 crosses for ascorbic acid. No single cross combination exhibited simultaneous significant *sca*for all the traits under study.

Based on the *sca* effects in pooled analysis, four $F_1$ hybrids *viz*., Kashi Tarux PLR 2, Kashi Taru x PLR 1, Kashi Taru x CO 2 and Purple Round x PLR 1 were identified as promising specific combiners for fruit yield plant$^{-1}$ and other characters (Table 3). The cross Kashi Tarux PLR 2 was a good specific combiner for number of primary branches plant$^{-1}$, days to first flowering, days to 50% flowering, fruit girth and ascorbic acid, where as the $F_1$ hybrid, Kashi Tarux PLR 2was a good specific combiner for the trait plant height and the $F_1$ hybrid, Purple Round x PLR 1a was good specific combiner for traits responsible for earliness *viz*., days to first flowering, days to 50% flowering and days to first harvest. The $F_1$ hybrids exhibiting high *per se* performance may result from either good x good, good x average, average x average and poor x poor general combining parents. Good general combining parents do not always produce $F_1$ hybrids with high *sca* effects, similarly, poor general combining parents do not always produce low *sca* effects in $F_1$. So, any parental combination either good x good, average x good, average x average or poor x poor may result into high *sca* effects. Similar results have been reported by Patil *et al.* (2019), Ramesh kumar *et al.* (2019), Makasare *et al.* (2020), Rajan *et al*. (2023) and Mishra *et al*. (2023) in brinjal. For exploitation of heterosis, the information on *gca* should be supplemented with *sca* and hybrid performance. The estimates of *sca* effects revealed that none of the $F_1$ hybrids were constantly superior for all the traits. This indicated that the specific combining ability of the $F_1$ hybrids was not always dependent on the *gca* of the parents involved. These results were supported by the findings of Bhushan *et al.* (2012), Hussain *et al.* (2017), Kachouli *et al.* (2019), Khanzode *et al.* (2023) and Nikhila *et al.* (2023) in brinjal High-performing $F_1$

hybrids can be the result of high x high, high x medium, medium x medium, or low x low combining parents. Good general combining parents may not always result in $F_1$ hybrids with high or low *sca* effects. Any parental combination (high x high, medium x high, medium x medium, or low x low) can lead to significant *sca* consequences. These results are in line with Pachiyappan *et al*. (2012) and Datta *et al*. (2021).

For exploitation of heterosis, the information on *gca* should be supplemented with *sca* and hybrid performance. Estimates of *sca* effects showed that no $F_1$ hybrid was consistently superior across all attributes. The combining ability of $F_1$ hybrids was not necessarily determined by the *gca* of their parents. Rajan*et al*. (2022), Singh *et al*. (2018), Singh and Chaudhary (2018) and Siva *et al*. (2020) also found similar kind of results in brinjal.

## Conclusion

From the present study it is concluded that the parents *viz*., Kashi Taru, PLR 2 and Udumalai Samba were identified as promising general combiners for fruit yield and other yield-related traits. Based on the specific combing ability of the 15 characters studied, it could be concluded that the hybrids Kashi Tarux PLR 2, Kashi Tarux PLR 1, Kashi Tarux CO 2 were the best for yield and yield contributing characters.

**Table 1 :** Analysis of variance for combining ability

| S.No. | Characters | Meansquares | | | GCA/SCA |
|---|---|---|---|---|---|
| | | GCA | SCA | RCA | |
| 1. | Plant height | 541.84** | 224.12** | 141.13** | 0.20 |
| 2. | Number of primary branches plant$^{-1}$ | 3.97** | 2.11** | 2.33** | 0.16 |
| 3. | Days to first flowering | 15.12** | 13.8** | 11.31** | 0.09 |
| 4. | Days to 50 % flowering | 17.69** | 12.57** | 13.97** | 0.12 |
| 5. | Number of flowers cluster$^{-1}$ | 0.08** | 0.14** | 0.29** | 0.04 |
| 6. | Number of clusters plant$^{-1}$ | 0.3** | 0.17** | 0.84** | 0.15 |
| 7. | Number of fruits cluster$^{-1}$ | 11.26** | 4.49** | 9.15** | 0.21 |
| 8. | Fruit length | 192.85** | 9.16** | 22.87** | 1.88 |
| 9. | Fruit girth | 10.98** | 8.71** | 9.7** | 0.10 |
| 10. | Individual fruit weight | 53.6** | 34.76** | 3.04** | 0.09 |
| 11. | Days to first harvest | 577.63** | 510.65** | 523.66** | 0.04 |
| 12. | Number of fruits plant$^{-1}$ | 12.3** | 17.96** | 17.28** | 0.12 |
| 13. | Fruit yield plant$^{-1}$ | 0.70** | 0.21** | 0.21** | 0.26 |
| 14. | Total phenol | 0.11** | 0.06** | 0.06** | 0.16 |
| 15. | Ascorbic acid content | 18.88** | 18.15** | 10.23** | 0.08 |

