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Inheritance of fruit yield and its components in muskmelon (*Cucumis melo* L.)

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ABSTRACT : Six generation (P_1, P_2, F_1, F_2, B_1 and B_2) means of five crosses obtained by crossing five inbreeds of muskmelon were used to study the inheritance of fruit length, fruit diameter, pulp thickness and fruit weight. In most of the crosses, the relative contribution of dominance gene action was higher than additive gene action. Epistasis interactions also played a prominent role in majority of interacting crosses for all studied characters. Heterosis breeding is suggested for the improvement of fruit traits in muskmelon.

KEY WORDS : Inheritance, Additive gene, Dominance, Epistasis gene action, Gene effects

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Muskmelon (*Cucumis melo* L.) is an important commercial crop of the tropics and sub tropics, grown all over the world. In India it is popular in Northern part of country especially in Uttar Pradesh and Punjab and is grown in almost every place in the plains. Muskmelon (2n=24) belongs to the family Cucurbitaceae and edible melons belong to either *Cucumis melo* var. *reticulatus* or *Cucumis melo* var. *cantaloupensis*. Plants are either monoecious or andromonoecious annuals with long trailing vines with shallow lobed round leaves. There is considerable variation in fruit size and shape. Fruits may be smooth or rough with or without netting. The skin colour may be white, green, yellow, yellowish brown, or speckles yellow or orange with green or yellow background. Fruits of some cultivars crack when ripe. Upon ripening, fruits soften and musky aromatic essences are formed. Muskmelon is used as dessert fruit and fruit juice has cooling effect. Fruits of oriental pickling melons are smooth, glabrous and do not have the musky flavour while muskmelon fruits are large with poor keeping and transport quality, thin and musky flesh, large cavity, low sugar content and fruit skin breaking at ripening stage accompanied with low yield. Thus, there is prime need for its improvement and to develop varieties or hybrids suited to specific agro-ecological conditions. Though, there is a wide range of genetic variability available in India, not much attention has been given to the genetical studies and crop improvement. Estimation of genetic parameters is needed to understand the genetic architecture of yield and yield contributing components. It is well known that yield is a complex phenomenon governed by many genes (polygenes). For better understanding of inheritance pattern of such traits, the biometrical technique like generation mean analysis (Hayman, 1958) and scaling test (Mather, 1949) are being widely used as they estimate the exact nature and magnitude of all the gene effects.

Gene action can vary from one population to another in the same crop and genetic studies are very essential for a given genetic stock before we employ any breeding method for crop improvement.

RESEARCH METHODS

The experiment was carried out at the Instructional cum research farm, Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar (M.S.) during the summer 2010 and *Kharif* 2010. The seed material were five varieties of muskmelon and their five promising F_1 hybrids *viz*., (1) Durgapur Selection x Punjab Sunehari, (2) Hara Madhu x IVMM-3, (3) Hara Madhu x Punjab Sunehari, (4) IVMM-3 x Pusa Madhuras and (5) IVMM-3 x Punjab Sunehari. The seed of all the five parents and their five F_1 crosses were sown in separate plots on ridges and furrows with spacing of 2 x 1m, each entry was represented by two rows of 5 m length for production of seeds of F_1, F_2, BC_1, BC_2, P_1 and P_2 generations. A few plants of each parent and their F_1's were selfed with butter paper bags for production of P_1, P_2 and F_2 seeds, respectively. Five F_1 crosses mentioned in and their back crosses were made for obtaining the seed of F_1, BC_1, and BC_2 generation using following procedure.

In order to get crossed seed, the flower buds of female and male parents were bagged a day prior to anthesis. On the next day morning, bagged flower bud from desired male parent was plucked and the pollens were dusted on the receptive stigma of desired female. In order to get assured good cross seed, the pollination was done for a period of fifteen days by adopting same procedure. At the same time the parents were also selfed to obtain pure seed of each parent. In this way sufficient selfed and crossed seed were obtained. The extracted seeds were dried properly and kept in perforated paper bags (Sidhu *et al.*, 1980). Seed materials of six generations, *viz*., P_1, P_2, F_1, F_2, BC_1 and BC_2 of five F_1 hybrids were evaluated during summer 2010 and *Kharif* 2010.

About 25 tonnes of FYM and the 50 per cent recommended dose of nitrogen (50 kg/ha) and full dose of phosphorus (50kg/ha) and potassium (50 kg/ha) were incorporated in the furrows and mixed in the soil. Seeds of these generations were sown at a spacing of 2m x 1m. In order to get sufficient precision in estimation of variation within each population, one row (10 plants) of P_1, P_2 and F_1 and two rows (20 plants) of BC_1 and BC_2 and forty rows (40 plants) of F_2 seeds were sown in each replication. The plants were thinned to one seedling per hill after germination. The remaining 50 per cent of nitrogen (50 kg/ha) was applied as a top dress on 30th day after sowing. Irrigation, weed control and other cultural practices were followed as per the package of practices of muskmelon crop. The vines were allowed to trail on the ground itself.

