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## COMBINING ABILITY STUDIES FOR YIELD AND ITS RELATED TRAITS IN MANGALORE MELON (*CUCUMIS MELO* VAR. *ACIDULUS*)

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### ABSTRACT

Mangalore melon (*Cucumis melo* var. *acidulus*) is an important vegetable crop of southern India, yet its productivity remains low due to limited systematic breeding efforts. The present study was conducted to evaluate combining ability and gene action for yield and related traits using a Line × Tester mating design. Eight lines and three testers were crossed to generate 24 F<sub>1</sub> hybrids, which along with the parents were evaluated during early summer 2025 in a randomized complete block design with two replications. Analysis of variance revealed significant differences among parents and hybrids for most traits, indicating substantial genetic variability. General combining ability analysis identified lines L2, L8 and L5 and tester T3 as superior general combiners for growth, earliness, yield and quality traits. Several hybrids showed high and desirable specific combining ability effects, particularly L8 × T2, L8 × T3, L4 × T3 and L3 × T1 for fruit yield and its components and L5 × T1 and L6 × T3 for earliness-related traits. The predominance of specific combining ability variance for most yield and quality traits indicated the major role of non-additive gene action, while additive effects were more important for structural traits such as peduncle length and flesh thickness. The identified parents and hybrids offer valuable genetic resources for the improvement of Mangalore melon through hybrid development.

**Keywords :** Combining ability, Gene action, Mangalore melon, Line × Tester analysis.

### Introduction

Mangalore melon (*Cucumis melo* var. *acidulus*) is a traditional culinary melon cultivated in the coastal regions of southern India (Fergany *et al.*, 2011). It belongs to the family Cucurbitaceae (2n = 24) and is known by various regional names across Karnataka, Kerala, Tamil Nadu, Telangana and Andhra Pradesh (Swamy 2017; Gunnaiah *et al.*, 2021). Owing to its prominence in Mangalore, the term “Mangalore melon” is adopted in this study. Although previously classified as conomon melon (*C. melo* subsp. *agrestis* var. *conomon*) (Gondi *et al.*, 2016; Lakshmi *et al.*,

2017; Vinutha *et al.*, 2017), recent studies confirm that *acidulus* and *conomon* melons, despite sharing a common wild progenitor, differ morphologically and genetically (John *et al.*, 2018; Gunnaiah *et al.*, 2022; Hiremata *et al.*, 2023). Independent domestication has resulted in substantial variation in fruit, seed, flowering behavior and shelf-life traits in mangalore melon (Liu *et al.*, 2004; Fergany *et al.*, 2011; Dhillon *et al.*, 2012; Manohar and Murthy 2012; Kamagoud *et al.*, 2018; Shet *et al.*, 2025; Swamy & Premnath, 2020). It is also known as the non-desert cucumber, is valued in traditional South Indian cuisine for its nutritional and

medicinal properties. Evaluation of 80 accessions from Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Telangana and Goa revealed significant genetic variability in fruit traits, flowering behavior, yield components and quality parameters such as flesh thickness and total soluble solids. This diversity highlights its strong regional adaptation and potential for breeding programs aimed at improving fruit quality and productivity.

Mangalore melon is widely used in coastal South Indian cuisine and is valued for its exceptional shelf life of 8–10 months under traditional storage practices (Gunnaiah *et al.*, 2021; Shet *et al.*, 2022). The fruits are nutritionally rich, containing proteins, fats, carbohydrates, minerals, vitamins, carotenoids and amino acids (Fergany *et al.*, 2011; Doddaraju *et al.*, 2022), and are traditionally used for digestive and cooling purposes (Pawar 2017; Swayampaka 2023). Sharing homeologous chromosomes with cultivated melon (*C. melo* ssp. *melo*), mangalore melon can be exploited in breeding programs to improve fruit quality and shelf life (Pitrat *et al.*, 2000; Hiremata *et al.*, 2022b, 2025; Venugopal *et al.*, 2025). Despite its adaptability and increasing demand, productivity remains low due to the continued use of low-yielding local cultivars. In this context, heterosis breeding and line  $\times$  tester analysis are effective approaches for identifying superior parents and developing high-yielding hybrids.

### Material and Methods

The present investigation on Mangalore melon (*Cucumis melo* var. *acidulus*) was carried out at the Seed Unit, Sector-1, College of Horticulture, Bagalkot during 2023–25. Eleven parental genotypes obtained from the UHSB-PNASF project, comprising eight lines and three testers with diverse traits for yield, quality, maturity, shelf-life and disease resistance, were used for hybrid development. Twenty-four  $F_1$  hybrids were generated by crossing eight lines with three testers following a Line  $\times$  Tester mating design during Kharif

2024 through manual emasculation and controlled pollination under field conditions. The parents and hybrids were evaluated during Early summer 2025 in a randomized complete block design with two replications at a spacing of 200  $\times$  45 cm. Standard agronomic practices including recommended fertilizer application, irrigation, weed management and plant protection measures were uniformly followed throughout the crop period. Observations were recorded on yield and yield-related horticultural traits and the experimental data were subjected to Line  $\times$  Tester analysis as proposed by Kempthorne (1957) for estimation of heterosis and combining ability effects using INDOSTAT statistical software. The estimation of combining ability variances and their effects was done as per the method suggested by Griffing (1956).

