The Pharma Innovation Journal 2021; 10(8): 1056-1063

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(8): 1056-1063

www.thepharmajournal.com
Received: 08-5-2021
Accepted: 15-07-2021

**Omprasad J**
College of Horticulture, Anantharajupet, Dr. Y.S.R Horticulture University Venkataramannagudem, West Godavari, Andhra Pradesh, India

**Dr. Madhumathi C**
Principal Scientist Horticulture and Head, Citrus Research Station, Petlur, Dr. Y.S.R Horticulture University, Venkataramannagudem, West Godavari, Andhra Pradesh, India

**Dr. Syed Sadarunnisa**
Professor, Department of Horticulture, College of Horticulture, Anantharajupeta, Dr. Y.S.R Horticulture University Venkataramannagudem, West Godavari, Andhra Pradesh, India

**Dr. Tanuja Priya B**
Associate Professor, Department of Horticulture, Research Station, Lam, Dr. Y.S.R Horticulture University Venkataramannagudem, West Godavari, Andhra Pradesh, India

**Dr. M Jayaprada**
Assistant Professor (GPBR), College of Horticulture, Anantharajupeta, Dr. Y.S.R Horticulture University Venkataramannagudem, West Godavari, Andhra Pradesh, India

**Dr. Arunodhayam K**
Assistant Professor, (Pl. Path), College of Horticulture, Anantharajupeta, Dr. Y.S.R Horticulture University Venkataramannagudem, West Godavari, Andhra Pradesh, India

**Corresponding Author:**
**Omprasad J**
College of Horticulture, Anantharajupet, Dr. Y.S.R Horticulture University Venkataramannagudem, West Godavari, Andhra Pradesh, India

# Heterosis for growth, yield and quality characters in muskmelon (*Cucumis melo* L.)

**Omprasad J, Dr. Madhumathi C, Dr. Syed Sadarunnisa, Dr. Tanuja Priya B, Dr. M Jayaprada and Dr. Arunodhayam K**

## Abstract
An investigation was carried out to assess the extent of heterosis for fruit, yield and quality parameters in muskmelon. Fifteen hybrids and six Parents two standard checks were investigated for twenty four characters for over a period of three Seasons *viz*., summer, *kharif* and *rabi* in 2019-2020 at vegetable block, College of Horticulture, Anantharajupet, Dr. YSR Horticultural University. Hybrids developed by half diallel design, with six lines. The analysis of variance indicated significant variation for all the characters except the node at which the first male flower appeared. Four crosses $C_{10}$ (AM Sel-3 × AM Sel-4), $C_{11}$ (AM Sel-3 × AM Sel-5), $C_{14}$ (AM Sel-4 × AM Sel-6) and $C_{15}$ (AM Sel-5 × AM Sel-6) showed superior performance of the yield and other important quality traits. After sufficient evaluation, these hybrids were identified as potential hybrids for widespread cultivation and commercial exploitation.

**Keywords:** Muskmelon, heterosis, melon, *Cucumis melo*

## Introduction
Muskmelon (*Cucumis melo* L.) 2n = 24 is one of the most important cucurbitaceous vegetables grown as a desert crop. It is a good cash crop in Asia and South American countries. In a tropical country like India, juicy dessert fruits like muskmelon and watermelon are considered as best thrust quenchers during the arid summer months. Fruits are good sources of vitamins and minerals and relatively low in protein.
One of the most powerful tools at breeder's disposal is the assessment of the heterotic effect of hybrid combinations. Heterosis, or hybrid vigour, measures the phenotypic superiority of $F_1$ hybrids over their parents, breeding of high fruit yield has been a major objective of many muskmelon breeding programs over the last few decades. Phenomenon of heterosis has been utilized in many crops to exploit dominance variance through the production of hybrids (Cramer and Wehner, 1999) [3]. Heterosis for fruit size and fruit number per plant was first observed by Hayes and Jones (1916) [6] in cucumber. A successful cultivar must have traits other than yield. High fruit quality is one of the major important traits which include bright colour, firmness, high sugar content, and shape. A speedy improvement can be brought about in muskmelon by assessing the genetic variability and its exploitation through hybrid breeding. Musk melon is highly cross pollinated crop (Swarup, 1991) [16] and shows considerable amount of heterosis. In spite of the wide range of genetic variability available in muskmelon, very little attention has been paid to exploit heterosis. $F_1$ hybrids of muskmelon yield higher than the standard cultivars. Thus there is a good scope for improvement of yield and other quality parameters through heterosis breeding. Therefore the present work was attempted to cross muskmelon local lines to obtain more number of fruits with appropriate size to suit the consumer's need with good yield, high sweetness and high shelf life.

## Material and Methods
The present investigation was conducted 2018-2020 at vegetable block, College of Horticulture, Anantharajupeta, Rly Kodur, YSR Kadapa district, Dr. Y.S.R. Horticultural University, Andhra Pradesh. The experimental material comprised six inbred lines *viz*., AM Sel-1, AM Sel-2, AM Sel-3, AM Sel-4, AM Sel-5, AM Sel-6, fifteen hybrids developed in half diallel fashion and two standard checks. Mature hermaphrodite /pistillate flower buds that would open on the next day were chosen in the female parent. The hermaphrodite flower buds were emasculated with help of fine forceps and bagged to prevent the contamination of foreign

pollen. The pistillate flower buds were simply bagged. Mature staminate flower buds were also bagged. The staminate flowers were collected from the respective male parent and pollen was dusted over stigma of the emasculated hermaphrodite flower of the female parent. The pollinated flowers were re bagged and labelled. The crossed flowers were observed daily for successful fruit set (Subramanian, 2008). The seeds extracted, dried and preserved in butter paper bags labelled with the details of cross. An experiment was laid out using six parents, 15 crosses and standard checks in RBD with three replications in three different seasons *i.e. kharif, rabi,* summer. Standard package of practices were followed to raise the crop as per the Dr YSRHU recommendations. Data was recorded on randomly selected 10 plants for growth characters like vine length, number of primary branches per plant, earliness traits *viz*., days taken to appearance of first male flower, days taken to appearance of first female flower, node at which the first male flower appeared, node at which the first female flower appeared, days taken to 50 per cent flowering, total number of male and female flower per vine (sex ratio), days taken to first fruit harvest, days taken to last fruit harvest, yield and yield attributing traits like number of fruits per plant, yield per plant (kg), fruit weight(kg), fruit length(cm), fruit diameter(cm), quality traits like fruit firmness (kg/cc), rind thickness(mm), pericarp thickness (cm), shelf life(days), total soluble solids ($^0$Brix) acidity, ascorbic acid (mg/100g), total sugars (%), reducing sugars (%), β-carotene (µg/g). Heterosis was calculated over mid parent and better parent and standard checks as per Fonsceca and Patterson (1968) [5]. As muskmelon being cross pollinated crop there was a chance of pollen contamination so to avoid pollen contamination effect on fruit quality controlled pollination (Selfing) was carried artificially.

**Results and Discussion**

In the present study, six inbred lines of melon and the 15 hybrids obtained by crossing them in a half diallel design were used to investigate heterosis in three different seasons. Pooled analysis of variance (Table 1) revealed highly significant differences for all the characters except the node at which the first male flower appeared indicating sufficient genetic variability among genotypes for exploitation of heterosis. Pooled data on heterosis for growth, yield and quality parameters in muskmelon are presented in Tables 2-6.