**Significant at 1 % level

**Table 2 :** Estimates of general combining ability of parents

| Parents | PH | PB | DFF | DFPF | NFC | NCP | FG | NFRC |
|---|---|---|---|---|---|---|---|---|
| CO 2 ($P_1$) | 0.92 | -0.031 | -0.43 | -0.55 | 0.0** | 0.13** | -0.58** | -1.45* |
| PLR 1 ($P_2$) | -5.01** | 0.22** | -0.54 | -0.46 | -0.10** | -0.04** | 0.18 | 0.41** |
| PLR 2 ($P_3$) | 6.12** | 1.04** | -0.41 | -0.65 | -0.04 | -0.05** | 0.60** | 0.05 |
| Kashi Taru ($P_4$) | 7.27** | -0.50** | -1.26** | -1.28** | 0.09** | -0.21** | 0.83** | 1.38** |
| Udumalai Samba ($P_5$) | 1.11 | -0.31* | 0.83 | 1.02* | 0.04* | 0.24** | -1.65** | 0.28** |
| Pusa Purple Round ($P_6$) | -0.41** | -0.41** | 1.82** | 1.92** | -0.09** | -0.05** | 0.61** | -0.63** |

| Parents | FL | FG | IFW | DFF | NFRP | FYP | TP | AA |
|---|---|---|---|---|---|---|---|---|
| CO 2 ($P_1$) | 0.65** | -0.58** | 0.01 | 0.12 | -3.21** | -0.17** | -0.02 | -1.22** |
| PLR 1 ($P_2$) | -2.03** | 0.18 | -0.65 | -0.25 | -1.02** | -0.09** | -0.11** | 0.79** |
| PLR 2 ($P_3$) | 0.51* | 0.60** | -6.81** | -1.55* | -0.70** | 0.03 | 0.14** | -1.92** |
| Kashi Taru ($P_4$) | 6.95** | 0.83** | 13.29** | -0.49 | 1.25** | 0.41** | 0.09** | 1.08** |
| Udumalai Samba ($P_5$) | -0.97** | -1.65** | -2.91** | 1.19** | 2.86** | 0.11** | -0.05* | 0.77** |
| Pusa Purple Round ($P_6$) | -5.12** | 0.61** | -2.93** | 0.98 | 0.82** | -0.26** | -0.04 | 0.49** |

PH - plant height; PB - number of primary branches plant$^{-1}$; DFF - days to first flowering; DFPF - days to 50% flowering; NFC - number of flowers cluster$^{-1}$; NCP -number of clusters plant$^{-1}$; NFRC - number of fruits cluster$^{-1}$, FL - fruit length; FG - fruit girth; IFW - individual fruit weight; DFH - days to first harvest; NFP - number of fruits plant$^{-1}$; FYP - fruit yield plant$^{-1}$; TP - total phenol; AA - ascorbic acid.

