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Estimation of heterosis for growth, earliness and yield parameters in muskmelon (*Cucumis melo* L.)

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Abstract
Muskmelon (*Cucumis melo* L.) is one of the most important cucurbitaceous vegetables grown as desert crop. As the area under muskmelon cultivation is less and less number of improved varieties are available, there is a need to develop hybrids in muskmelon. The present investigation was carried out with the objective to assess the magnitude and direction of heterosis for growth, earliness and yield parameters during *late kharif* 2021 and *early summer* 2022. A total of 15 hybrids were developed by crossing six lines of muskmelon. Hybrids were developed using hand emasculation and hand pollination technique and the developed hybrids were evaluated using RBD design with two replications. The results showed that, the maximum heterosis over mid parent, better parent, and the commercial checks was observed in the cross VRMM-310×VRMM-7 for number of branches per vine. The hybrids VRMM-35×VRMM-7, VRMM-310×VRMM-29, VRMM-37×VRMM-7, VRMM-310×VRMM-37 were found promising for earliness. The cross VRMM-310×VRMM-37 showed significant heterosis over the commercial check in order of merit for fruit yield per vine.

Keywords: Muskmelon, RBD, heterosis, earliness, fruit yield per vine

Introduction

Muskmelon (*Cucumis melo* L.) is an important vegetable crop grown in India. Muskmelon has many vernacular names, such as Kharbooza (Hindi), Kharbuz (Punjabi), Sakkartoti (Gujarati), Kaling (Sanskrit), Velampalam (Tamil) and Kakkarikka (Kannada). Most of the researchers believed that melon was domesticated in Tropical Africa because several related wild species had been observed in that region (Kerje and Grum 2000) [5], but later data suggested that this species might have originated in Asia. It is used as dessert fruit and fruit juice has cooling effect. It is supposed to be very wholesome and nutritive as it is a rich source of carbohydrates, sugar, mineral salts, vitamin A and B. The fruit juice is nutritive and acts as demulcent and diuretic drink. Round netted fruits with thick orange flesh and tough rind suitable for long transportation are preferred by the growers and salesmen. Early harvest in muskmelon is of great importance, as market prices for such a crop ensure great returns to the farmers. Thus, heterosis breeding can be an effective strategy for combining all possible desirable characters in melon cultivars.

Material and Methods

The investigation on "Estimation of heterosis for growth, earliness and yield parameters in muskmelon (*Cucumis melo* L)" was conducted at Dr. Y.S.R. Horticultural college, Venkataramannagudem during the period from 2021-2022. The present study was carried out broadly under two experiments.

1. Generation of breeding material

Seeds of parental lines were sown in polyhouse during October 2021 for development of F_1 hybrids in partial diallel fashion without reciprocals. A total of 15 hybrids were developed by crossing six parental lines. Flower buds of male and female parents were selected on the previous evening prior to the day of their opening and selected buds were covered with butter paper bags to avoid out-crossing and contamination. Pollination was carried out on the next day morning between 5.30 am and 8.00 am by using pollen of desired male parents. After pollination, the female flower buds were again covered with butter paper bags to avoid contamination and tagged them with the details of cross and date of pollination. Simultaneously, the male and female parents were selfed and bagged with butter paper bags.

2. Evaluation of F_1 hybrids and estimation of heterosis

The resultant hybrids along with parents were evaluated during summer season of 2022 in Randomized Block Design with two replications. The data were recorded on five randomly selected vines from each replication for the characters number of branches per vine, days to male flower appearance, days to female flower appearance, number of male flowers per vine, number of female flowers per vine, sex ratio, weight of fruits (g), yield of fruits per vine (kg).

Heterosis was calculated as the percentage increase or decrease of mean F_1 performance (F_1) over the means of the mid parent (MP), better parent (BP) and the Standard check (SC) following formulae given by Jinks and Jones (1958) [4].