Top three crosses with positive better parental heterosis for vine length were $C_5$ (9.66%), $C_{13}$ (21.46%) and $C_{14}$ (21.22%), whereas the hybrids $C_5$ (18.01%), $C_{13}$ (15.01%) and $C_{14}$ (14.78%) were the top three crosses with positive standard heterosis over Kundan for vine length. Top three hybrids with better parental heterosis for number of primary branches per plant were $C_1$ (13.95%), $C_3$ (16.98%) and $C_8$ (17.52%) whereas the hybrid $C_3$ (13.70 and 16.38) was the only one single cross with positive standard heterosis over Kundan and Papasa respectively. These results are align with the findings of Vishwantha *et al*. (2003) [18], Choudhary *et al*. (2003) [2] and Aravindkumar *et al*. (2005) [1] in muskmelon.

Earliness indicated by negative estimation of heterosis is well recognised and the prime objective of any hybrid breeding programme. For days taken to appearance of first female flower the Cross $C_1$ (-6.36%), recorded significantly negative heterobeltiosis followed by $C_2$ (-5.65%), $C_{10}$ (-4.84%) and cross combinations $C_{10}$ (-7.25%), $C_{12}$ (-5.07%), $C_{13}$ (-4.71%), attributed significant negative standard heterosis over Kundan. With respect to node at which the first female flower appeared six hybrids ($C_1$, $C_2$, $C_3$, $C_4$, $C_6$ and $C_{11}$) recorded early flowering than their mid parents by exhibiting significant negative average heterosis. Ten hybrids ($C_1$, $C_2$, $C_3$, $C_4$, $C_6$, $C_8$, $C_9$, $C_{11}$, $C_{12}$ and $C_{15}$) showed significant negative heterobeltiosis. The cross $C_{10}$ manifesting standard heterosis over check Kundan and Papasa of -3.72 and -7.78 respectively was the top cross for days to 50% flowering. The single cross $C_3$ (-7.23%), $C_3$ (-5.98%) with respect to standard heterosis over check Kundan and Papasa respectively was better for days to first fruit harvest. The crosses $C_9$ and $C_1$ were the top two crosses, manifesting a standard heterosis over Kundan of 6.98 per cent and 5.68 per cent respectively for days taken to last fruit harvest. These results were in conformity with the findings of Kamer *et al*. (2015) [8] Shivaji *et al*. (2018) [12], Singh and Vashisht (2018) [13], Rolania and Fageria (2018) [10] in muskmelon.

The poor performance of hybrids can be attributed to the fact that the hybrids had bigger and heavier fruits which were less in number compared to parents. For number of fruits per plant the crosses $C_4$ and $C_{11}$ manifested significantly positive average heterosis, one cross $C_{11}$ exhibited better parent heterosis and thirteen crosses ($C_1$, $C_3$, $C_4$, $C_5$, $C_6$, $C_8$, $C_9$, $C_{10}$, $C_{11}$, $C_{12}$, $C_{13}$, $C_{14}$ and $C_{15}$) exhibited significantly positive standard heterosis over Papasa. For fruit weight the cross $C_{10}$ (71.57%), $C_{15}$ (40.40%) and $C_{14}$ (32.56%) were the top three crosses which recorded the highest heterobeltiosis. The crosses $C_{10}$ (65.48%), $C_{15}$ (58.06%) and $C_{14}$ (47.10%) were the top three crosses which recorded the highest standard heterosis over check Kundan.

For fruit yield per plant, significantly positive heterosis has been observed in crosses over their mid and better parents. The crosses, $C_{10}$ (80.05%), $C_{11}$ (68.96%), $C_{15}$ (43.83%), $C_8$ (39.77%) and $C_{14}$ (35.16%) were the top five heterotic crosses manifesting positively significant heterosis over mid parent, while the crosses $C_{10}$ (70.26%), $C_{11}$ (48.29%), $C_{15}$ (26.14%) and $C_8$ (23.41%) were the top four crosses exhibiting positively significant heterobeltiosis. The five crosses $C_{15}$ (63.04%), $C_{11}$ (44.52%), $C_{14}$ (43.16%), $C_{10}$ (40.62%), $C_{12}$ (33.94%) were the top five heterotic crosses manifesting positively significant standard heterosis over standard check Kundan and Papasa. This is in line with the findings of Sulochanamma (2001) [15], Feyzian *et al*. (2009) [4], Shivaji *et al*. (2018) [12], Rolania and Fageria (2018) [10].

The crosses $C_9$ (258.07%), $C_{12}$ (257.06%) and $C_7$ (123.03%) were the top three crosses which recorded the highest standard heterosis over check Papasa for the fruit firmness. For pericarp thickness $C_{10}$ (28.79%), $C_{12}$ (26.63%) and $C_{14}$ (16.52%) were the top three crosses which recorded the highest heterobeltiosis, The crosses $C_{11}$ (14.24%), $C_{10}$ (9.35%) and $C_{15}$ (7.44%) were the top three crosses recorded the highest standard heterosis over check Kundan, The crosses $C_{11}$ (11.51%) and $C_{10}$ (6.74%) were the top two crosses which recorded the highest standard heterosis over check Papasa for pericarp thickness.

For shelf life $C_{15}$ (172.16%), $C_6$ (60.50%) and $C_9$ (55.83%) were the top three crosses which recorded the highest standard heterosis over check Papasa. For TSS four crosses ($C_3$, $C_6$, $C_7$ and $C_{12}$) displayed significantly positive heterosis over mid parent and one cross $C_3$ displayed significantly positive heterosis over better parent. None of the crosses recorded significantly positive heterosis over check Kundan and nine crosses ($C_3$, $C_6$, $C_7$, $C_8$, $C_9$, $C_{12}$, $C_{13}$, $C_{14}$ and $C_{15}$) recorded significantly positive heterosis over standard check

Papasa. Similar findings observed by Vishwantha *et al*. (2003) [18], Choudhary *et al*. (2003) [2] and Aravindkumar (2005) [1]. For ascorbic acid $C_7$ (200.28%), $C_6$ (178.13%) and $C_{11}$ (162.72%) were the top three crosses based on heterobeltiosis, while crosses $C_{11}$ (191.15%), $C_2$ (163.35%) and $C_7$ (156.82%) were the top three based on standard heterosis over Kundan and $C_1$ (208.05%), $C_2$ (178.63%) and $C_7$ (171.72%) top three crosses based on standard heterosis over Papasa for ascorbic acid content. Vishwantha *et al*. (2003) [18], Kamer *et al*. (2015) [8] and Saha *et al*. (2018) [11] also observed significant and positive heterosis for this trait in muskmelon.

For total sugars $C_2$ (31.10%) and $C_1$ (4.59%) were the top two crosses on the basis of heterobeltiosis, while cross $C_{12}$ (2.28%) was the top on the basis of standard heterosis over Kundan and $C_{12}$ (13.26%), $C_2$ (4.19%) and $C_{15}$ (2.95%) were the top three crosses on the basis of standard heterosis over Papasa for total sugars. For reducing sugars one cross ($C_2$) manifested significantly positive average heterosis, better parent heterosis and significantly positive standard heterosis over Papasa. For beta carotene the crosses $C_6$ (41.66%), $C_3$ (11.94%) and $C_{13}$ (6.33%) were the top three crosses on the basis of heterobeltiosis, while cross $C_{13}$ (23.06%), $C_3$ (22.58%), $C_{15}$ (2.69%) were top three crosses on basis of standard heterosis over Kundan for β-carotene. A similar magnitude of heterosis was also reported by Kamer *et al*. (2015) [8] in muskmelon.

