# Heterosis studies in muskmelon (Cucumis melo L.) 

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#### Abstract

Ten parental lines and $45 \mathrm{~F}_{1}$ hybrids of muskmelon obtained from half dialleles were studied to investigate the extent of heterosis in muskmelon. Heterotic effects over the better parent were observed to be higher for number of the node on which first female flower appeared, fruits per plant, fruit weight, fruit yield per plant, moisture content and total soluble sugars in $\mathrm{E}_{2}$ than in $\mathrm{E}_{1}$. The hybrids AMM-01-18 x AMM-02-26, Hara Madhu x RM50, AMM-00-25 x AMM-00-11 and AMM-01-18 $\times$ DM-1 were found to be high-yielding and heterotic in both the seasons studied and even when averaged over the two environments, with other yield attributes and quality traits. Hence, after sufficient evaluation, these hybrids were identified as potential hybrids for widespread cultivation and commercial exploitation.


Key words : Heterosis, muskmelon, yield, quality traits, F1 hybrids

Muskmelon (Cucumis melo L., $2 \mathrm{n}=24$ ) is the most common dessert vegetable crop grown all over the world. It is highly relished because of its flavour, sweet taste and refreshing effect. It is a good source of dietary fiber, vitamins and minerals. In spite of the wide range of genetic variability available in muskmelon, very little attention has been paid to exploit heterosis. Observations showed that $F_{1}$ hybrids of muskmelon yield higher than the standard cultivars. There is, thus, a good scope for improvement of yield and other desirable traits through heterosis breeding. Therefore, the present work was conducted to study the extent of heterosis for desirable attributes.

The experiment was carried out at the Main Vegetable Research Station, Anand Agricultural University, Anand, during 2003-04. Ten varieties of muskmelon, viz., Punjab Sunehri, Pusa Madhuras, AMM- 00-25, AMM- 0011, AMM- 01-18, DM-1, AMM- 02-26, PMM- 96-20, Hara Madhu and RM-50 were crossed in all possible combinations, excluding reciprocals. The resulting $45 \mathrm{~F}_{1}$ hybrids along with their parents were grown in randomized block design with three replications at a spacing of 150 cm (row to row) and 90 cm (plant to plant) in plots of $6 \times 4.5 \mathrm{~m}$ size in two environments created by sowing dates $\left(\mathrm{E}_{1}=15^{\text {th }}\right.$ October, 2003 and $E_{2}=15^{\text {th }}$ February, 2004). All the recommended cultural practices were followed during experimentation. Observations were recorded on 10 selected
plants from each plot on the positional number of the node on which the first female flower appeared, days to opening of the first female flower, number of primary branches per plant, days to first harvest, fruit length (cm), fruit girth (cm), fruits per plant, fruit weight (g), fruit yield per plant (kg), flesh thickness (cm), moisture content (\%), total soluble solids (TSS in \%), acidity (\%) and total soluble sugars (mg $\left.\mathrm{g}^{-1}\right)$. Heterosis was calculated in the favourable direction over the better parent and over the best parental line/s for each character.

In the present investigation, parents and hybrids were found to show significant differences for all the traits studied except for the number of the node on which first female flower appeared and days to first female flower opening in both the environments, number of primary branches/plant and flesh thickness in $\mathrm{E}_{2}$ and fruit weight and moisture content in $\mathrm{E}_{1}$ indicating the existence of a considerable heterosis for these traits. The extent of heterosis observed was variable for other traits in different seasons, probably due to the presence of significant genotype $x$ environment interaction as indicated by the significant and high value of its variance except for the number of primary branches per plant, acidity and total soluble sugars.

Heterotic effects over mid-parent in desirable direction were, in general observed to be marginally higher

Table 1. Number of hybrids with significant heterosis in the desirable direction for different traits in muskmelon