Results and Discussion

The mainobjective of present study was to assess hybrids performances for a number of important productivity traits. The results of mid parent better parent and standard heterosis for various productivity traits were presented in Tables. The growth traits namely number of branches per vine, days for first male flower appearance, days for first female flower appearance, number of male flowers per vine, number of female flowers per vine and sex ratio has greater advantage for increasing the yield of hybrid Out of 15 crosses, five F_1 hybrids over mid parent, six hybrids over better parent, eight F_1 hybrids over Arka Siri,12 F_1 hybrids over the Check Shabrathi exhibited positive and significant heterosis for number of branches. The cross VRMM-310×VRMM-7 showed the highest heterosis over mid parent, better parent and standard checks. Heterosis over better parent, the best parent and the commercial check was also reported by Shivaji *et al.* (2018) [9] in muskmelon.

Earliness indicated by negative estimates of heterosis is well recognized and prime objective of any hybrid breeding programme. Days to first male and female flowering are the indicating traits for early yield. For all these characters, significant variability was observed among the genotypes and significant negative heterosis was observed to be desirable.

For days to male flower appearance, one hybrid over mid parent, one hybrid over better parent, four hybrids over Arka Siri and three hybrids over shabrathi exhibited negative and significant heterosis. The cross VRMM-35×VRMM-7 showed the highest negative heterosis over mid parent, better parent and standard checks. Similar results are obtained by Omprasad *et al*. (2021) [8] in muskmelon and Doloi *et al.* (2018) [2], Khot *et al.* (2018) [6] in bottlegourd for days to female flower appearance, three hybrids over better parent, three F_1 hybrids over Arka Siri and three F_1 hybrids over the check shabrathi showed negative and significant heterosis. The cross VRMM-35×VRMM-7 showed the highest negative heterosis over mid parent, better parent and VRMM-7×VRMM-29 over checks Arka Siri and shabrathi. Similar results are obtained in for Omprasad *et al*. (2021) [8] in muskmelon.

For number of male flowers per vine, one hybrid over mid parent, one hybrid over better parent, one hybrid over Arka Siri and one hybrid over shabrathi exhibited negative and significant heterosis. The cross VRMM-310×VRMM-29 showed the highest negative heterosis over mid parent, better parent and standard checks. These results are similar with Mohsin *et al*. (2022) [7] in pumpkin.

For number of female flowers per vine, four hybrids over mid parent, two hybrids over better parent, two hybrids over Arka Siri, six hybrids over check shabrathi exhibited positive and significant heterosis. The hybrid VRMM-37×VRMM-29 showed highest heterosis over mid, better parent and the hybrid VRMM-37×VRMM-27 over commercial checks. These results are similar with Mohsin *et al.* (2022) [7] in pumpkin sex ratio is another important parameter which indicates the required male to female flower for successful fruit set. The lower ratio of male to female flowers during peak flowering stage enhance the number of female flowers that results in more fruits per vine (Thangamani *et al*. 2011) [11]. Two hybrids over mid parent, four hybrids over better parent three hybrids over Arka Siri and five hybrids over check shabrathi exhibited exhibited negative and significant heterosis. The hybrid VRMM-29×VRMM-14 showed highest negative heterosis over mid parent and the hybrid VRMM-310×VRMM-37 showed highest negative heterosis over better parent and commercial checks. Similar results are obtained for Thangamani *et al.* (2013) [13], Bhatt *et al.* (2017) [1] in bitter gourd.

For weight of fruit, positive heterosis is desirable. Increase in weight of fruit increases the overall yield. Out of 15 F_1 hybrids, three hybrids over mid parent and two hybrids over better parent showed positive and significant heterosis. The hybrid VRMM-35×VRMM-7 exhibited highest positive heterosis over midparent and better parent. Similar results were obtained by Singh and Vashisht (2018) [10] in muskmelon.

Fruit yield per vine is the most important trait in present study. It revealed that the heterosis should be positive for this trait. Among all hybrids, five hybrids over mid parent, three hybrids over better parent two hybrids over Arka Siri and two hybrids over Check Shabrathi exhibited exhibited positive and significant heterosis.