## Results and Discussion

### General Combining Ability

The highest significant and positive GCA (Table 1) effect for vine length at harvest was recorded in L8 (0.385) among the lines, while tester T3 (0.170) was the best general combiner. For number of branches per vine, L2 (0.829) and tester T2 (0.208) exhibited the highest positive GCA effects. Desirable earliness for node to first male flower appearance was governed by L6 (-0.266) among the lines and T3 (-0.117) among testers, whereas for node to first female flower appearance, the highest negative GCA effect was observed in L7 (-0.257) and tester T3 (-0.214). For days to first male flowering, L2 (-3.037) and tester T2 (-0.400) showed the most desirable negative GCA effects. Similarly, for days to first female flowering and days to 50 per cent flowering, L2 recorded the highest negative GCA effects, while tester T1 showed the most favourable negative influence. A favourable reduction in sex ratio was mainly contributed by L2 (-1.606) among lines and T1 (-0.13) among testers.

**Table 1:** General combining ability effect of parents for different traits in Mangalore melon

| Genotypes       | Vine length at harvest (m) | Number of branches per vine | Node at first male flower appearance | Node at first female flower appearance | Days to first male flowering | Days to first female flowering | Days to 50 per cent flowering | Sex ratio | Fruit length (cm) | Peduncle length (cm) | Fruit diameter (cm) |
|-----------------|----------------------------|-----------------------------|--------------------------------------|--|------------------------------|--------------------------------|-------------------------------|-----------|-------------------|----------------------|---------------------|
| <b>Lines</b>    |                            |                             |                                      |  |                              |                                |                               |           |                   |                      |                     |
| L1              | -0.275**                   | -0.04                       | -0.08                                | 0.287**                                | -1.510**                     | -2.922**                       | -1.972**                      | -0.21     | -0.53             | -0.38                | -0.59               |
| L2              | 0.301**                    | 0.829**                     | 0.471**                              | 0.07                                   | -3.037**                     | -3.140**                       | -2.194**                      | -1.606**  | 0.34              | 0.609**              | 0.430*              |
| L3              | -0.172*                    | -0.971**                    | -0.08                                | -0.06                                  | 1.962**                      | 2.755**                        | 2.083**                       | 0.42      | 0.15              | -0.491*              | 0.1                 |
| L4              | 0.281**                    | 0.629**                     | -0.04                                | -0.207**                               | 0.24                         | -0.19                          | -1.469**                      | 1.159**   | 0.740*            | 0.399*               | 0.1                 |
| L5              | -0.352**                   | -0.938**                    | -0.04                                | 0.180**                                | -1.175**                     | -0.468**                       | -0.64                         | -0.05     | 1.016*            | -0.2                 | 0.767*              |
| L6              | 0.12                       | -0.2                        | -0.266**                             | 0.217**                                | 0.35                         | 2.300**                        | 2.361**                       | 0.54      | -0.48             | -0.21                | -0.870**            |
| L7              | -0.289**                   | 0.329*                      | -0.164**                             | -0.257**                               | 1.375**                      | -0.32                          | -0.25                         | -1.359**  | -1.920**          | 0.479*               | -0.29               |
| L8              | 0.385**                    | 0.363*                      | 0.187**                              | -0.232**                               | 1.792**                      | 1.978**                        | 2.084**                       | 1.108*    | 0.68              | -0.21                | 0.35                |
| <b>S. Em±</b>   | 0.07                       | 0.13                        | 0.04                                 | 0.06                                   | 0.19                         | 0.15                           | 0.42                          | 0.41      | 0.47              | 0.19                 | 0.27                |
| <b>CD at 5%</b> | 0.14                       | 0.27                        | 0.08                                 | 0.13                                   | 0.38                         | 0.32                           | 0.86                          | 0.85      | 0.98              | 0.39                 | 0.57                |
| <b>CD at 1%</b> | 0.19                       | 0.37                        | 0.1                                  | 0.18                                   | 0.52                         | 0.43                           | 1.17                          | 1.15      | 1.33              | 0.53                 | 0.77                |
| <b>Testers</b>  |                            |                             |                                      |  |                              |                                |                               |           |                   |                      |                     |
| T1              | -0.080*                    | 0.06                        | -0.02                                | 0.04                                   | 0.02                         | -0.874**                       | -0.889**                      | -0.13     | -0.36             | 0.11                 | -0.522**            |
| T2              | -0.090*                    | 0.208**                     | 0.138**                              | 0.179**                                | -0.400**                     | 0.320**                        | 0.13                          | 0.12      | 0.2               | -0.313**             | 0.13                |
| T3              | 0.170**                    | -0.267**                    | -0.117**                             | -0.214**                               | 0.385**                      | 0.554**                        | 0.757**                       | 0.01      | 0.15              | 0.200*               | 0.395**             |
| <b>S. Em±</b>   | 0.04                       | 0.08                        | 0.02                                 | 0.04                                   | 0.11                         | 0.09                           | 0.26                          | 0.25      | 0.29              | 0.12                 | 0.17                |
| <b>CD at 5%</b> | 1.04                       | 0.17                        | 0.05                                 | 0.08                                   | 0.23                         | 0.19                           | 0.53                          | 0.52      | 0.6               | 0.24                 | 0.35                |
| <b>CD at 1%</b> | 2.04                       | 0.23                        | 0.06                                 | 0.11                                   | 0.32                         | 0.26                           | 0.72                          | 0.71      | 0.82              | 0.32                 | 0.47                |