**Table 3 :** Estimates of specific combining ability of hybrids

| Hybrids | PH | PB | DFF | DFPF | NFC | NCP | NFRC | FL | FG | IFW | DFF | NFRP | FYP | TP | AA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $P_1$ x $P_2$ | 3.05 | 0.25 | -0.07 | -0.93 | 0.00 | -0.18** | -0.85** | -0.27 | 0.82** | -15.54** | -0.57 | -0.34 | 0.06** | 0.13* | -2.04** |
| $P_1$ x $P_3$ | 0.88 | 1.08** | -1.40 | -1.82 | 0.06 | -0.42** | 0.52** | -1.57** | 0.85** | -10.38** | -0.51 | 2.83** | 0.18** | 0.11 | 0.36 |
| $P_1$ x $P_4$ | 11.52** | -1.06** | 2.30* | 3.15** | -0.17** | -0.01 | 0.34* | 2.80 | -2.76** | 46.29** | 7.55** | -4.77** | -0.63** | -0.31** | -1.63** |
| $P_1$ x $P_5$ | 7.24** | -0.86** | -1.80 | -2.50** | -0.18** | 0.01 | -2.36** | 0.50 | -2.39** | -13.87** | -1.10 | -0.66 | 0.16** | -0.27** | -1.13** |
| $P_1$ x $P_6$ | -11.74** | 0.20 | 0.70 | -0.07 | 0.12* | -0.09** | 0.61** | 0.75 | 4.75** | 4.20* | -0.38 | -0.23 | 0.06** | 0.13* | 0.86** |
| $P_2$x$P_1$ | -0.95 | -0.73* | -3.14** | -2.16* | 0.26** | 0.43** | 0.44** | -2.22** | -1.20** | 9.58** | -3.89** | -1.84** | -0.14** | 0.08 | -3.87** |
| $P_2$ x$P_3$ | 13.32** | 1.15** | 0.26 | -0.11 | -0.34** | -0.03 | -1.45** | -0.08 | 0.63* | -8.62** | -0.74 | -1.72** | -0.32** | 0.12* | -0.24 |
| $P_2$x$P_4$ | -6.65** | 0.12 | 3.56** | 3.08** | 0.40** | -0.34** | 2.03** | 1.09* | 1.67** | 5.21** | 2.48 | 2.41** | 0.14** | -0.15 | -2.00** |
| $P_2$x$P_5$ | 3.12 | -0.19 | 1.61 | 1.80 | -0.05 | -0.07* | 1.01** | 0.46 | -1.62** | -1.67 | 2.95* | 1.93** | 0.29** | -0.03 | -1.50** |
| $P_2$x$P_6$ | -3.59 | -0.54 | -1.08 | -1.59 | 0.51** | -0.20** | 2.30** | 3.44** | 0.24 | -2.29 | -0.73 | 9.32** | 0.72** | 0.13* | -3.25** |
| $P_3$x$P_1$ | 17.09** | 0.42 | -0.22 | -0.32 | -0.37** | 0.13** | -0.24 | -2.02** | 1.63** | 1.34 | -0.29 | -2.11** | -0.19** | -0.13* | 2.06** |
| $P_3$x$P_2$ | -8.79** | -0.73* | -0.42 | -0.14 | -0.19** | 0.02 | -1.77** | -1.70** | -0.77** | 5.64** | -0.37 | -1.26** | -0.27** | -0.19** | 2.44** |
| $P_3$x$P_4$ | -20.83** | -1.84** | 1.87 | 1.32 | 0.30** | -0.31** | -1.62** | -1.59** | -1.26** | -8.46** | -1.06 | -4.18** | -0.24** | 0.09 | -0.01 |
| $P_3$x$P_5$ | -2.90 | -0.55 | -0.87 | -0.41 | -0.05 | 0.02 | -1.29** | -2.75** | -1.62** | -20.91** | -0.60 | -5.43** | -0.09** | 0.07 | 1.34** |
| $P_3$x$P_6$ | 4.41* | 1.05** | 2.93** | 2.94** | 0.00 | 0.39** | 1.25** | -0.38 | 0.44 | 15.38** | -1.65 | 4.60** | -0.08** | 0.09 | 2.27** |
| $P_4$ x $P_1$ | 2.68 | -1.04** | 1.25 | 0.67 | 0.09 | -0.14** | 0.36* | 3.17** | 1.29** | -15.43** | 0.04 | 4.12** | -0.25** | 0.41** | 0.62* |