Similar results were obtained for Omprasad *et al*. (2021) [8] in muskmelon and Gograj *et al.* (2015) [3] in cucumber.

Table 1: Estimation of average heterosis, better parent heterosis and standard heterosis for number of branches per vine and days to first male flower appearance

Sl. No	Cross	Number of branches per vine				Days to first male flower appearance			
		Average heterosis	Better parent Heterosis	Standard heterosis		Average heterosis	Better parent Heterosis	Standard heterosis	
				Arka Siri	Check shabrathi			Arka Siri	Check shabrathi
1.	VRMM-35 × VRMM-310	23.75 **	8.79	15.12*	41.43 **	0.23	-0.47	-1.38	-0.47
2.	VRMM-35 × VRMM-37	25.00 **	14.46*	10.47**	35.71 **	1.18	-0.47	-1.38	-0.47
3.	VRMM-35 × VRMM-7	21.92 *	15.58*	3.49	27.14 *	-6.94 **	-7.37 *	-7.37 *	-6.51*
4.	VRMM-35 × VRMM-29	14.29	3.53	2.33	25.71 *	-0.47	-1.86	-2.76	-1.86*
5.	VRMM-35 × VRMM-14	8.97	-2.30	-1.16	21.43	-3.76	-4.65	-5.53	-4.65
6.	VRMM-310×VRMM-37	1.15 *	-3.30	2.33	25.71 *	0.48	-0.47	-2.76	-1.86
7.	VRMM-310×VRMM-7	26.19 **	16.48 **	23.26 *	51.43 **	-4.43	-5.53	-5.53	-4.65
8.	VRMM-310×VRMM-29	2.27	-1.10*	4.65	28.57 *	-0.24	-0.94	-3.23*	-2.33

9.	VRMM-310×VRMM-14	0.00	-2.20	3.49**	27.14 *	4.96*	4.72*	2.30*	3.26*
10.	VRMM-37×VRMM-7	11.25	7.23*	3.49*	27.14 *	2.59*	0.46	0.46*	1.40
11.	VRMM-37×VRMM-29	8.33	7.06**	5.81*	30.00 **	-3.12	-3.35	-6.91 *	-6.05 *
12.	VRMM-37×VRMM-14	-9.41*	-11.49*	-10.47*	10.00	-0.24	-0.95	-3.69	-2.79
13.	VRMM-7×VRMM-29	11.11	5.88	4.65*	28.57 *	0.47	-1.38	-1.38	-0.47
14.	VRMM-7 × VRMM-14	2.44	-3.45	-2.33	20.00	0.00	-1.38	-1.38	-0.47
15.	VRMM-29×VRMM-14	11.63	10.34**	11.63*	37.14 **	1.43	0.95*	-1.84*	-0.93
	SE (d)	0.619	0.715	0.715	0.715	1.53	0.57	0.57	0.57
	CD at 5%	1.32	1.53	1.53	1.53	1.06	1.23	1.23	1.23

Table 2: Estimation of average heterosis, better parent heterosis and standard heterosis for days to first female flower appearance and number of male flowers per vine