RESEARCH FINDINGS AND DISCUSSION

The mean value of parents, hybrids, F_2's, BC_1's and BC_2's for five characters under study was averaged over replication and presented in Table 1. The variation for fruit length ranged between 8.14 and 8.04 to 11.25 and 11.01cm in parental lines. Among the parents, Hara Madhu produced the longest fruits (11.25 and 11.01 cm) in both season. Among the hybrids, cross 2 (Hara Madhu x IVMM-3) produced longest fruits (12.09 cm) in summer season, whereas in *Kharif* season cross 5 IVMM-3 x Punjab Sunehari produced longest fruits (11.78 cm) in both the summer and *Kharif* season. The fruit length in F_2's, the F_2 of cross 2 (Hara Madhu x IVMM-3) produced longest fruits (11.85 cm) in summer season, whereas in *Kharif* season cross 5 IVMM-3 x Punjab Sunehari produced longest fruits (11.58 cm) in both the summer and *Kharif* season. Among the BC_1's, the BC_1 of cross 2 (Hara Madhu x IVMM-3) x Hara Madhu produced the longest fruits (11.65 and 11.18 cm) and the BC_1 of cross 4 (IVMM-3 x Pusa Madhuras) x IVMM-3 produced the shortest fruits (8.96 and 9.30 cm) in both seasons. In BC_2, cross 5 (IVMM-3 x Punjab Sunehari) x Punjab Sunehari produced the longest fruits (11.18 and 11.02 cm) and BC_2 of cross 4 (IVMM-3 x Pusa Madhuras) x Pusa Madhuras produced the shortest fruits (9.49 and 9.28 cm).

The parent Hara Madhu produced thickest fruit (12.20 and 12.02 cm) and parent Punjab Sunehari produced thinnest fruit diameter (9.43 and 9.70 cm). Among the hybrids, cross 2 (Hara Madhu x IVMM-3) produced thickest fruit diameter (13.27) in summer season. Whereas in *Kharif* season cross 3 (Hara Madhu x Punjab Sunehari) produced thickest fruit diameter (12.28 cm) and cross 1 (Durgapur Selection x Punjab Sunehari) produced thinnest fruits (11.70 and 11.50 cm) in both the summer and *Kharif* season. Among the F_2's, the cross 2 (Hara Madhu x IVMM-3) produced thickest fruits (12.93 and 12.15 cm) and the F_2 of cross 1 (Durgapur Selection x Punjab Sunehari) produced thinnest fruits (11.53 and 11.35 cm) in both seasons.

The parents Durgapur Selection (2.21 and 2.09) and Hara Madhu (2.07 and 1.99) had maximum pulp thickness of fruit and parent, Pusa Madhuras (1.71 and 1.65) had minimum pulp thickness of fruit in both season. Among the F_2's, the F_2 of cross IVMM-3 x Punjab Sunehari (2.48 and 2.31) recorded maximum pulp thickness of fruit in summer and *Kharif* season while cross 3 Hara Madhu x Punjab Sunehari recorded minimum pulp thickness of fruit (2.11 and 2.04) in both season.

The parents Durgapur Selection (1.90 and 1.70), had maximum fruit yield per vine in both season. Among the hybrids cross 5 IVMM-3 x Punjab Sunehari (2.80 and 2.32) exhibited maximum fruit yield per vine in both season and cross 1 Durgapur Selection x Punjab Sunehari (2.20 and 1.77) exhibited minimum fruit yield per vine in summer season. In the group of F_2's, the F_2 of cross 5 IVMM-3 x Punjab Sunehari (2.60 and 2.05) recorded the highest fruit yield per vine in both seasons. The highest fruit yield per vine was recorded by cross 2 (Hara Madhu x IVMM-3) x Hara Madhu (2.20 and 1.85) amongst all BC_1's while the BC_1 of cross 4 (IVMM-3 x Pusa Madhuras) x IVMM-3 (1.85 and 1.50) recorded the lowest fruit yield per vine in both season. Amongst the group of BC_2's the highest and lowest fruit yield per vine recorded by cross 5 (IVMM-3 x Punjab Sunehari) x Punjab Sunehari (2.24 and 1.71) and cross 4 (IVMM-3 x Pusa Madhuras) x Pusa Madhuras (1.78 and 1.40), respectively.