Note: \* and \*\* indicate significance values at p=0.05 and p=0.01 respectively

**Table 1. contd ...**

| Genotypes       | Number of fruits per vine | Average fruit weight (kg) | Days to first harvest | Fruit yield per vine (kg) | Seed cavity width (cm) | Seed cavity length (cm) | Flesh thickness (cm) | Shelf life (days) | TSS (°Brix) | Ascorbic acid (%) |
|-----------------|---------------------------|---------------------------|-----------------------|---------------------------|------------------------|-------------------------|----------------------|-------------------|-------------|-------------------|
| L1              | 0.021                     | -0.06                     | -2.715**              | -0.379*                   | 0.032                  | -0.527                  | -0.490**             | -10.833**         | 0.24        | -1.281            |
| L2              | 1.188**                   | 0.03                      | -3.383**              | 0.889**                   | 0.345*                 | 0.343                   | 0.307**              | 46.667**          | 0.073       | 2.552**           |
| L3              | -1.179**                  | 0.01                      | 2.729**               | -0.483*                   | 0.005                  | 0.146                   | -0.11                | 11.167**          | -0.244      | 1.219             |
| L4              | -0.579**                  | 0.04                      | 0.34                  | -0.148                    | 0.002                  | 0.743                   | 0.207                | 21.167**          | 0.106       | 0.552             |
| L5              | -0.012                    | 0.121*                    | -0.66                 | 0.288                     | 0.482**                | 1.016*                  | 0.174                | 8.16**            | -0.127      | -0.615            |
| L6              | -0.213                    | -0.149*                   | 1.950**               | -0.751**                  | -0.565**               | -0.477                  | -0.386**             | -27.167**         | -0.144      | -0.365            |
| L7              | 0.721**                   | -0.136*                   | 0.68                  | -0.263                    | -0.065                 | -1.920**                | -0.183               | -27.500**         | -0.994**    | 2.885**           |
| L8              | 0.054                     | 0.141*                    | 1.06                  | 0.846**                   | -0.238                 | 0.676                   | 0.480**              | -21.667**         | 1.090**     | -4.948**          |
| <b>S. Em±</b>   | 0.1511                    | 0.05                      | 0.52                  | 0.1764                    | 0.136                  | 0.474                   | 0.104                | 1.899             | 0.145       | 0.699             |
| <b>CD at 5%</b> | 0.3126                    | 0.11                      | 1.08                  | 0.3649                    | 0.282                  | 0.981                   | 0.215                | 3.928             | 0.299       | 1.446             |
| <b>CD at 1%</b> | 0.4243                    | 0.15                      | 1.46                  | 0.4952                    | 0.383                  | 1.331                   | 0.292                | 5.331             | 0.406       | 1.963             |
| T1              | 0.067                     | -0.132**                  | -0.610*               | -0.585**                  | -0.085                 | -0.356                  | -0.491**             | 24.354**          | 0.081       | 0.958*            |
| T2              | 0.092                     | 0.02                      | -0.3                  | 0.251**                   | 0.034                  | 0.203                   | 0.228**              | -32.833**         | -0.438**    | 1.115**           |
| T3              | -0.158*                   | 0.111**                   | 0.909**               | 0.334**                   | 0.05                   | 0.153                   | 0.264**              | 8.479**           | 0.356**     | -2.073**          |
| <b>S. Em±</b>   | 0.0925                    | 0.03                      | 0.32                  | 0.108                     | 0.084                  | 0.29                    | 0.064                | 1.163             | 0.089       | 0.428             |
| <b>CD at 5%</b> | 0.1914                    | 0.07                      | 0.66                  | 0.2235                    | 0.173                  | 0.601                   | 0.132                | 2.405             | 0.183       | 0.886             |
| <b>CD at 1%</b> | 0.2598                    | 0.09                      | 0.9                   | 0.3033                    | 0.235                  | 0.815                   | 0.179                | 3.264             | 0.249       | 1.202             |