Sl. No	Cross	Days to first female flower appearance				Number of male flowers per vine			
		Average heterosis	Better parent Heterosis	Standard heterosis		Average heterosis	Better parent Heterosis	Standard heterosis	
				Arka Siri	Check shabrathi			Arka Siri	Check shabrathi
1.	VRMM-35 × VRMM-310	-2.13	-3.02	-0.93	-2.43	-4.63	-8.04	-4.63	-4.19
2.	VRMM-35 × VRMM-37	-5.50 **	-6.65 **	-4.63 *	-6.08 **	12.69 *	12.44*	17.13 *	17.67 *
3.	VRMM-35 × VRMM-7	3.42	0.60	2.78	1.22	-5.38	-5.80	-2.31	-1.86
4.	VRMM-35 × VRMM-29	-1.82	-2.27	-0.15	-1.67	2.05	-0.22	3.47	3.95
5.	VRMM-35 × VRMM-14	0.00	-3.02	-0.93	-2.43	3.42	1.34	5.09	5.58
6.	VRMM-310×VRMM-37	0.00	-0.31	0.00	-1.52	1.62	-2.22	1.85	2.33
7.	VRMM-310×VRMM-7	-2.82	-4.62 *	-4.32 *	-5.78 **	-2.33	-5.41	-2.78	-2.33
8.	VRMM-310×VRMM-29	-2.60	-3.05	-1.85	-3.34	-13.27 *	-14.49 *	-15.28 *	-14.88 *
9.	VRMM-310×VRMM-14	0.94	-1.23	-0.93	-2.43	13.95 *	12.09	11.57	12.09
10.	VRMM-37×VRMM-7	2.20	0.62	0.31	-1.22	-4.70	-5.33	-1.39	-0.93
11.	VRMM-37×VRMM-29	-2.61	-3.35	-2.16	-3.65	6.15	3.56	7.87	8.37
12.	VRMM-37×VRMM-14	-0.32	-2.17	-2.47	-3.95	-2.73	-4.89	-0.93	-0.47
13.	VRMM-7×VRMM-29	-4.21 *	-6.40 **	-5.25 *	-6.69 **	12.39 *	10.36*	13.43*	13.95*
14.	VRMM-7 × VRMM-14	1.28	0.96	-2.47	-3.95	-2.97	-4.50	-1.85	-1.40
15.	VRMM-29×VRMM-14	3.60	0.91	2.16	0.61	-11.89	-12.09	-12.50	-12.09
	SE (d)	0.55	0.63	0.63	0.63	1.247	1.44	1.44	1.44
	CD at 5%	1.18	1.37	1.37	1.37	2.67	3.08	3.08	3.08

Table 3: Estimation of average heterosis, better parent heterosis and standard heterosis for number of female flowers per vine and sex ratio

Sl. No	Cross	Number of female flowers per vine				Sex ratio			
		Average heterosis	Better parent Heterosis	Standard heterosis		Average heterosis	Better parent Heterosis	Standard heterosis	
				Arka Siri	Check shabrathi			Arka Siri	Check shabrathi
1.	VRMM-35 × VRMM-310	11.86*	8.20*	4.76	13.79*	-7.05	-12.92 **	-6.55	-9.85 *
2.	VRMM-35 × VRMM-37	0.00	-1.59	-1.59	6.90	-5.25	-7.25	-0.46	-3.98
3.	VRMM-35 × VRMM-7	0.76	-5.71	4.76	13.79*	-12.24 **	-16.28 **	-10.15 *	-13.33 **
4.	VRMM-35 × VRMM-29	2.82	1.19	1.19	9.91*	-0.50	-9.08 *	-2.42	-5.87
5.	VRMM-35 × VRMM-14	6.25	1.49	7.94	17.24	4.27	0.24	7.58	3.78
6.	VRMM-310×VRMM-37	15.00**	9.52	9.52	18.97	-19.12 **	-22.67 **	-20.52 **	-23.32 **
7.	VRMM-310×VRMM-7	-5.51*	-14.29*	-4.76	3.45	1.59	-0.32	-2.89	-6.32
8.	VRMM-310×VRMM-29	11.67	6.35	6.35	15.52*	-5.53	-8.03	-13.76 **	-16.81 **
9.	VRMM-310×VRMM-14	3.23	-4.48	1.59	10.34	7.65	4.79	3.76	0.10
10.	VRMM-37×VRMM-7	12.78*	7.14	19.05*	29.31 **	-1.13	-3.71	-1.03	-4.53
11.	VRMM-37×VRMM-29	15.87**	15.87*	15.87*	25.86*	6.48	-0.75	2.01	-1.59
12.	VRMM-37×VRMM-14	-12.31*	-14.93*	-9.52*	-1.72*	7.69	5.72	8.66	4.82
13.	VRMM-7×VRMM-29	0.75	-4.29	6.35	15.52	1.47	-3.02	-5.52	-8.85 *
14.	VRMM-7 × VRMM-14	-9.49*	-11.43	-1.59	6.90	-1.50	-2.29	-3.25	-6.66
15.	VRMM-29×VRMM-14	-6.15	-8.96	-3.17	5.17	21.79 **	15.51 **	14.38 **	10.34 *
	SE (d)	0.64	0.73	0.73	0.73	0.35	0.40	0.40	0.40
	CD at 5%	1.37	1.58	1.58	1.58	0.75	0.87	0.87	0.87

