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Short communication

Heterosis studies in muskmelon (*Cucumis melo* L.)

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ABSTRACT

Ten parental lines and 45 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 E_2 than in E_1. 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 x 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., 2n = 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- 00-11, 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 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 x 4.5 m size in two environments created by sowing dates (E_1 = 15th October, 2003 and E_2 = 15th 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 g^{-1}). 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 E_2 and fruit weight and moisture content in 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		
	E_1	E_2	P	E_1	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	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

E_1 = 15th October, E_2 = 15th February, P = Pooled

during E_1 compared to 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 E_1 compared to E_2.

Relative heterosis for fruit yield/plant was observed to extent of 207.39 and 194.65% during E_1 and 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 E_1 and 190.89% in 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 mid-parent 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 E_1, 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 RM-50 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

Cross		Fruit yield / plant	Number of the node on which first female flower appeared	Days to first open female flower	Number of primary branches/ plant	Days to first harvest	Fruit length	Fruit girth
RELATIVE HETEROSIS								
AMM-01-18 x AMM-02-26	E_1	38.79 **	-8.93 **	-4.51 **	27.71 **	-7.49 **	9.65 **	6.02 **
	E_2	194.65 **	-55.79 **	9.31 **	11.76 **	1.58 **	18.20 **	27.36 **
	P	140.81 **	-40.68 **	3.91 **	18.97 **	-2.72 **	14.31 **	18.38 **
AMM-00-25 x AMM-00-11	E_1	100.41 **	13.33 **	6.95 **	20.70 **	-1.99	13.95 **	18.78 **
	E_2	119.79 **	7.63 **	-1.79 *	2.81	0.59	19.89 **	6.73 **
	P	112.05 **	9.43 **	1.48 **	11.04 **	-0.62	17.34 **	11.60 **
Hara Madhu x RM-50	E_1	207.39 **	-23.08 **	3.96 **	-2.36	4.76 **	3.02	1.48
	E_2	60.98 **	-7.26 **	-0.60	-18.23	-3.62 **	-4.63 *	-3.77 *
	P	104.20 **	-12.92 **	1.21	-11.16 **	0.22	-1.42	-1.43
AMM-01-18 x DM-1	E_1	96.00 **	-7.69 *	-9.11 **	35.23 **	-13.33	9.44 **	-0.55
	E_2	106.96 **	-32.85 **	3.63 **	23.87 **	0.49	22.35 **	31.93 **
	P	104.20 **	-23.91 **	-1.30 *	29.14 **	-6.17 **	16.37 **	17.45 **
AMM-00-25 x AMM-01-18	E_1	31.41 *	10.00 **	0.15	32.92 **	-10.04 **	-0.97	11.17 **
	E_2	97.86 **	-11.49 **	0.84	25.56 **	-1.42 **	20.38 **	24.52 **
	P	75.80 **	-4.52 *	0.58	29.02 **	-5.47 **	10.34 **	18.85 **
HETEROBELTIOSIS								
Hara Madhu x RM-50	E_1	322.55 **	8.11	8.77 **	-1.64	0.00	4.98 *	0.86
	E_2	70.79 **	-11.28	-1.82 **	-17.74 **	-4.01 **	-6.34 **	-6.90 **
	P	132.28 **	-5.95 *	2.24 **	-10.57 **	-2.13 **	-1.69	-3.58 **
AMM-01-18 x AMM-02-26	E_1	25.75 **	-1.92	-3.64 **	37.54 **	-6.90 **	19.85 **	9.99 **
	E_2	190.89 **	-44.68 **	12.89 **	18.75 **	2.08 **	9.56 **	19.45 **
	P	130.61 **	-29.45 **	6.33 **	27.17 **	-2.17 **	13.82 **	15.70 **
AMM-00-25 x AMM-00-11	E_1	72.28 **	2.00	1.25	-0.86	-3.48 **	20.90 **	19.88 **
	E_2	132.11 **	-17.93 **	-0.25	-22.89 **	0.43	18.33 **	7.02 **
	P	105.52 **	-12.33 **	0.33	-13.25 **	-1.41 **	19.39 **	12.20 **
AMM-01-18 x DM-1	E_1	154.43 **	-5.26	-10.19 **	59.82 **	-15.10 **	12.33	-8.72 **
	E_2	82.44 **	0.28	2.79 **	54.83 **	1.26 **	11.38 **	21.12 **
	P	95.88 **	-2.19	-2.24 **	57.22 **	-6.73 **	11.80 **	7.81 **
AMM-02-26 x RM-50	E_1	101.26 **	78.38 **	8.58 **	31.97 **	-9.96 **	-1.71	1.47
	E_2	71.02 **	-4.72	2.94 **	5.96	-0.65	38.84 **	7.42 **
	P	78.39 **	18.14 **	5.10 **	17.54 **	-5.02 **	22.08 **	5.07 **

Cross		Number of fruits/ plant	Fruit weight	Flesh thickness	Moisture content	Total soluble solids	Acidity	Total soluble sugars
RELATIVE HETEROSIS								
AMM-01-18 x AMM-02-26	E_1	64.84 **	-13.41 **	-4.86	-1.15 **	117.28 **	-23.46 **	58.48 **
	E_2	39.09 **	112.81 **	2.77	0.87 **	46.86 **	-33.40 **	25.41 **
	P	51.06 **	66.74 **	-0.39	-0.11	77.55 **	-27.35 **	36.07 **
AMM-00-25 x AMM-00-11	E_1	51.79 **	23.90 **	76.67	3.24 **	134.38 **	-18.75 **	26.74 **
	E_2	57.34 **	40.35 **	11.08 **	3.04 **	-0.09	-15.13 **	8.96 **
	P	54.02 **	35.02 **	37.31 **	3.14 **	49.34 **	-17.34 **	14.84 **
Hara Madhu x RM-50	E_1	-4.79	219.92 **	2.78	-0.19	7.69	-12.78 **	34.19 **
	E_2	31.82 **	22.37 **	-31.57 **	-0.70 **	29.58 **	-17.92 **	16.53 **
	P	14.65 **	86.08 **	-18.96 **	-0.45 *	19.39 **	-14.82 **	22.29 **
AMM-01-18 x DM-1	E_1	135.27 **	-11.55 **	-13.37	-0.86 **	19.30 **	-43.15 **	110.41 **
	E_2	54.21 **	34.19 **	18.61 **	-1.88 **	118.24 **	-70.05 **	72.40 **
	P	85.43 **	18.49 **	3.64	-1.38 **	65.37 **	-53.97 **	84.16 **
AMM-00-25 x AMM-01-18	E_1	72.91 **	-24.49 **	22.19 **	-0.13	100.51 **	-4.31 **	6.62
	E_2	43.23 **	38.46 **	5.31 *	0.59 **	26.38 **	-7.61 **	-1.42
	P	57.26 **	15.94 **	12.26 **	0.24	57.18 **	-5.61 **	1.14

Table 2 (continued)

HETEROBELTIOSIS								
Hara Madhu x RM-50	E_1	9.33	280.52**	0.19	-0.08	7.69	-12.59**	29.36**
	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	E_1	47.26**	-12.21**	-0.81	-1.68**	151.43**	-20.44**	36.65**
	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	E_1	18.07*	43.38**	52.88**	2.67**	134.38**	-25.49**	36.49**
	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	E_1	171.29**	-3.56	-23.90	-1.02*	0.00	-41.78**	98.52**
	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	E_1	30.83*	48.47**	4.07	-0.57	105.13**	-6.47**	-1.40
	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

E_1 = 15th October, E_2 = 15th February, 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 x 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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