Note: \* and \*\* indicate significance values at p=0.05 and p=0.01 respectively

**Table 2:** Estimates of specific combining ability (SCA) effects of crosses for different traits in Mangalore melon

| Sl. No.         | Genotypes | Vine length at harvest (m) | Number of branches per vine | Node at first male flower appearance | Node at first female flower appearance | Days to first male flowering | Days to first female flowering | Days to 50 per cent flowering | Sex ratio | Fruit length (cm) | Peduncle length (cm) | Fruit diameter (cm) |
|-----------------|-----------|----------------------------|-----------------------------|--------------------------------------|--|------------------------------|--------------------------------|-------------------------------|-----------|-------------------|----------------------|---------------------|
| 1               | L1×T1     | -0.06                      | -0.525*                     | 0.054                                | -0.450**                               | 0.345                        | 0.33                           | -0.109                        | 0.052     | 1.596             | 0.32                 | 0.485               |
| 2               | L1×T2     | 0.085                      | 0.525*                      | -0.155*                              | 0.136                                  | 0.845*                       | -0.563*                        | -0.466                        | -0.826    | -2.543**          | -0.154               | -0.714              |
| 3               | L1×T3     | -0.025                     | 0.1                         | 0.101                                | 0.314**                                | -1.190**                     | 0.233                          | 0.575                         | 0.774     | 0.947             | -0.166               | 0.229               |
| 4               | L2×T1     | -0.026                     | 0.408                       | -0.223**                             | -0.04                                  | 1.207**                      | 0.864**                        | 1.112                         | -0.7      | 0.796             | -0.18                | 0.215               |
| 5               | L2×T2     | 0.443**                    | 0.658**                     | 0.619**                              | -0.084                                 | -0.543                       | -0.815**                       | -0.579                        | -0.067    | -0.713            | 0.436                | -0.534              |
| 6               | L2×T3     | -0.417**                   | -1.067**                    | -0.396**                             | 0.124                                  | -0.663                       | -0.049                         | -0.533                        | 0.767     | -0.083            | -0.256               | 0.319               |
| 7               | L3×T1     | 0.227                      | 0.008                       | 0.004                                | -0.163                                 | 0.043                        | -2.846**                       | -2.669**                      | -0.11     | 1.422             | 0.41                 | 0.688               |
| 8               | L3×T2     | -0.144                     | -0.542*                     | -0.105                               | -0.082                                 | -1.212**                     | 1.290**                        | 0.314                         | 0.533     | 1.254             | -0.064               | -0.090              |
| 9               | L3×T3     | -0.084                     | 0.535*                      | 0.101                                | 0.246*                                 | 1.168**                      | 1.556**                        | 2.355**                       | -0.423    | -2.676**          | -0.346               | -0.598              |
| 10              | L4×T1     | -0.126                     | 0.808**                     | 0.069                                | 0.049                                  | 0.765*                       | 0.597*                         | 1.222                         | -1.840*   | 0.436             | -0.02                | -0.188              |
| 11              | L4×T2     | -0.077                     | -0.542*                     | 0.13                                 | 0.389**                                | 0.51                         | -0.767**                       | -1.299                        | 0.798     | -1.473            | -0.154               | -0.597              |
| 12              | L4×T3     | 0.203                      | -0.267                      | -0.199**                             | -0.438**                               | -1.275**                     | 0.17                           | 0.077                         | 1.042     | 1.037             | 0.174                | 0.785               |