Amongst all F_2's, the F_2 of cross 5 (IVMM-3 x Punjab Sunehari) exhibited the highest fruit weight (848.00 and 775.00) and F_2 of cross 4 (IVMM-3 x Pusa Madhuras) showed the lowest fruit weight (671.00 and 659.00) in both the summer and *Kharif* seasons. In all BC_1's, the BC_1 of cross 1 (Durgapur Selection x Punjab Sunehari) x Durgapur Selection recorded the highest fruit weight (782.00 and 771.70) and BC_1 of cross 4 (IVMM-3 x Pusa Madhuras) x IVMM-3 expressed lowest fruit weight (660.00 and 643.00) in both season. In case BC_2's, the BC_2 of cross 5 (IVMM-3 x Punjab Sunehari) x Punjab Sunehari recorded the highest fruit weight (758.00 and 692.00) and BC_2 of cross 3 (Hara Madhu x Punjab Sunehari) x Punjab Sunehari showed the minimum fruit weight (626 and 570.50) in both the summer and *Kharif* seasons.

The overall performance of different population *viz.*, parents F_1's, F_2's, BC_1's and BC_2's revealed that cross 5 (IVMM-3 x Punjab Sunehari) x Punjab Sunehari among the crosses, had exhibited highest fruit length, fruit diameter, pulp thickness, yield per vine, and weight of fruit in both the seasons.

The estimates of the six parameters for five characters are presented (Table 2).The relative magnitude of additive gene effects to the mean effect was significant in all the crosses for fruit length in both summer and *Kharif* season. All the crosses except cross 2 (Hara Madhu x IVMM-3) showed significant dominance gene effects to the mean effects in both summer and *Kharif* season. The relative magnitude of dominance gene effects was greater than the additive gene effects for all the crosses except in cross 2 (Hara Madhu x IVMM-3) in both summer and *Kharif* season. As regards the digenic interaction additive x additive (i), additive x dominance (j) and dominance x dominance (l) were found to be significant for all the crosses except cross 2 (Hara Madhu x IVMM-3) and 3 (Hara Madhu x Punjab Sunehari) in both summer and *Kharif* season. The additive x additive (i) and dominance x dominance (l) gene effects were recorded to be significant in all the crosses in both summer and *Kharif* season. The additive x dominance (j) gene effects were found to be significant for all the crosses except cross 2 (Hara Madhu x IVMM-3) and 3 (Hara Madhu x Punjab Sunehari) in both summer and *Kharif* season. The signs of h and l were in opposite direction and hence, duplicate type of interaction was noticed in the all the crosses except cross 2 (Hara Madhu x IVMM-3) in both summer and *Kharif* season.

The additive gene effects were found to be significant in all the crosses except cross 2 (Hara Madhu x IVMM-3), while dominant gene effect (h) was significant in all the crosses in both summer and *Kharif* season. The relative magnitude of dominance gene effects was greater than the additive gene effects for all the crosses except cross 3 (Hara Madhu x Punjab Sunehari) in both summer and *Kharif* season for fruit diameter. As regards the digenic interaction the values of additive x additive (i), additive x dominance (j) and dominance x dominance (l) were significant in cross 4 (IVMM-3 x Pusa Madhuras) and cross 5 (IVMM-3 x Punjab Sunehari) in both summer and *Kharif* season. The additive x additive (i) were found to be non-significant in cross 2 (Hara Madhu x IVMM-3). The additive x dominance (j) gene effects were found to be significant in cross 4 (IVMM-3 x Pusa Madhuras) and cross 5 (IVMM-3 x Punjab Sunehari) and dominance x dominance (l) gene effects were recorded to be significant in all the crosses in both summer and *Kharif* season. The signs of h and l were in opposite direction and hence, duplicate type of interaction was noticed in the all the crosses in both summer and *Kharif* season.

As regards both the genetic effects *i.e.* additive

(d) and dominance (h) were found to be significant in all the crosses in both summer and *Kharif* season for pulp thickness. The relative magnitude of additive gene effects was greater than the dominant gene effects for all the crosses in both summer and *Kharif* season. The significant epistatic interaction (i, j and l) were found in all the crosses except cross 4 (IVMM-3 x Pusa Madhuras) in both summer and *Kharif* season. The dominance x dominance interaction exhibited high magnitude followed by additive x dominance and additive x additive in both summer and *Kharif* season. The additive x additive and dominance x dominance gene interaction were found to be significant in all the crosses in both summer and *Kharif* season. The additive x dominance gene interaction was found significant in all the crosses except cross 4 (IVMM-3 x Pusa Madhuras) in both summer and *Kharif* season. The signs of h and l were in opposite direction and hence, duplicate type of interaction was noticed in the all the crosses in both summer and *Kharif* season.