Four crosses $C_{11}$, $C_{10}$, $C_{14}$ and $C_{15}$ showed superior performance of the yield and yield attributing characters. These crosses had higher values than the parents in terms of yield per plant. These hybrids had positive average heterosis, heterobeltiosis and standard heterosis over the checks Kundan and Papasa. Magnitude of heterosis was high in comparison with the findings of Choudary *et al*. (2003) [2] Vishwantha (2003) [18] and low in comparison with the findings of Subramanian (2008) [14] and it is attributed to the use of different genetic stocks and also varied environmental conditions. Sulochanamma (2001) [15] obtained the highest heterobeltiosis value for the total production in single hybrid melons. Hays and Jones (1916) [6] reported that the first generation crosses in cucumber frequently show high heterosis because of increased fruit size and fruit number per plant. The results of the present investigation are similar to the reports of Tomar and Bhalala (2006) [17], Moon *et al*. (2006) [9], Jagtap (2010) [7] in muskmelon where they have reported a moderate range of heterosis for yield. After sufficient evaluation, these hybrids were identified as potential hybrids for widespread cultivation and commercial exploitation.

**Table 1:** Pooled analysis of variance for heterosis in muskmelon

| Character | Replicates | Treatments | Parents | Hybrids | Parents Vs. Hybrids | Error |
|---|---|---|---|---|---|---|
| Degrees of Freedom | 2 | 20 | 5 | 14 | 1 | 40 |
| Vine Length (m) | 0.01 | 0.36** | 0.59** | 0.28** | 0.41** | 0.02 |
| Number of primary branches per plant | 0.04 | 0.20** | 0.23** | 0.16** | 0.62** | 0.06** |
| Days taken to appearance of first male flower | 0.08 | 3.98** | 2.24** | 4.80** | 1.24** | 0.11 |
| taken to appearance of first female flower | 0.39 | 3.09** | 4.28** | 2.80** | 1.22 | 0.36 |
| Node at which the first male flower appeared | 0.89 | 0.38 | 0.24 | 0.45 | 0.15 | 0.24 |
| Node at which the first female flower appeared | 0.07 | 1.72** | 3.34** | 1.25** | 0.15 | 0.11 |
| Days taken to 50% flowering | 0.51 | 2.92** | 3.64** | 1.97** | 12.66** | 0.41 |
| Sex ratio | 0.52 | 16.71** | 17.31** | 16.97** | 10.05** | 0.47 |
| Days taken to first fruit harvest | 3.28 | 15.25** | 24.94** | 12.86** | 0.17 | 1.11 |
| Days taken to last fruit harvest | 6.36 | 31.14** | 20.83** | 35.51** | 21.64** | 3.91 |
| Number of fruits per plant | 0.04 | 0.96** | 1.40** | 0.86** | 0.20 | 0.07 |
| Fruit weight (g) | 0.01 | 0.24** | 0.64** | 0.10** | 4.62** | 0.01 |
| Yield per plant (kg) | 0.09 | 4.30** | 4.69** | 4.13** | 0.13** | 0.18 |
| Fruit length (cm) | 0.07 | 15.66** | 31.56** | 9.34** | 24.62** | 0.18 |
| Fruit diameter (cm) | 0.21 | 2.35** | 2.15** | 2.17** | 5.86** | 0.35 |
| Fruit firmness (kg/cc) | 0.15 | 40.20** | 38.92** | 39.45** | 56.96** | 0.08 |
| Rind thickness (mm) | 0.01 | 6.25** | 9.93** | 4.94** | 6.23** | 0.02 |
| Pericarp thickness (cm) | 0.05 | 0.52** | 0.27** | 0.61** | 0.45** | 0.01 |
| Shelf life | 0.14 | 66.19** | 116.33** | 36.25** | 234.57** | 0.27 |
| Total soluble solids | 0.03 | 8.97** | 13.07** | 7.68** | 6.44** | 0.07 |
| Ascorbic acid | 1.88 | 248.01** | 48.24** | 210.23** | 1775.69** | 2.01 |
| Total sugars | 0.05 | 11.08** | 10.15** | 9.95** | 31.52** | 0.02 |
| Reducing sugars (%) | 0.33 | 4.70** | 5.21** | 3.64** | 17.07** | 0.17 |
| β - carotene (μg) | 0.01 | 26.93** | 38.62** | 23.43** | 17.43** | 0.01 |

**Table 2:** Pooled analysis estimates of relative heterosis, heterobeltiosis and standard heterosis for vine length (m), number of primary branches per plant, days taken to appearance of first male flower, days taken to appearance of first female flower

| Cross combinations | Vine length (m) | | | | Number of primary branches per plant | | | | Days taken to appearance of first male flower | | | | Days taken to appearance of first female flower | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Relative heterosis | Hetero beltiosis | Standard heterosis | | Relative heterosis | Hetero beltiosis | Standard heterosis | | Relative heterosis | Hetero beltiosis | Standard heterosis | | Relative heterosis | Hetero beltiosis | Standard heterosis | |
| | | | Kundan | Papasa | | | Kundan | Papasa | | | Kundan | Papasa | | | Kundan | Papasa |
| $C_{1}$ | -8.66 ** | -9.44 ** | -2.54 | -8.16 * | 20.49 ** | 13.95 * | 2.9 | 5.32 | -2.27 * | -4.83 ** | -6.32 ** | -6.32 ** | -1.31 | -6.36 ** | -3.99 * | -0.38 |
| $C_{2}$ | -22.99 ** | -24.89 ** | -19.17 ** | -23.83 ** | 1.85 | -2.53 | -3.7 | -1.43 | -1.61 | -1.61 | -3.15 ** | -3.15 ** | -3.26 * | -5.65 ** | -3.26 | 0.37 |
| $C_{3}$ | 4.34 | -1.93 | 5.54 | -0.54 | 21.28 ** | 16.98 ** | 13.70 * | 16.38 ** | 4.69 ** | 2.79 ** | 1.19 | 1.19 | 0.56 | -4.24 ** | -1.82 | 1.87 |
| $C_{4}$ | 2.00 | -4.29 | 3.00 | -2.94 | 11.69 | 11.63 | 0.8 | 3.17 | 7.10 ** | 6.01 ** | 4.35 ** | 4.35 ** | 1.98 | 0.00 | 2.53 | 6.38 ** |
| $C_{5}$ | 35.99 ** | 9.66 ** | 18.01 ** | 11.21 ** | 9.92 | 2.59 | 6.9 | 9.42 | -3.76 ** | -5.43 ** | -3.56 ** | -3.56 ** | -1.81 | -4.24 ** | -1.82 | 1.87 |
| $C_{6}$ | -2.55 | -4.15 | 1.39 | -4.46 | 10.09 | -0.10 | -1.3 | 1.02 | 4.74 ** | 2.00 | 0.39 | 0.39 | 3.25 * | 0.37 | -2.17 | 1.50 |
| $C_{7}$ | -6.57 | -11.46 ** | -6.35 | -11.75 ** | 20.09 ** | 9.77 | 6.7 | 9.21 | 11.77 ** | 10.82 ** | 5.15 ** | 5.15 ** | 11.76 ** | 11.33 ** | 3.26 | 7.14 ** |
| $C_{8}$ | -1.10 | -6.44 | -1.04 | -6.75 | 24.19 ** | 17.52 * | 6 | 8.50 | 5.01 ** | 3.28 ** | -0.39 | -0.39 | 2.29 | -1.09 | -2.53 | 1.13 |
| $C_{9}$ | 19.57 ** | -2.95 | 2.66 | -3.26 | 8.18 | -4.13 | -0.1 | 2.25 | 8.10 ** | 3.49 ** | 5.54 ** | 5.54 ** | 8.61 ** | 5.59 ** | 2.90 | 6.77 ** |
| $C_{10}$ | 11.61 ** | 7.45 | 9.93 * | 3.59 | -3.88 | -4.66 | -5.8 | -3.58 | -3.90 ** | -5.63 ** | -7.11 ** | -7.11 ** | -2.48 | -4.84 ** | -7.25 ** | -3.77 * |
| $C_{11}$ | 0.53 | -3.39 | -1.15 | -6.86 | 9.63 | 4.86 | 3.6 | 6.04 | 1.03 | 0.01 | -1.57 | -1.57 | -2.40 | -2.93 | -4.35 ** | -0.76 |
| $C_{12}$ | 0.48 | -17.38 ** | -15.47 ** | -20.35 ** | -1.18 | -3.74 | 0.3 | 2.66 | -0.98 | -2.71 ** | -0.78 | -0.78 | -2.59 | -2.60 | -5.07 ** | -1.50 |
| $C_{13}$ | 21.69 ** | 21.46 ** | 15.01 ** | 8.38 * | -5.98 | -9.36 | -11.9 | -9.83 | -2.48 ** | -3.27 ** | -6.71 ** | -6.71 ** | -0.37 | -3.30 | -4.71 ** | -1.13 |
| $C_{14}$ | 42.92 ** | 21.22 ** | 14.78 ** | 8.16 * | -8.74 | -11.80 | -8.1 | -5.94 | -7.22 ** | -10.45 ** | -8.68 ** | -8.68 ** | 0.20 | -2.22 | -4.71 ** | -1.13 |
| $C_{15}$ | 18.01 ** | 0.24 | -5.43 | -10.88 ** | -5.76 | -12.09 * | -8.4 | -6.24 | -2.40 ** | -5.05 ** | -3.17 ** | -3.17 ** | 2.04 | 1.48 | 0.00 | 3.76 * |
| S.E.D | 0.09 | 0.10 | 0.10 | 0.10 | 0.16 | 0.19 | 0.19 | 0.19 | 0.23 | 0.27 | 0.27 | 0.27 | 0.42 | 0.49 | 0.49 | 0.49 |
| CD at 95% | 0.19 | 0.22 | 0.22 | 0.22 | 0.36 | 0.41 | 0.41 | 0.41 | 0.50 | 0.58 | 0.58 | 0.58 | 0.91 | 1.05 | 1.05 | 1.05 |
| Range | -22.99 to 42.92 | -24.89 to 21.46 | -19.17 to 18.01 | -23.83 to 11.21 | -8.74 to 24.19 | -12.09 to 17.52 | -11.90 to 13.70 | -9.83 to 16.38 | -7.22 to 11.77 | -10.45 to 10.82 | -8.68 to 5.54 | -8.68 to 5.54 | -3.26 to 11.76 | -6.36 to 11.33 | -7.25 to 3.26 | -3.77 to 6.77 |