| 13              | L5×T1     | 0.307*                     | 0.475*                      | -0.086                               | -0.023                                 | -1.820**                     | -0.293                         | -0.444                        | 0.792     | -0.358            | -0.083               | -0.038              |
| 14              | L5×T2     | -0.084                     | -0.675**                    | 0.125                                | -0.208                                 | 1.595**                      | 0.013                          | 0.534                         | 0.064     | -1.176            | -0.387               | 0.013               |
| 15              | L5×T3     | -0.224                     | 0.2                         | -0.039                               | 0.231*                                 | 0.225                        | 0.28                           | -0.09                         | -0.856    | 1.534             | 0.47                 | 0.025               |
| 16              | L6×T1     | 0.114                      | 0.742**                     | -0.021                               | -0.115                                 | 0.652                        | 2.574**                        | 2.222**                       | 0.52      | 0.836             | 0.147                | 0.408               |
| 17              | L6×T2     | -0.217                     | -0.608*                     | -0.015                               | -0.199                                 | 0.067                        | 0.915**                        | 0.871                         | -0.717    | 0.687             | -0.077               | 0.250               |
| 18              | L6×T3     | 0.103                      | -0.133                      | 0.036                                | 0.314**                                | -0.718*                      | -3.489**                       | -3.093**                      | 0.197     | -1.523            | -0.07                | -0.658              |
| 19              | L7×T1     | -0.116                     | -0.592*                     | 0.092                                | 0.364**                                | -0.37                        | 0.344                          | 0.332                         | -0.071    | -0.431            | -0.4                 | -0.432              |
| 20              | L7×T2     | -0.267*                    | 0.258                       | -0.231**                             | -0.036                                 | -0.890*                      | -0.640*                        | -0.354                        | 0.596     | -0.21             | 0.316                | 0.200               |
| 21              | L7×T3     | 0.383**                    | 0.333                       | 0.139*                               | -0.328**                               | 1.260**                      | 0.296                          | 0.022                         | -0.525    | 0.64              | 0.084                | 0.232               |
| 22              | L8×T1     | -0.320*                    | -1.325**                    | 0.111                                | 0.379**                                | -0.822*                      | -1.570***                      | -1.666*                       | 1.357     | -4.298**          | -0.193               | -0.432              |
| 23              | L8×T2     | 0.260*                     | 0.925**                     | -0.368**                             | 0.084                                  | -0.372                       | 0.567*                         | 0.978                         | -0.381    | 4.174**           | 0.083                | 0.200               |
| 24              | L8×T3     | 0.06                       | 0.4                         | 0.257**                              | -0.463**                               | 1.193**                      | 1.003***                       | 0.688                         | -0.976    | 0.124             | 0.11                 | 0.232               |
| <b>S. Em±</b>   |           | 0.119                      | 0.228                       | 0.064                                | 0.11                                   | 0.321                        | 0.264                          | 0.723                         | 0.711     | 0.821             | 0.326                | 0.475               |
| <b>CD at 5%</b> |           | 0.245                      | 0.471                       | 0.133                                | 0.227                                  | 0.664                        | 0.546                          | 1.495                         | 1.471     | 1.699             | 0.674                | 0.982               |
| <b>CD at 1%</b> |           | 0.333                      | 0.639                       | 0.18                                 | 0.308                                  | 0.901                        | 0.741                          | 2.028                         | 1.997     | 2.305             | 0.915                | 1.333               |