| Character | Heterosis over mid-parent |  |  | Heterosis over better parent |  |  |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\mathrm{E}_{1}$ | $\mathrm{E}_{2}$ | P | $\mathrm{E}_{1}$ | $\mathrm{E}_{2}$ | P |
| Number of the node on which first female flower appeared | 13 | 18 | 16 | 15 | 19 | 17 |
| Days to first open female flower | 19 | 17 | 15 | 24 | 17 | 18 |
| Number of primary branches per plant | 34 | 15 | 20 | 17 | 25 | 12 |
| 17 |  |  |  |  |  |  |
| Days to first harvest | 36 | 10 | 32 | 30 | 13 | 28 |
| Fruit length (cm) | 26 | 32 | 35 | 28 | 24 | 32 |
| Fruit girth (cm) | 24 | 26 | 29 | 26 | 20 | 29 |
| Number of fruits per plant | 24 | 37 | 28 | 26 | 34 | 30 |
| Fruit weight (g) | 14 | 30 | 28 | 15 | 31 | 28 |
| Fruit yield per plant (kg) | 22 | 36 | 37 | 24 | 35 | 38 |
| Flesh thickness (cm) | 20 | 21 | 21 | 19 | 18 | 20 |
| Moisture content | 13 | 27 | 18 | 20 | 26 | 26 |
| Total soluble solids (\%) | 37 | 29 | 38 | 37 | 35 | 39 |
| Acidity (\%) | 35 | 31 | 35 | 36 | 32 | 36 |
| Total soluble sugars (\%) | 29 | 30 | 30 | 31 | 32 | 33 |

$\mathrm{E}_{1}=15^{\text {th }}$ October, $\mathrm{E}_{2}=15^{\text {th }}$ February, $\mathrm{P}=$ Pooled
during $\mathrm{E}_{1}$ compared to $\mathrm{E}_{2}$ for all traits except fruit length, fruit girth and acidity. Similarly, heterotic effects over the better parent were observed to be higher for number of the node on which first female flower appeared, days to first female flower opening, number of primary branches/plant, days to first harvest, number of fruits/plant, fruit weight, fruit yield/plant, flesh thickness, moisture content, total soluble solids, and total soluble sugars during $\mathrm{E}_{1}$ compared to $\mathrm{E}_{2}$.

Relative heterosis for fruit yield/plant was observed to extent of 207.39 and $194.65 \%$ during $\mathrm{E}_{1}$ and $\mathrm{E}_{2}$, respectively. Similar high levels of relative heterosis for fruit yield/plant is reported earlier by several workers (Chadha and Nandpuri, 1977; Randhawa and Singh, 1990; Singh and Randhawa, 1990). Heterobeltiosis effects for fruit yield/plant were $322.55 \%$ in $\mathrm{E}_{1}$ and $190.89 \%$ in $\mathrm{E}_{2}$. Appreciable levels of heterobeltiosis for fruit yield/plant were also reported earlier by Pandey and Kalloo (1976), Nandpuri et al, (1974), Chadha and Nandpuri (1977), Kalb and Davis (1984), Randhawa and Singh (1990), Singh and Randhawa (1990), Munshi and Verma (1997) and Chaudhary et al (2003).

A perusal of table 1 reveals that heterosis over midparent was the highest for total soluble solids followed by fruit yield/plant, fruit length and acidity, while, the maximum number of hybrids showing heterobeltiosis was observed for total soluble solids, followed by fruit yield/ plant and total soluble sugars. For yield/plant, 22 hybrids in $E_{1}, 36$ in $E_{2}$ and 37 on pooled basis displayed significant heterosis over the mid-parent. For heterobeltiosis, twentyfour, thirtyfive and thirtyeight hybrids registered significant heterosis in $\mathrm{E}_{1}, \mathrm{E}_{2}$ and on pooled basis,
respectively. Out of these, five hybrids, namely, Hara Madhu x RM-50, AMM-01-18 x AMM-02-26, AMM-00-25 x AMM-00-11, AMM-01-18 x DM-1 and AMM-02-26 x RM50 showed significant heterobeltiosis on pooled basis.

Data on yield contributing traits of the five most heterotic crosses for fruit yield/plant in each environment and on pooled basis is presented in table 2. None of the hybrids exhibited significant and positive heterosis over the mid-parent as well as over better parent in both the environments and even when pooled over the two environments, indicating non-consistency of hybrids across the environments. On the basis of pooled data, out of the five most heterotic hybrids for fruit yield/plant, four hybrids viz., Hara Madhu x RM-50, AMM-01-18 x AMM-02-26, AMM-00-25 x AMM-00-11 and AMM-01-18 x DM-1 showed heterosis for number of fruits/plant, fruit weight, total soluble solids, acidity and total soluble sugars over the mid-parent and the better parent. In addition, significant relative heterosis and heterobeltiosis for flesh thickness was seen in the hybrid Hara Madhu x RM-50; for number of the node on which first female flower appeared, number of primary branches, days to first harvesti, fruit length and fruit girth in the hybrid AMM-01-18 x AMM-02-26; for fruit length, fruit girth and flesh thickness in AMM-00-25 x AMM-00-11; for days to first female flower opening, number of primary branches, fruit length, fruit girth and moisture content in AMM-01-18 x DM-1.