*: Significant at 5% level; **: Significant at 1% level

**Table 3:** Pooled analysis estimates of relative heterosis, heterobeltiosis and standard heterosis for node at which the first male flower, node at which the first female flower, days taken to 50% flowering and sex ratio

| Cross combinations | Node at which the first male flower | | | | Node at which the first female flower | | | | Days taken to 50% flowering | | | | Sex ratio | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Relative heterosis | Hetero beltiosis | Standard heterosis | | Relative heterosis | Hetero beltiosis | Standard heterosis | | Relative heterosis | Hetero beltiosis | Standard heterosis | | Relative heterosis | Hetero beltiosis | Standard heterosis | |
| | | | Kundan | Papasa | | | Kundan | Papasa | | | Kundan | Papasa | | | Kundan | Papasa |
| $C_{1}$ | -2.27 * | -4.83 ** | -6.32 ** | -6.32 ** | -15.09 ** | -21.22 ** | 40.90 ** | 3.18 | -6.05 ** | -6.05 ** | 0.00 | -4.22 ** | 29.16 ** | 23.59 ** | 6.2 | 4.60 |
| $C_{2}$ | -1.61 | -1.61 | -3.15 ** | -3.15 ** | -17.54 ** | -17.89 ** | 25.66 ** | -7.98 | -7.71 ** | -8.59 ** | -2.71 | -6.81 ** | -8.62 * | -19.06 ** | -9.86 * | -11.22 * |
| $C_{3}$ | 4.69 ** | 2.79 ** | 1.19 | 1.19 | -10.03 * | -17.09 ** | 26.89 ** | -7.08 | -5.59 ** | -8.59 ** | -2.71 | -6.81 ** | -28.37 ** | -33.05 ** | -33.82 ** | -34.82 ** |
| $C_{4}$ | 7.10 ** | 6.01 ** | 4.35 ** | 4.35 ** | -10.16 * | -11.89 ** | 34.84 ** | -1.26 | -0.50 | -4.14 ** | 2.03 | -2.27 | -41.69 ** | -50.14 ** | -39.69 ** | -40.59 ** |
| $C_{5}$ | -3.76 ** | -5.43 ** | -3.56 ** | -3.56 ** | 25.08 ** | 4.18 | 59.43 ** | 16.75 ** | -7.31 ** | -9.23 ** | -3.39 | -7.46 ** | -15.44 ** | -21.06 ** | -32.17 ** | -33.19 ** |
| $C_{6}$ | 4.74 ** | 2.00 | 0.39 | 0.39 | -18.72 ** | -24.89 ** | 34.34 ** | -1.62 | -6.76 ** | -7.64 ** | -1.70 | -5.84 ** | -32.28 ** | -42.27 ** | -35.71 ** | -36.67 ** |
| $C_{7}$ | 11.77 ** | 10.82 ** | 5.15 ** | 5.15 ** | 13.42 ** | -2.38 | 74.59 ** | 27.85 ** | -3.29 * | -6.36 ** | -0.34 | -4.54 ** | -1.70 | -11.81 * | -12.83 ** | -14.14 ** |
| $C_{8}$ | 5.01 ** | 3.28 ** | -0.39 | -0.39 | -2.69 | -11.32 ** | 58.61 ** | 16.15 ** | -1.48 | -5.08 ** | 1.03 | -3.23 | -5.31 | -21.92 ** | -5.55 | -6.97 |
| $C_{9}$ | 8.10 ** | 3.49 ** | 5.54 ** | 5.54 ** | 13.99 ** | -10.54 ** | 60.00 ** | 17.17 ** | -0.48 | -2.54 | 3.73 * | -0.64 | 37.29 ** | 33.77 ** | 5.03 | 3.46 |
| $C_{10}$ | -3.90 ** | -5.63 ** | -7.11 ** | -7.11 ** | 7.80 | -0.27 | 51.31 ** | 10.80 * | -5.65 ** | -7.79 ** | -3.72 * | -7.78 ** | -18.29 ** | -22.88 ** | -14.12 ** | -15.41 ** |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C11 | 1.03 | 0.01 | -1.57 | -1.57 | -15.25 ** | -16.53 ** | 26.64 ** | -7.26 | 0.17 | -2.60 | 1.70 | -2.59 | -6.31 | -10.03 ** | 8.83 | 7.20 |
| C12 | -0.98 | -2.71 ** | -0.78 | -0.78 | 5.95 | -11.45 * | 34.34 ** | -1.62 | -2.46 | -3.57 * | 0.68 | -3.57 * | -15.98 ** | -29.89 ** | -21.92 ** | -23.09 ** |
| C13 | -2.48 ** | -3.27 ** | -6.71 ** | -6.71 ** | -2.34 | -8.36 | 34.84 ** | -1.26 | 1.19 | 0.67 | 0.35 | -3.89 * | 6.66 | -3.09 | 17.22 ** | 15.46 ** |
| C14 | -7.22 ** | -10.45 ** | -8.68 ** | -8.68 ** | 13.60 ** | 1.65 | 31.15 ** | -3.96 | 3.53 * | 2.33 | 4.41 ** | 0.01 | -5.53 | -17.16 ** | -18.13 ** | -19.35 ** |
| C15 | -2.40 ** | -5.05 ** | -3.17 ** | -3.17 ** | -2.50 | -17.49 ** | 21.39 ** | -11.10 * | -1.01 | -2.65 | -0.67 | -4.86 ** | 11.57 ** | -9.86 ** | 9.04 | 7.40 |
| S.E.D | 0.34 | 0.39 | 0.39 | 0.39 | 0.23 | 0.53 | 0.53 | 0.53 | 0.45 | 0.52 | 0.52 | 0.52 | 0.48 | 0.56 | 0.56 | 0.56 |
| CD at 95% | 0.73 | 0.85 | 0.85 | 0.85 | 0.49 | 0.57 | 0.57 | 0.57 | 0.97 | 1.12 | 1.12 | 1.12 | 1.04 | 1.20 | 1.20 | 1.20 |
| Range | -7.22 to 11.77 | -10.45 to 10.82 | -8.68 to 5.54 | -8.68 to 5.54 | -18.72 to 25.08 | -24.89 to 4.18 | 21.39 to 74.59 | -11.10 to 27.85 | -7.71 to 3.53 | -9.23 to 2.33 | -3.73 to 4.41 | -7.78 to 0.01 | -41.69 to 37.29 | -50.14 to 23.59 | -35.71 to 17.22 | -4.59 to 15.46 |