Note: \* and \*\* indicate significance values at p=0.05 and p=0.01 respectively.

**Table 2. contd ...**

| Sl. No. | Genotypes | Number of fruits per vine | Average fruit weight (kg) | Days to first harvest | Fruit yield per vine (kg) | Seed cavity width (cm) | Seed cavity length (cm) | Flesh thickness (cm) | Shelf life (days) | TSS (°Brix) | Ascorbic acid (%) |
|---------|-----------|---------------------------|---------------------------|-----------------------|---------------------------|------------------------|-------------------------|----------------------|-------------------|-------------|-------------------|
| 1       | L1×T1     | -0.433                    | 0.106                     | 2.777**               | 0.334                     | -0.042                 | 1.596                   | 0.875**              | 5.646             | 0.835**     | -6.125**          |
| 2       | L1×T2     | 1.042***                  | -0.237*                   | -1.364                | -0.678*                   | -0.321                 | -2.543**                | -0.744**             | 45.333**          | -0.996**    | 8.219**           |
| 3       | L1×T3     | -0.608*                   | 0.132                     | -1.413                | 0.344                     | 0.363                  | 0.947                   | -0.130               | -50.979**         | 0.160       | -2.094            |
| 4       | L2×T1     | 0.100                     | 0.037                     | 0.610                 | 0.32                      | -0.055                 | 0.796                   | 0.098                | -20.354**         | -0.998**    | 3.042*            |
| 5       | L2×T2     | -0.425                    | -0.061                    | 0.134                 | -0.521                    | -0.344                 | -0.713                  | 0.119                | 33.833**          | 1.171**     | -7.115**          |
| 6       | L2×T3     | 0.325                     | 0.024                     | -0.744                | 0.201                     | 0.400                  | -0.083                  | -0.217               | -13.479**         | -0.173      | 4.073**           |
| 7       | L3×T1     | 0.667*                    | 0.156                     | -2.497*               | 0.962**                   | 0.385                  | 1.423                   | 0.275                | 25.646**          | 0.369       | -0.625            |
| 8       | L3×T2     | 0.242                     | 0.028                     | 0.353                 | 0.681*                    | 0.316                  | 1.254                   | -0.404*              | -12.667**         | -0.312      | 2.719*            |
| 9       | L3×T3     | -0.908**                  | -0.183                    | 2.144*                | -1.642**                  | -0.700**               | -2.676**                | 0.130                | -12.979**         | -0.056      | -2.094            |
| 10      | L4×T1     | 0.767**                   | -0.031                    | 0.390                 | 0.662*                    | 0.098                  | 0.436                   | -0.402*              | -51.854**         | 0.019       | -1.458            |
| 11      | L4×T2     | -0.558*                   | -0.239*                   | -0.261                | -1.554**                  | -0.551*                | -1.473                  | 0.079                | 48.833**          | 1.237**     | -9.115**          |
| 12      | L4×T3     | -0.208                    | 0.270**                   | -0.129                | 0.892**                   | 0.453                  | 1.037                   | 0.323                | 3.021             | -1.256**    | 10.573**          |
| 13      | L5×T1     | -0.400                    | 0.009                     | 0.053                 | -0.228                    | 0.288                  | -0.357                  | -0.269               | 4.646             | -1.798**    | 11.208**          |
| 14      | L5×T2     | -0.225                    | -0.054                    | -0.587                | -0.189                    | -0.151                 | -1.176                  | -0.118               | -36.167**         | 0.271       | -4.448**          |
| 15      | L5×T3     | 0.625*                    | 0.045                     | 0.534                 | 0.417                     | -0.137                 | 1.534                   | 0.386*               | 31.521**          | 1.527**     | -6.760**          |
| 16      | L6×T1     | 0.500                     | 0.109                     | 1.612                 | 0.705*                    | 0.225                  | 0.836                   | 0.061                | -26.521**         | 0.019       | -1.792            |
| 17      | L6×T2     | -0.025                    | 0.091                     | 0.466                 | 0.449                     | 0.196                  | 0.687                   | 0.272                | -38.833**         | -0.562*     | 5.802**           |
| 18      | L6×T3     | -0.475                    | -0.200*                   | -2.078*               | -1.154**                  | -0.420                 | -1.523                  | -0.334               | 65.354**          | 0.544*      | -4.010**          |
| 19      | L7×T1     | 0.467                     | -0.069                    | 1.057                 | -0.313                    | -0.285                 | -0.431                  | -0.012               | 22.313**          | -0.181      | 1.208             |
| 20      | L7×T2     | -0.558*                   | 0.073                     | -0.594                | 0.031                     | 0.126                  | -0.21                   | -0.041               | -39.500**         | 0.438       | -1.948            |
| 21      | L7×T3     | 0.092                     | -0.003                    | -0.463                | 0.282                     | 0.160                  | 0.640                   | 0.053                | 17.188**          | -0.256      | 0.740             |
| 22      | L8×T1     | -1.667**                  | -0.310**                  | -4.002**              | -2.441**                  | -0.612*                | -4.298**                | -0.625**             | 40.479**          | 1.735**     | -5.458**          |

|                 |       |         |         |        |         |         |         |         |           |          |         |
|-----------------|-------|---------|---------|--------|---------|---------|---------|---------|-----------|----------|---------|
| 23              | L8×T2 | 0.508   | 0.401** | 1.853  | 1.782** | 0.729** | 4.174** | 0.836** | -0.833    | -1.246** | 5.885** |
| 24              | L8×T3 | 1.158** | -0.085  | 2.149* | 0.659 * | -0.117  | 0.124   | -0.210  | -39.646** | -0.490   | -0.427  |
| <b>S. Em±</b>   |       | 0.2618  | 0.093   | 0.902  | 0.3055  | 0.236   | 0.8211  | 0.8211  | 3.289     | 0.251    | 1.2108  |
| <b>CD at 5%</b> |       | 0.5415  | 0.193   | 1.866  | 0.6321  | 0.489   | 1.6986  | 1.6986  | 6.803     | 0.518    | 2.5048  |
| <b>CD at 1%</b> |       | 0.7349  | 0.262   | 2.532  | 0.8578  | 0.663   | 2.3051  | 2.3051  | 9.233     | 0.703    | 3.3991  |