| $P_4$ x $P_2$ | -3.23 | -2.31** | -0.45 | -0.59 | 0.48** | 0.04 | 0.10 | -0.18 | 0.60 | 1.50 | -5.79** | -4.10** | -0.28** | 0.04 | -0.42 |
| $P_4$ x $P_3$ | 7.15** | 0.46 | -3.00* | -3.75** | 0.25** | -0.07 | 2.79** | -6.41** | 2.78** | -51.28** | -2.42 | 2.10** | -0.29** | -0.06 | 3.03** |
| $P_4$ x $P_5$ | -0.92 | 1.79** | -1.10 | -1.25 | -0.19** | 0.24** | -1.72** | 3.25** | 3.15** | 1.34 | -2.71 | 1.15** | 0.43** | 0.25** | 0.68** |
| $P_4$ x $P_6$ | 13.45** | -0.43 | -4.10** | -4.25** | 0.31** | 0.02 | -3.81** | 3.00** | 0.60 | -3.88 | -3.21* | -2.08** | 0.00 | 0.14* | 0.87** |
| $P_5$ x $P_1$ | -18.59** | 0.46 | 2.10 | 3.67** | 0.35** | -0.36** | 0.49** | -1.13 | -0.88** | -3.38 | 2.04 | 0.80 | 0.18** | 0.01 | 1.87** |
| $P_5$ x $P_2$ | 4.90 | -0.69 | 2.65* | 1.92 | -0.16** | 0.16** | -2.98** | -4.35** | -2.46** | -10.97** | 1.00 | -0.77 | -0.39** | -0.08 | -0.90** |
| $P_5$ x $P_3$ | -1.56 | 0.72* | -1.15 | -0.75 | 0.82** | -0.12** | 2.61 | -2.62 | -0.93** | -1.25 | 0.00 | 2.74** | -0.46** | -0.12 | -1.13** |
| $P_5$ x $P_4$ | 5.94* | 1.61** | -1.80 | -0.46 | -0.15** | -0.01 | 2.31 | 0.86 | -0.17 | -3.08 | -2.08 | -0.45 | -0.13** | -0.09 | -1.64** |
| $P_5$ x $P_6$ | 1.56 | 1.23** | 1.15 | 0.59 | -0.89** | -0.04 | -2.96 | -1.82 | -3.87** | -20.54 | 0.88 | -2.00** | -0.56** | 0.11 | -0.09 |
| $P_6$ x $P_1$ | 13.80** | 0.20 | -1.50 | -2.33* | -0.08 | -0.15** | 1.57 | -1.82 | -0.24 | 5.29 | -4.75** | -4.44** | -0.39** | 0.09 | -2.61** |
| $P_6$ x $P_2$ | 8.24** | 0.49 | -5.70** | -6.08** | -0.13* | -0.04 | 0.40 | 0.69 | 1.14** | -3.57 | -2.71 | -7.98** | -0.10** | -0.28** | -1.63** |
| $P_6$ x $P_3$ | -9.94** | 0.15 | 1.16 | 1.00 | 0.36** | 0.07 | -0.34 | 4.83 | -4.55** | -0.40 | -3.29* | -5.79** | -0.03 | 0.34** | 4.45** |
| $P_6$ x $P_4$ | 3.02 | 0.47 | -1.00 | -2.00 | -0.14** | -0.13** | 1.70 | 6.49 | -2.69** | 3.13 | -0.57 | -0.34 | 0.06** | 0.13* | -2.04** |
| $P_6$ x $P_5$ | 5.67* | 1.30** | -1.30 | -2.17* | 0.09 | 0.58** | -2.76 | -0.81 | 0.82** | -20.63 | -0.51 | 2.83** | 0.18** | 0.11 | 0.36 |

PH - plant height; PB - number of primary branches plant$^{-1}$; DFF - days to first flowering; DFPF - days to 50 % flowering; NFC - number of flowers cluster$^{-1}$; NCP - number of clusters plant$^{-1}$; NFRC - number of fruits cluster$^{-1}$; FL - fruit length; FG - fruit girth; IFW - individual fruit weight; DFH - days to first harvest; NFP - number of fruits plant$^{-1}$; FYP - fruit yield plant$^{-1}$; TP - total phenol; AA - ascorbic acid.

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