*: Significant at 5% level; **: Significant at 1% level

**Table 4:** Pooled analysis estimates of relative heterosis, heterobeltiosis and standard heterosis for days taken to first fruit harvest, days taken to last fruit harvest, number of fruits per plant and fruit weight (g)

| Cross combinations | Days taken to first fruit harvest | | | | Days taken to last fruit harvest | | | | Number of fruits per plant | | | | Fruit weight (g) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Relative heterosis | Hetero beltiosis | Standard heterosis | | Relative heterosis | Hetero beltiosis | Standard heterosis | | Relative heterosis | Hetero beltiosis | Standard heterosis | | Relative heterosis | Hetero beltiosis | Standard heterosis | |
| | | | Kundan | Papasa | | | Kundan | Papasa | | | Kundan | Papasa | | | Kundan | Papasa |
| C1 | -2.10 | -4.45 ** | 1.90 | 3.28 * | 4.58 * | 4.33 | 5.68 * | 9.60 ** | 5.30 | -1.87 | -23.38 ** | 21.96 ** | -21.57 ** | -40.97 ** | 25.48 ** | -36.33 ** |
| C2 | 6.19 ** | 1.32 | 2.86 | 4.24 ** | 5.79 ** | 1.13 | 2.44 | 6.23 * | -24.27 ** | -26.84 ** | -38.72 ** | -2.45 | -26.93 ** | -46.89 ** | 12.90 ** | -42.72 ** |
| C3 | -9.38 ** | -10.13 ** | -7.23 ** | -5.98 ** | -16.35 ** | -17.14 ** | -14.45 ** | -11.28 ** | -14.51 ** | -23.44 ** | -24.43 ** | 20.28 * | -15.24 ** | -38.39 ** | 30.97 ** | -33.55 ** |
| C4 | 1.05 | -0.75 | 0.76 | 2.12 | 2.85 | 1.28 | 2.6 | 6.39 * | 11.68 * | 5.35 | -7.22 | 47.67 ** | -15.67 ** | -35.51 ** | 37.10 ** | -30.44 ** |
| C5 | -3.48 ** | -4.11 ** | -2.66 | -1.35 | -3.92 | -4.00 | -2.76 | 0.84 | -10.17 * | -24.61 ** | -13.23 * | 38.11 ** | -36.59 ** | -51.75 ** | 2.58 | -47.95 ** |
| C6 | 1.72 | -5.17 ** | 1.15 | 2.51 | 7.57 ** | 3.06 | 3.9 | 7.75 ** | 10.68 | -0.10 | -16.31 ** | 33.20 ** | 4.11 | -1.20 | 6.13 | -46.15 ** |
| C7 | 1.81 | 0.18 | 6.84 ** | 8.28 ** | 2.78 | 1.57 | 4.87 | 8.75 ** | -25.45 ** | -37.25 ** | -38.07 ** | -1.42 | 12.34 ** | 6.61 | 14.52 ** | -41.90 ** |
| C8 | -4.28 ** | -8.20 ** | -2.09 | -0.77 | 0.65 | -0.65 | 0.16 | 3.87 | 11.59 | -1.47 | -13.23 * | 38.11 ** | 23.17 ** | 20.34 ** | 35.48 ** | -31.26 ** |
| C9 | 0.18 | -2.86 | 3.61 * | 5.01 ** | 5.95 ** | 5.78 * | 6.98 ** | 10.94 ** | -5.74 | -25.25 ** | -13.96 ** | 36.95 ** | 27.62 ** | 25.58 ** | 39.35 ** | -29.30 ** |
| C10 | 0.98 | -4.41 ** | -1.32 | 0.01 | 4.57 * | -0.94 | 2.28 | 6.07 * | -5.69 | -12.83 * | -13.96 ** | 36.95 ** | 71.57 ** | 71.57 ** | 65.48 ** | -16.04 ** |
| C11 | 10.60 ** | 7.38 ** | 5.13 ** | 6.55 ** | 8.52 ** | 5.29 * | 3.41 | 7.24 ** | 25.37 ** | 22.30 ** | 7.71 | 71.45 ** | 26.85 ** | 17.77 ** | 32.58 ** | -32.73 ** |
| C12 | 6.72 ** | 2.47 | 2.66 | 4.05 ** | 7.22 ** | 2.57 | 3.74 | 7.58 ** | 0.41 | -13.26 ** | -0.16 | 58.91 ** | 40.59 ** | 31.40 ** | 45.81 ** | -26.02 ** |
| C13 | -2.46 | -4.97 ** | -1.90 | -0.58 | 1.05 | -1.42 | 1.79 | 5.56 * | -11.52 * | -16.28 ** | -17.37 ** | 31.52 ** | 26.85 ** | 17.77 ** | 32.58 ** | -32.73 ** |
| C14 | -2.61 | -4.05 ** | -0.95 | 0.39 | -2.30 | -3.30 | -0.16 | 3.54 | -10.33 * | -16.71 ** | -4.14 | 52.58 ** | 41.84 ** | 32.56 ** | 47.10 ** | -25.37 ** |
| C15 | -0.58 | -1.71 | -1.52 | -0.20 | 0.98 | -0.48 | 0.65 | 4.37 | -2.52 | -13.96 ** | -0.97 | 57.62 ** | 41.41 ** | 40.40 ** | 58.06 ** | -19.80 ** |
| S.E.D | 0.74 | 0.86 | 0.86 | 0.86 | 1.39 | 1.61 | 1.61 | 1.61 | 0.18 | 0.20 | 0.20 | 0.20 | 0.03 | 0.04 | 0.04 | 0.04 |
| CD at 95% | 1.59 | 1.84 | 1.84 | 1.84 | 2.99 | 3.46 | 3.46 | 3.46 | 0.38 | 0.44 | 0.44 | 0.44 | 0.08 | 0.09 | 0.09 | 0.09 |
| Range | -9.38 to 10.60 | -10.13 to 7.38 | -7.23 to 6.84 | -5.98 to 8.28 | -16.35 to 8.52 | -17.14 to 5.78 | -14.45 to 6.98 | -11.28 to 10.94 | -25.45 to 25.37 | -37.25 to 22.30 | -38.72 to 7.71 | -2.45 to 71.45 | -36.59 to 71.57 | -46.89 to 71.57 | 2.58 to 65.48 | -47.95 to -16.04 |