Note: \* and \*\* indicate significance values at p=0.05 and p=0.01 respectively

**Table 3 :** Relative Contribution of GCA and SCA Variances for various Traits in Mangalore Melon

| Sl. No. | Traits                                 | GCA      | SCA      | GCA: SCA |
|---------|--|----------|----------|----------|
| 1       | Vine length at harvest (m)             | 0.077    | 0.068    | 1.127    |
| 2       | Number of branches per vine            | 0.315    | 0.580    | 0.544    |
| 3       | Node at first male flower appearance   | 0.052    | 0.070    | 0.741    |
| 4       | Node at first female flower appearance | 0.079    | 0.105    | 0.754    |
| 5       | Days to first male flowering           | 1.902    | 1.422    | 1.338    |
| 6       | Days to first female flowering         | 3.597    | 2.734    | 1.316    |
| 7       | Days to 50 per cent flowering          | 2.808    | 2.233    | 1.258    |
| 8       | Sex ratio                              | 0.425    | 0.474    | 0.897    |
| 9       | Fruit length (cm)                      | 0.391    | 4.265    | 0.092    |
| 10      | Peduncle length (cm)                   | 0.170    | 0.003    | 67.470   |
| 11      | Fruit diameter (cm)                    | 0.405    | 0.317    | 1.275    |
| 12      | Number of fruits per vine              | 0.291    | 0.660    | 0.441    |
| 13      | Average fruit weight (kg)              | 0.025    | 0.036    | 0.706    |
| 14      | Days first harvest                     | 3.151    | 3.273    | 0.963    |
| 15      | Fruit yield per vine (kg)              | 0.546    | 1.398    | 0.390    |
| 16      | Shelf life (days)                      | 1645.423 | 1908.191 | 0.862    |
| 17      | TSS (°Brix)                            | 0.396    | 1.280    | 0.310    |
| 18      | Ascorbic acid (%)                      | 7.534    | 49.215   | 0.153    |
| 19      | Flesh thickness (cm)                   | 0.317    | 0.217    | 1.457    |
| 20      | Seed cavity width (cm)                 | 0.045    | 0.173    | 0.258    |
| 21      | Seed cavity length (cm)                | 0.3906   | 4.27     | 0.0916   |

GCA - General combining ability      SCA- Specific combining ability

For yield and fruit quality traits, the highest positive GCA effect for fruit length was recorded in L5 (1.016). Peduncle length was maximally influenced by L2 (0.609) and tester T3 (0.200), while fruit diameter showed the highest positive GCA effect in L5 (0.767) and tester T3 (0.395). The maximum positive GCA effect for fruit number per vine was recorded in L2 (1.188), whereas average fruit weight was highest in L8 (0.141) and tester T3 (0.111). Earliness in fruit maturity was best governed by L2 (-3.383) and tester T1 (-0.610). For fruit yield per vine, L2 (0.889) and tester T3 (0.334) recorded the highest positive GCA effects. Desirable reduction in seed cavity width and length was associated with L6 (-0.565) and L7 (-1.920), respectively. Flesh thickness was maximally influenced by L8 (0.480) and tester T3 (0.264). Shelf life improvement was highest in L2 (46.667) among lines and T1 (24.354) among testers, while maximum positive GCA effects for TSS and ascorbic acid content were recorded in L8 (1.090) and L7 (2.885), respectively, with tester T2 (1.115) showing the highest effect for ascorbic acid. Overall, the significant GCA effects indicated the predominance of additive

gene action and L2, L8 and L5 among the lines and T3 among the testers emerged as the most consistent superior general combiners for yield, earliness and quality traits in Mangalore melon. The predominance of significant gca effects for most traits indicated the importance of additive and additive × additive gene action, suggesting that these parents offer good prospects for utilization in hybridization programmes aimed at improving yield, earliness and fruit quality in Mangalore melon.

Thus, lines L2, L8 and L5 and tester T3 emerged as the most useful parents, as these were identified as good general combiners for the majority of growth, earliness, yield and quality traits studied in Mangalore melon. Hence, these parents may be recommended for exploitation in hybridization programmes aimed at improving yield and its component traits, as well as earliness and fruit quality attributes for which they exhibited superior combining ability. These findings agree with earlier reports in cucurbits, where the importance of selecting parents with high general combining ability for effective hybrid development has

been emphasized (Singh *et al.*, 2019; Chauhan *et al.*, 2020; Krishnamoorthy, 2020; Patel *et al.*, 2024; Saha *et al.* 2022; Kaur *et al.*, 2022 and Patel and Mehta 2021).

### Specific Combining Ability

The specific combining ability (SCA) effects of the evaluated hybrids, showing that distinct cross combinations exhibited the highest and desirable SCA effects across vegetative growth, flowering behaviour, and sex expression, confirming the importance of non-additive gene action (Table 2). Superior vine growth and branching were recorded in L2 × T2 (0.443) for vine length and L8 × T2 (0.925) for number of branches per vine. Earliness-related traits showed pronounced favourable negative SCA effects, with L2 × T3 (-0.396) and L8 × T3 (-0.463) expressing the lowest nodal position for first male and female flowers, respectively. The earliest flowering was observed in L5 × T1 (-1.820) for days to first male flowering, L6 × T3 (-3.489) for days to first female flowering, and L6 × T3 (-3.093) for days to 50 per cent flowering, while L8 × T1 (-4.002) recorded the earliest first harvest. A higher proportion of female flowers was favoured by L4 × T1 (-1.840). No hybrid expressed significant SCA effects for peduncle length and fruit diameter, indicating the predominance of additive gene action for these traits.