Hybrids showing heterosis for fruit yield/plant also showed heterosis for the number of fruits/plant and fruit weight. Thus, total fruit yield could be a result of combinational heterosis. These results are similar to those

Table 2. Manifestation of relative heterosis (\%) and heterobeltiosis (\%) for different characters of the five most heterotic crosses for fruit yield per plant in individual environment and on pooled basis in muskmelon


Table 2 (continued)

| HETEROBELTIOSIS |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Hara Madhu x RM-50 | $\mathrm{E}_{1}$ | 9.33 |  | 280.52 | ** | 0.19 |  | -0.08 |  | 7.69 | -12.59 | ** | 29.36 | ** |
|  | $\mathrm{E}_{2}$ | 39.24 | ** | 23.40 | ** | -32.96 | ** | -0.77 | ** | 37.93 ** | -16.45 | ** | 14.47 | ** |
|  | P | 25.93 | ** | 97.32 | ** | -20.76 | ** | -0.43 |  | 23.38 ** | -14.11 | ** | 19.38 | ** |
| AMM-01-18 x AMM-02-26 | $\mathrm{E}_{1}$ | 47.26 | ** | -12.21 | ** | -0.81 |  | -1.68 | * | 151.43 ** | -20.44 | ** | 36.65 | ** |
|  | $\mathrm{E}_{2}$ | 35.20 | ** | 116.53 | ** | -11.59 | ** | 0.53 | ** | 50.68 ** | -26.86 | ** | 16.55 | ** |
|  | P | 40.99 | ** | 69.43 | ** | -7.62 | ** | -0.54 |  | 91.64 ** | -22.87 | ** | 23.36 | ** |
| AMM-00-25 x AMM-00-11 | $\mathrm{E}_{1}$ | 18.07 | * | 43.38 | ** | 52.88 | * | 2.67 | ** | 134.38 ** | -25.49 | * | 36.49 | ** |
|  | $\mathrm{E}_{2}$ | 66.63 | ** | 41.40 | ** | 14.50 | * | 3.23 | ** | 1.66 | -24.09 | ** | 18.19 | * |
|  | P | 34.24 | ** | 41.99 | ** | 31.49 | * | 2.96 | * | 50.99 ** | -24.93 | ** | 24.28 | ** |
| AMM-01-18 x DM-1 | $\mathrm{E}_{1}$ | 171.29 | ** | -3.56 |  | -23.90 |  | -1.02 |  | 0.00 | -41.78 | ** | 98.52 | ** |
|  | $\mathrm{E}_{2}$ | 37.76 | ** | 32.60 | ** | 4.37 | * | -1.68 | ** | 137.82 ** | -69.16 | ** | 67.89 | ** |
|  | P | 81.50 | ** | 20.98 | ** | -8.88 | * | -1.36 | * | 55.31 ** | -52.76 | ** | 77.57 |  |
| AMM-02-26 x RM-50 | $\mathrm{E}_{1}$ | 30.83 |  | 48.47 | ** | 4.07 |  | -0.57 |  | 105.13 ** | -6.47 | ** | -1.40 |  |
|  | $\mathrm{E}_{2}$ | 19.13 | ** | 43.12 | ** | -8.01 | ** | -2.28 | ** | 62.74 ** | -4.02 |  | -5.37 |  |
|  | P | 24.44 | ** | 44.66 | ** | -3.57 |  | -1.45 | ** | 83.13 ** | -5.51 | ** | -4.06 |  |

$\mathrm{E}_{1}=15^{\text {th }}$ October, $\mathrm{E}_{2}=15^{\text {th }}$ February, $\mathrm{P}=$ Pooled
reported by Nandpuri et al (1974), Altaf et al (1979), Randhawa and Singh (1990), Munshi and Verma (1998) and Chaudhary et al (2003).

However, it was seen that not all the yield contributing traits contributed equally to heterosis for fruit yield/plant. This was because the component characters competed for the sum total of metabolic substances produced by the plant and conditions which favoured development of one component may have adversely affected the other component. Therefore, to obtain maximum yield in a selection programme, desired levels of each component need to be known.

The hybrids AMM-01-18 x AMM-02-26, Hara Madhu x RM-50, AMM-00-25 x AMM-00-11 and AMM-$01-18 \times$ DM-1 were found to be high-yielding and heterotic in both the seasons and even when averaged over the environments with other yield attributes and quality traits. Hence, after sufficient evaluation, these hybrids were identified as potential hybrids for widespread cultivation and commercial exploitation.

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(MS Received 20 May 2006, Revised 30 September 2006)