*: Significant at 5% level; **: Significant at 1% level

**Table 5:** Pooled analysis estimates of relative heterosis, heterobeltiosis and standard heterosis for yield per plant (kg), fruit length (cm), fruit diameter and fruit firmness (kg/cc)

| Cross combinations | Yield per plant (kg) | | | | Fruit length (cm) | | | | Fruit diameter | | | | Fruit firmness (kg/cc) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Relative heterosis | Hetero beltiosis | Standard heterosis | | Relative heterosis | Hetero beltiosis | Standard heterosis | | Relative heterosis | Hetero beltiosis | Standard heterosis | | Relative heterosis | Hetero beltiosis | Standard heterosis | |
| | | | Kundan | Papasa | | | Kundan | Papasa | | | Kundan | Papasa | | | Kundan | Papasa |
| C1 | -10.87 | -32.34 ** | -2.54 | -14.39 | 3.11 | -20.61 ** | 18.73 ** | -16.93 ** | -8.55 ** | -9.24 * | -5.69 | -1.07 | -36.18 ** | -50.90 ** | -76.23 ** | -22.66 ** |
| C2 | -34.55 ** | -50.55 ** | -28.78 ** | -37.43 ** | -8.09 ** | -24.58 ** | 12.78 ** | -21.09 ** | -4.10 | -9.45 * | -7.33 | -2.79 | -30.20 ** | -32.56 ** | -81.14 ** | -38.62 ** |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $C_3$ | -12.59 | -31.24 ** | -0.95 | -12.99 | -14.79 ** | -30.60 ** | 3.78 | -27.39 ** | -7.94 * | -13.80 ** | -11.79 ** | -7.46 | -48.98 ** | -63.80 ** | -77.47 ** | -26.70 ** |
| $C_4$ | 6.58 | -10.65 | 28.70 ** | 13.06 | -12.98 ** | -29.62 ** | 5.25 | -26.36 ** | -8.73 ** | -13.14 ** | -11.11 ** | -6.76 | -51.59 ** | -68.63 ** | -72.37 ** | -10.09 |
| $C_5$ | -33.57 ** | -36.98 ** | -9.22 | -20.25 ** | -20.86 ** | -34.72 ** | -2.39 | -31.70 ** | -12.16 ** | -13.24 ** | -11.21 ** | -6.86 | -69.47 ** | -80.73 ** | -80.86 ** | -37.71 ** |
| $C_6$ | 20.97 * | 20.13 | -10.33 | -21.23 ** | 9.35 ** | 0.73 | -3.43 | -32.43 ** | -15.21 ** | -20.51 ** | -17.40 ** | -13.35 ** | -26.76 ** | -42.22 ** | -72.03 ** | -8.99 |
| $C_7$ | -9.61 | -13.96 | -28.93 ** | -37.57 ** | -4.40 | -11.16 ** | -16.44 ** | -41.53 ** | -4.70 | -11.39 ** | -7.93 * | -3.42 | 23.90 ** | 10.15 ** | -31.46 ** | 123.03 ** |
| $C_8$ | 39.77 ** | 23.41 ** | 20.27 * | 5.66 | 29.21 ** | 21.08 ** | 11.84 ** | -21.75 ** | 1.66 | -3.95 | -0.20 | 4.69 | -46.66 ** | -58.67 ** | -63.60 ** | 18.44 ** |
| $C_9$ | 17.97 * | -6.95 | 20.27 * | 5.66 | 24.54 ** | 14.03 ** | 10.77 ** | -22.50 ** | -16.06 ** | -17.71 ** | -14.50 ** | -10.30 ** | 48.97 ** | 10.79 ** | 10.04 ** | 258.07 ** |
| $C_{10}$ | 80.05 ** | 70.26 ** | 40.62 ** | 23.53 ** | 30.97 ** | 29.73 ** | 24.37 ** | -12.98 ** | -0.68 | -1.56 | -10.49 ** | -6.10 | -39.61 ** | -56.23 ** | -72.77 ** | -11.38 |
| $C_{11}$ | 68.96 ** | 48.29 ** | 44.52 ** | 26.96 ** | 18.62 ** | 16.45 ** | 11.64 ** | -21.89 ** | 3.65 | 2.80 | -4.97 | -0.31 | -48.20 ** | -65.88 ** | -69.95 ** | -2.2 |
| $C_{12}$ | 32.05 ** | 3.63 | 33.94 ** | 17.67 * | 29.91 ** | 29.06 ** | 25.37 ** | -12.28 ** | -6.20 | -10.39 ** | -10.54 ** | -6.16 | 72.40 ** | 10.47 ** | 9.73 ** | 257.06 ** |
| $C_{13}$ | 16.29 | 7.42 | 4.69 | -8.03 | 38.47 ** | 37.23 ** | 29.07 ** | -9.69 ** | -11.00 ** | -12.51 ** | -19.12 ** | -15.15 ** | -66.01 ** | -71.00 ** | -74.46 ** | -16.88 * |
| $C_{14}$ | 35.16 ** | 10.76 | 43.16 ** | 25.77 ** | 22.09 ** | 20.15 ** | 16.71 ** | -18.34 ** | 7.61 * | 1.94 | 1.77 | 6.76 | -73.61 ** | -78.54 ** | -78.69 ** | -30.64 ** |
| $C_{15}$ | 43.83 ** | 26.14 ** | 63.04 ** | 43.23 ** | 38.40 ** | 35.00 ** | 31.14 ** | -8.25 ** | 5.94 | 2.02 | 1.84 | 6.83 | -52.61 ** | -55.29 ** | -55.60 ** | 44.50 ** |
| S.E.D | 0.30 | 0.35 | 0.35 | 0.35 | 0.29 | 0.34 | 0.34 | 0.34 | 0.41 | 0.48 | 0.48 | 0.48 | 0.19 | 0.22 | 0.22 | 0.22 |
| CD at 95% | 0.65 | 0.75 | 0.75 | 0.75 | 0.63 | 0.73 | 0.73 | 0.73 | 0.89 | 1.03 | 1.03 | 1.03 | 0.42 | 0.49 | 0.49 | 0.49 |
| Range | -34.55 to 80.05 | -50.55 to 70.26 | -28.93 to 63.04 | -37.43 to 43.23 | -20.86 to 38.47 | -34.72 to 37.23 | -16.44 to 31.14 | -41.53 to -8.25 | -16.06 to 7.61 | -20.51 to 2.80 | -19.12 to 1.84 | -15.15 to 6.83 | -73.61 to 72.40 | -80.73 to 10.79 | -81.14 to 10.04 | -38.62 to 258.07 |

*: Significant at 5% level; **: Significant at 1% level

**Table 6:** Pooled analysis estimates of relative heterosis, heterobeltiosis and standard heterosis for rind thickness (mm), pericarp thickness (cm), shelf life and total soluble solids