For yield and fruit quality attributes, several hybrids exhibited outstanding and trait-specific SCA effects, reflecting strong non-additive gene interactions. The highest improvement in fruit length (4.174), fruit weight (0.401) and fruit yield per vine (1.782) was recorded in L8 × T2, establishing it as the best specific combiner for major yield-contributing traits. The maximum number of fruits per vine was observed in L8 × T3 (1.158). For flesh thickness, the highest positive SCA effect was recorded in L1 × T1 (0.875), while the maximum ascorbic acid content was contributed by L5 × T1 (11.208), indicating their superiority for nutritional quality. The hybrid L6 × T3 (65.354) exhibited the highest SCA effect for shelf life, highlighting its potential for enhanced post-harvest performance. Fruit sweetness, measured as total soluble solids, was highest in L8 × T1 (1.735). Desirable reductions in seed cavity width and seed cavity length were most pronounced in L3 × T3 (-0.700) and L8 × T1 (-4.298), respectively, contributing to improved fruit quality. Collectively, these superior hybrids demonstrate the predominance of non-additive gene action and can be effectively exploited in

breeding programmes aimed at improving yield, quality and market acceptability of Mangalore melon.

In general, crosses exhibiting significant and desirable specific combining ability (SCA) effects were often associated with superior *per se* performance for the respective traits; however, high SCA effects did not invariably translate into high mean performance. This indicates that SCA effects are not always directly proportional to *per se* performance, as the latter represents a realized phenotypic value, whereas SCA is an estimated deviation of F<sub>1</sub> performance over the parental mean. Therefore, both *per se* performance and SCA effects should be jointly considered while evaluating the superiority of crosses, with greater emphasis on *per se* performance when the objective is commercial F<sub>1</sub> hybrid development. The analytical examination further revealed that crosses with highly significant and desirable SCA effects involved parents representing all possible combinations of general combining ability (GCA), including high × high, high × average, high × low, average × average, average × low and low × low, suggesting that superior hybrid performance is not restricted to specific parental classes. In Mangalore melon, the predominance of SCA effects for growth, earliness, yield and quality traits highlights the major role of non-additive gene action, likely involving dominance and epistatic interactions. Notably, hybrids L8 × T2, L4 × T3, L3 × T1 and L8 × T3 consistently expressed superior SCA effects for fruit yield and its components, while L5 × T1, L6 × T3 and L3 × T1 were outstanding for earliness-related traits, demonstrating their potential for developing early, high-yielding hybrids. These findings agree with earlier reports in cucurbits that emphasize the importance of non-additive gene action in conferring hybrid superiority (Singh *et al.*, 2019; Chauhan *et al.*, 2020; Krishnamoorthy, 2020; Patel *et al.*, 2024 and Wani *et al.*, 2009).

### Gene action

The estimates of general and specific combining ability variances, indicating differential genetic control of traits in Mangalore melon (Table 3). Peduncle length recorded a markedly high GCA: SCA ratio, clearly reflecting the predominance of additive gene action, while traits such as vine length at harvest, flowering-related characters, fruit diameter and flesh thickness also showed GCA: SCA ratios around or above unity, suggesting a greater role of additive genetic effects in their inheritance. In contrast, moderate GCA: SCA ratios observed for branching,

flowering nodes, fruit number, average fruit weight, sex ratio, shelf life and days to first harvest indicated the involvement of both additive and non-additive gene action. Conversely, low GCA: SCA ratios for fruit yield per vine, TSS, ascorbic acid content and seed cavity traits revealed the dominance of non-additive gene action, emphasizing the potential advantage of exploiting hybrid breeding for these economically important traits.

The combining ability analysis indicated the predominance of non-additive gene action for most yield and quality traits in Mangalore melon, as reflected by lower GCA: SCA ratios for fruit yield, fruit number, average fruit weight, TSS, ascorbic acid and seed cavity traits, suggesting the effectiveness of heterosis breeding. In contrast, higher GCA: SCA ratios for vine length, flowering traits, fruit diameter, flesh thickness and peduncle length indicated the importance of additive gene effects, offering scope for improvement through selection. The involvement of both additive and non-additive effects in certain traits highlights the potential of integrating hybridization with selection. These results are consistent with earlier findings in cucurbits reporting non-additive gene action for yield and quality traits and additive control for structural traits (Handayani *et al.*, 2022; Patel *et al.*, 2024; Triveni *et al.*, 2024; Zehra *et al.*, 2024; Janarnjani *et al.*, 2016 and Pandey *et al.*, 2011).

### Conclusion

On the basis of the above results and discussion, it may be safely concluded that the parents L2, L8 and L5 among the lines and T3 among the testers were identified as good general combiners, while the crosses L8 × T2, L8 × T3, L4 × T3 and L3 × T1 emerged as the best specific combiners and can be effectively exploited in future breeding programmes of Mangalore melon. The predominance of non-additive gene action for most yield and quality traits indicates that heterosis breeding would be a more rewarding approach for genetic improvement in this crop.

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