Table 4: Estimation of average heterosis, better parent heterosis and standard heterosis for weight of fruit (g) and fruit yield per vine (kg)

Sl. No	Cross	Weight of fruit (g)				Fruit yield per vine (kg)			
		Average heterosis	Better parent Heterosis	Standard heterosis		Average heterosis	Better parent Heterosis	Standard heterosis	
				Arka Siri	Check shabrathi			Arka Siri	Check shabrathi
1.	VRMM-35 × VRMM-310	-7.62	-24.69	-22.45	-23.90	14.69	-14.58	-5.53	-5.53
2.	VRMM-35 × VRMM-37	-11.23	-29.18 *	-22.82	-24.26	20.86	-8.70	-3.23	-3.23
3.	VRMM-35 × VRMM-7	60.70 **	53.85 *	9.18	7.15	101.46 **	76.11 *	27.42	27.42
4.	VRMM-35 × VRMM-29	20.01	14.05	-17.79	-19.33	124.39 **	81.58 **	58.99 **	58.99 **
5.	VRMM-35 × VRMM-14	-3.87	-8.68	-34.13 *	-35.36 *	48.87	33.33	-8.76	-8.76
6.	VRMM-310×VRMM-37	6.79	3.85	13.16	11.05	59.15 **	55.83 **	72.35 **	72.35 **
7.	VRMM-310×VRMM-7	29.57 *	9.43	12.69	10.58	44.08 *	19.17	31.80	31.80
8.	VRMM-310×VRMM-29	4.55	-11.13	-8.49	-10.20	27.21	13.96	26.04	26.04
9.	VRMM-310×VRMM-14	-9.49	-23.04	-20.75	-22.23	9.65	-11.25	-1.84	-1.84
10.	VRMM-37×VRMM-7	-13.39	-28.49 *	-22.08	-23.53	13.18	-4.78	0.92	0.92
11.	VRMM-37×VRMM-29	-21.84	-35.07 *	-29.25 *	-30.57 *	-27.62	-33.91	-29.95	-29.95
12.	VRMM-37×VRMM-14	11.02	-7.74	0.53	-1.34	24.97	2.83	8.99	8.99
13.	VRMM-7×VRMM-29	42.78 *	41.68 *	2.12	0.22	62.82 **	48.68	30.18	30.18
14.	VRMM-7 × VRMM-14	-1.71	-2.50	-29.67 *	-30.98 *	33.55	29.94	-5.99	-5.99
15.	VRMM-29×VRMM-14	-6.00	-6.03	-32.22 *	-33.48 *	-3.40	-13.95	-24.65	-24.65
	SE (d)	110.1	127.19	127.19	127.19	0.37	0.43	0.43	0.43
	CD at 5%	236.2	272.80	272.8	272.80	0.80	0.92	0.92	0.92

Conclusion

In the present study among 15 hybrids the cross VRMM-310×VRMM-7 showed the maximum heterosis over mid parent, better parent, and the commercial checks for number of branches per vine. The hybrids VRMM-35×VRMM-7, VRMM-310 × VRMM-29, VRMM-37×VRMM-7, VRMM-310 × VRMM-37 were found promising for earliness. The cross VRMM-310×VRMM-37 showed maximum significant heterosis over the commercial check for fruit yield per vine.

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