| Cross combinations | Rind thickness (mm) | | | | Pericarp thickness (cm) | | | | Shelf life | | | | Total soluble solids | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Relative heterosis | Hetero beltiosis | Standard heterosis | | Relative heterosis | Hetero beltiosis | Standard heterosis | | Relative heterosis | Hetero beltiosis | Standard heterosis | | Relative heterosis | Hetero beltiosis | Standard heterosis | |
| | | | Kundan | Papasa | | | Kundan | Papasa | | | Kundan | Papasa | | | Kundan | Papasa |
| $C_1$ | 27.24 ** | 25.05 ** | -36.50 ** | 32.50 ** | -16.23 ** | -23.20 ** | -22.95 ** | -24.79 ** | -48.21 ** | -65.34 ** | -75.58 ** | 0.24 | -15.69 ** | -28.44 ** | -27.98 ** | -4.97 |
| $C_2$ | 50.22 ** | 26.65 ** | -6.27 | 95.58 ** | -2.04 | -13.67 ** | -13.39 ** | -15.46 ** | -5.96 | -23.86 * | -81.83 ** | -25.61 ** | -0.67 | -3.67 | -32.38 ** | -10.77 ** |
| $C_3$ | 3.94 | -25.12 ** | -13.73 ** | 80.00 ** | 8.78 ** | 0.42 | 0.74 | -1.66 | -17.14 ** | -33.35 ** | -73.87 ** | 6.98 | 12.66 ** | 9.81 ** | -18.82 ** | 7.13 ** |
| $C_4$ | -45.90 ** | -65.06 ** | -39.17 ** | 26.92 ** | 2.55 | 2.22 | 2.55 | 0.10 | -70.11 ** | -81.41 ** | -81.83 ** | -25.61 ** | -21.47 ** | -33.40 ** | -32.84 ** | -11.37 ** |
| $C_5$ | -64.70 ** | -75.72 ** | -67.19 ** | -31.54 ** | -25.29 ** | -31.14 ** | -30.92 ** | -32.57 ** | -52.47 ** | -68.05 ** | -77.86 ** | -9.35 | -40.80 ** | -51.52 ** | -46.65 ** | -29.60 ** |
| $C_6$ | -0.82 | -17.56 ** | -38.99 ** | 27.31 ** | -9.09 ** | -12.96 ** | -27.21 ** | -28.94 ** | -8.02 | -44.36 ** | -60.80 ** | 60.50 ** | 8.98 ** | -9.80 ** | -9.23 ** | 19.78 ** |
| $C_7$ | -34.68 ** | -53.44 ** | -46.36 ** | 11.92 | -6.43 * | -7.13 * | -21.15 ** | -23.03 ** | -53.37 ** | -63.72 ** | -74.43 ** | 4.68 | 16.86 ** | 1.36 | 2.00 | 34.60 ** |
| $C_8$ | -59.11 ** | -73.80 ** | -54.38 ** | -4.81 | 13.28 ** | 4.16 | 3.83 | 1.35 | -69.58 ** | -73.82 ** | -74.42 ** | 4.75 | -6.58 ** | -6.68 ** | -5.89 ** | 24.19 ** |
| $C_9$ | 62.06 ** | 10.44 ** | 49.22 ** | 211.35 ** | 5.75 | 5.15 | -11.05 ** | -13.17 ** | -45.54 ** | -45.98 ** | -61.94 ** | 55.83 ** | -14.58 ** | -18.23 ** | -10.02 ** | 18.74 ** |
| $C_{10}$ | -27.03 ** | -40.08 ** | -30.97 ** | 44.04 ** | 35.48 ** | 28.79 ** | 9.35 ** | 6.74 * | -9.50 | -37.70 ** | -75.58 ** | 0.00 | -8.18 ** | -13.14 ** | -35.78 ** | -15.26 ** |
| $C_{11}$ | 19.09 ** | -15.14 ** | 47.74 ** | 208.27 ** | 29.67 ** | 14.61 ** | 14.24 ** | 11.51 ** | -44.45 ** | -68.03 ** | -68.76 ** | 27.91 ** | -17.94 ** | -32.14 ** | -31.56 ** | -9.69 ** |
| $C_{12}$ | -20.23 ** | -38.27 ** | -16.59 ** | 74.04 ** | 32.98 ** | 26.63 ** | 7.12 * | 4.56 | -41.90 ** | -64.76 ** | -75.58 ** | 0.00 | 10.92 ** | -11.31 ** | -2.4 | 28.79 ** |
| $C_{13}$ | -41.57 ** | -51.46 ** | -15.48 ** | 76.35 ** | 3.86 | -3.84 | -4.14 | -6.43 * | -69.30 ** | -78.49 ** | -78.98 ** | -13.96 | -6.79 ** | -19.23 ** | -18.54 ** | 7.49 ** |
| $C_{14}$ | -58.76 ** | -61.80 ** | -48.39 ** | 7.69 | 16.74 ** | 16.52 ** | -1.06 | -3.42 | -42.41 ** | -54.92 ** | -68.76 ** | 27.91 ** | -12.50 ** | -26.86 ** | -19.51 ** | 6.21 * |
| $C_{15}$ | -19.76 ** | -28.75 ** | 24.06 ** | 158.85 ** | 16.61 ** | 7.78 ** | 7.44 ** | 4.88 | 8.85 ** | -6.98 ** | -9.10 ** | 172.16 ** | -8.04 ** | -11.89 ** | -3.03 | 27.95 ** |
| S.E.D | 0.09 | 0.11 | 0.11 | 0.11 | 0.07 | 0.08 | 0.08 | 0.08 | 0.36 | 0.42 | 0.42 | 0.42 | 0.18 | 0.21 | 0.21 | 0.21 |
| CD at 95% | 0.20 | 0.23 | 0.23 | 0.23 | 0.15 | 0.18 | 0.18 | 0.18 | 0.78 | 0.91 | 0.91 | 0.91 | 0.40 | 0.46 | 0.46 | 0.46 |
| Range | -64.70 to 62.06 | -75.72 to 26.65 | -67.19 to 49.22 | -31.54 to 211.35 | -25.29 to 35.48 | -31.14 to 28.79 | -30.92 to 14.24 | -32.57 to 11.51 | -70.11 to 8.85 | -81.41 to -6.98 | -81.13 to -9.10 | -25.61 to 172.61 | -40.80 to 16.86 | -51.12 to 9.81 | -46.65 to 2.00 | -29.60 to 34.60 |

*: Significant at 5% level; **: Significant at 1% level

**Table 7:** Pooled analysis estimates of relative heterosis, heterobeltiosis and standard heterosis for ascorbic acid, total sugars, reducing sugars and β – carotene

| Cross combinations | Ascorbic acid (mg/100g) | | | | Total sugars (%) | | | | Reducing sugars (%) | | | | β – carotene (µg/g) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Relative heterosis | Hetero beltiosis | Standard heterosis | | Relative heterosis | Hetero beltiosis | Standard heterosis | | Relative heterosis | Hetero beltiosis | Standard heterosis | | Relative heterosis | Hetero beltiosis | Standard heterosis | |
| | | | Kundan | Papasa | | | Kundan | Papasa | | | Kundan | Papasa | | | Kundan | Papasa |
| $C_1$ | 13.60 * | -11.79 * | 36.43 ** | 44.35 ** | 9.87 ** | 4.59 ** | -16.95 ** | -8.04 ** | 5.72 | 1.37 | -20.25 ** | -6.91 | -3.53 ** | -39.69 ** | -33.95 ** | -41.57 ** |
| $C_2$ | 116.29 ** | 70.26 ** | 163.35 ** | 178.63 ** | 34.05 ** | 31.10 ** | -5.90 ** | 4.19 ** | 45.06 ** | 39.59 ** | 0.78 | 17.64 ** | -56.43 ** | -72.50 ** | -69.89 ** | -73.36 ** |
| $C_3$ | 66.86 ** | 23.28 ** | 90.68 ** | 101.74 ** | -12.02 ** | -23.32 ** | -25.94 ** | -18.00 ** | -26.97 ** | -36.71 ** | -37.69 ** | -27.27 ** | 15.60 ** | 11.94 ** | 22.58 ** | 8.45 ** |
| $C_4$ | 11.34 | -4.44 | 47.81 ** | 56.38 ** | -35.29 ** | -45.51 ** | -42.83 ** | -36.70 ** | -17.64 ** | -30.37 ** | -27.25 ** | -15.07 ** | -44.30 ** | -45.73 ** | -37.36 ** | -44.58 ** |
| $C_5$ | 59.87 ** | 30.01 ** | 101.10 ** | 112.76 ** | -29.49 ** | -40.01 ** | -38.64 ** | -32.05 ** | -29.32 ** | -40.35 ** | -37.39 ** | -26.92 ** | -49.90 ** | -50.75 ** | -44.18 ** | -50.61 ** |
| $C_6$ | 183.41 ** | 178.13 ** | 147.09 ** | 161.43 ** | -13.19 ** | -19.08 ** | -35.74 ** | -28.85 ** | -13.24 * | -19.81 ** | -36.92 ** | -26.36 ** | 44.95 ** | 41.66 ** | -59.31 ** | -64.00 ** |
| $C_7$ | 222.24 ** | 200.28 ** | 156.82 ** | 171.72 ** | -3.58 ** | -12.16 ** | -15.15 ** | -6.05 ** | 4.29 | -6.18 | -7.64 | 7.81 | -52.03 ** | -69.60 ** | -68.82 ** | -72.42 ** |
| $C_8$ | 114.01 ** | 89.59 ** | 110.11 ** | 122.30 ** | -20.96 ** | -30.57 ** | -27.15 ** | -19.34 ** | -34.84 ** | -42.89 ** | -40.33 ** | -30.34 ** | -9.46 ** | -43.98 ** | -35.34 ** | -42.80 ** |
| $C_9$ | 51.30 ** | 42.42 ** | 38.01 ** | 46.01 ** | -12.81 ** | -22.56 ** | -20.79 ** | -12.30 ** | -11.73 ** | -22.79 ** | -18.96 ** | -5.39 | 44.27 ** | -10.42 ** | 1.55 | -10.16 ** |
| $C_{10}$ | 141.32 ** | 120.99 ** | 96.33 ** | 107.72 ** | -22.77 ** | -33.95 ** | -36.21 ** | -29.36 ** | -32.51 ** | -43.38 ** | -44.26 ** | -34.93 ** | 52.81 ** | -2.20 ** | 0.32 | -11.25 ** |
| $C_{11}$ | 191.64 ** | 162.72 ** | 191.15 ** | 208.05 ** | -34.88 ** | -46.14 ** | -43.49 ** | -37.43 ** | -30.51 ** | -43.06 ** | -40.50 ** | -30.54 ** | -44.69 ** | -65.47 ** | -60.14 ** | -64.74 ** |
| $C_{12}$ | 91.04 ** | 83.10 ** | 77.42 ** | 87.71 ** | 19.70 ** | 0.00 | 2.28 * | 13.26 ** | 1.84 | -16.70 ** | -12.56 ** | 2.07 | -59.68 ** | -74.73 ** | -71.36 ** | -74.66 ** |
| $C_{13}$ | 14.41 | -4.67 | 5.65 | 11.78 | -28.36 ** | -31.20 ** | -27.82 ** | -20.08 ** | -28.17 ** | -30.25 ** | -27.12 ** | -14.92 ** | 12.90 ** | 6.63 ** | 23.06 ** | 8.87 ** |
| $C_{14}$ | 30.22 ** | 14.74 | 11.18 | 17.63 | -53.15 ** | -54.45 ** | -53.41 ** | -48.41 ** | -44.94 ** | -46.65 ** | -44.00 ** | -34.63 ** | -39.78 ** | -42.64 ** | -34.98 ** | -42.48 ** |
| $C_{15}$ | 10.15 | 3.23 | 14.4 | 21.04 * | -10.26 ** | -11.38 ** | -7.03 ** | 2.95 * | -19.77 ** | -19.95 ** | -15.98 ** | -1.92 | -10.22 ** | -11.02 ** | 2.69 ** | -9.15 ** |
| S.E.D | 1.00 | 1.15 | 1.15 | 1.15 | 0.10 | 0.11 | 0.11 | 0.11 | 0.28 | 0.33 | 0.33 | 0.33 | 0.06 | 0.07 | 0.07 | 0.07 |
| CD at 95% | 2.14 | 2.48 | 2.48 | 2.48 | 0.22 | 0.25 | 0.25 | 0.25 | 0.61 | 0.71 | 0.71 | 0.71 | 0.13 | 0.15 | 0.15 | 0.15 |
| Range | 10.15 to 222.24 | -11.79 to 200.28 | 5.65 to 156.82 | 11.78 to 208.05 | -53.15 to 34.05 | -54.45 to 31.10 | -53.41 to 2.28 | -48.81 to 13.26 | -44.94 to 45.06 | -46.65 to 39.59 | -44.00 to 0.78 | -34.63 to 17.64 | -59.68 to 52.81 | -74.73 to 41.66 | -71.36 to 23.06 | -74.66 to 8.87 |

*: Significant at 5% level; **: Significant at 1% level

**References**


1. Aravindkumar JS, Prabhakar M, Pitchaimuthu M, Gowda NCN. Heterosis and combining ability studies in muskmelon (*Cucumis melo* L.) for earliness and growth parameters. Karnataka Journal of Horticulture 2005;1(4):12-19.
2. Choudhary BR, Dhaka RS, Fageria MS. Heterosis for yield and yield related attributes in muskmelon (*Cucumis melo* L.). Indian Journal of Genetics 2003;63(1):91-92.
3. Cramer CS, Wehner TC. Little heterosis for yield and yield components in hybrids of six cucumber inbred, *Euphytica* 1999;110:99-108.
4. Feyzian E, Dehghani H, Rezai AM, Jalali-Javaran M. Diallel cross analysis for maturity and yield related traits in melon (*Cucumis melo* L.). Euphytica. 2009;168:215-223.
5. Fonsceca S, Paterson PL. Hybrid vigour in seven parental diallel cross in common winter wheat (*Triticum aestivum* L.) Crop Science. 1968;8:85-88.
6. Hayes HK, Jones DF. First generation crosses in cucumbers. Conn. Agr. Exp Stn. Ann. Rep 1916, 319-322.
7. Jagtap SV. Heterosis and combining ability in muskmelon (*Cucumis melo* L.) *Doctoral dissertation*. Mahatma Phule Krishi Vidyapeeth, Rahuri 2010.
8. Kamer K, Abou ME, Mona MY. Heterosis and heritability studies for fruit characters and yield in melon (*Cucumis melo*, L.). Middle East Journal of Applied Science 2015;5(1):262-273.
9. Moon SS, Munshi AD, Verma VK, Sureja AK. Heterosis for biochemical traits in muskmelon (*Cucumis melo* L.). Journal of Breeding and Genetics. 2006;38(1):53-57.
10. Rolania Saroj, Fageria MS. Heterosis and combining ability evaluation for yield, quality, and fruit fly resistance in muskmelon. International Journal of Current Microbiology and Applied Sciences. 2018;7(07):902-915.
11. Saha K, Choudhary H, Mishra S, Mahapatra S. Gene action of nutritional and quality traits in muskmelon (*Cucumis melo* L.). International Journal of Chemical Studies. 2018;6(3):3094-3097.
12. Shivaji Duradundi K, Gasti VD, Mulge R, Masuthi MKD. Heterosis studies in muskmelon (*Cucumis melo* L.) for growth, earliness and yield traits. International Journal of Chemical Studies 2018;6(4):3079-3086.
13. Singh Varinder, Vashisht VK. Heterosis and combining ability for yield in muskmelon (*Cucumis melo* L.). International Journal of Current Microbiology and Applied Sciences 2018;7(8):2996-3006.
14. Subramanian D. Studies on heterosis expression and association of fruit yield and yield component characters among five intervarietal crosses of vellari melon (*Cucumis melo* L) Madras Agriculture Journal 2008;95(1-6):24-31.
15. Sulochanamma BN. Heterosis in diverse musk melon (*Cucumis melo* L.) types. Journal of Research ANGRAU 2001;29(1):66-70.
16. Swarup V. Breeding procedures for Cross pollinated vegetable crops. ICAR, New Delhi 1991.
17. Tomar RS, Bhalala MK. Heterosis studies in muskmelon (*Cucumis melo* L.). Journal of Horticulture Sciences. 2006;1(2):144-147.
18. Vishwantha PD. Genetic variability and heterosis studies in muskmelon (*Cucumis melo* L.). Doctoral dissertation University of Agricultural Sciences GKVK, Dharwad) 2003.