Both the additive and dominance gene effects were almost equally important in respect of fruit yield per vine. The cross 3 (Hara Madhu x IVMM-3) recorded the highest magnitude of additive gene effects in both summer and *Kharif* season. The dominance gene effects were found to be significant for all the crosses in both summer and *Kharif* season. The magnitude of dominance gene effects was greater than those of additive gene effects for all the crosses in both summer and *Kharif* season. The epistasis gene effects (i, j and l) were found to be significant in cross 5 (IVMM-3 x Punjab Sunehari) in both summer and *Kharif* season. The additive x additive (i) interaction was found to be significant for all the crosses except cross 2 (Hara Madhu x IVMM-3) in both summer and *Kharif* season. The additive x dominance (j) interaction were significant in cross 4 (IVMM-3 x Pusa Madhuras) and cross 5 (IVMM-3 x Punjab Sunehari) in both summer and *Kharif* season. The dominance x dominance (l) interactions were recorded to be significant in cross 1 (Durgapur Selection x Punjab Sunehari), cross 3 (Hara Madhu x IVMM-3) and cross 5 (IVMM-3 x Punjab Sunehari) in both summer and *Kharif* season. The signs of h and l were in opposite direction and hence, duplicate type of interaction was noticed in the entire cross combinations in both summer and *Kharif* season.

As regards both the genetic effects *i.e.* additive (d) and dominance (h) were found to be significant in all the crosses for fruit weight in both summer and *Kharif* season. The relative contribution of dominance gene effects to the mean effect was higher than that of the additive gene effects for the crosses cross 1 (Durgapur Selection x Punjab Sunehari), cross 2 (Hara Madhu x Punjab Sunehari) and cross 4 (IVMM-3 x Pusa Madhuras) in both summer and *Kharif* season. The cross 4 (IVMM-3 x Pusa Madhuras) exhibited the highest significant dominance gene effects in both summer and *Kharif* season.The significant epistatic interaction (i, j and l) were found in all the crosses except cross 2 (Hara Madhu x IVMM-3) in both summer and *Kharif* season. The dominance x dominance interaction exhibited high magnitude followed by additive x dominance and additive x additive in both summer and *Kharif* season. The additive x additive and dominance x dominance gene interaction were found to be significant in all the crosses in both summer and *Kharif* season. The additive x dominance gene interaction was found significant in all the crosses except cross 2 (Hara Madhu x IVMM-3) in both summer and *Kharif* season. The cross 3 (Hara Madhu x Punjab Sunehari) observed to have complimentary type of interaction for fruit weight in both summer and *Kharif* season.

The relative magnitude of dominance gene effects was greater than additive gene effects in all the crosses except cross 2(Hara Madhu x IVMM-3) for fruit length. In the crosses, cross 1 (Durgapur Selection x Punjab Sunehari), cross 4(IVMM-3 x Pusa Madhuras) and cross 5(IVMM-3 x Punjab Sunehari) additive, dominance and epistasis interaction played the significant role in the producing more fruit length. In all the crosses the contribution of additive x additive gene effects was relatively higher than dominance x dominance epistasis effects except cross 2 (Hara Madhu x IVMM-3). Duplicate type of gene interaction was observed in all the crosses except cross 2 (Hara Madhu x IVMM-3). Evidently the characters could be exploited through heterosis breeding as well as selection. Similar results have been reported by Tomar *et al.* (2008) and Pornsuriya *et al.* (2009) in muskmelon; Singh *et al.* (2000) in bottle gourd observed both additive and dominance effects were highly significant for fruit length.

The additive gene effects to the mean effect was significant in all the crosses except cross 2 (Hara Madhu x IVMM-3) for the trait fruit diameter. The dominant gene effects were greater than the additive gene effect in all the crosses expect cross 3 (Hara Madhu x Punjab

Sunehari). As regard the digenic interaction, additive x dominance (j) and dominance x dominance (l) gene effects were found to be significant in cross 4 (IVMM-3 x Pusa Madhuras) and cross 5 (IVMM-3 x Punjab Sunehari). Duplicate type of gene interaction was observed in all the crosses. Moon *et al.* (2004) and Tomar *et al.* (2008) in muskmelon reported same results. Sirohi and Choudhury (1980); Ram *et al.* (1997) and Kumar *et al.* (2010) also reported similar type of results in bitter gourd.

As regards both the genetic effects *i.e.* additive (d) and dominance (h) were found to be significant in all the crosses in both summer and *Kharif* season for the trait pulp thickness. As regards the digenic interaction additive x additive, additive x dominance and dominance x dominance gene effects were found significant in all the crosses except cross 4(IVMM-3 x Pusa Madhuras). Duplicate type of gene interaction was observed in all the crosses in both summer and *Kharif* season. Similar type of results also reported by Chadha *et al.* (1972); Singh *et al.* (1990); Munshi and Verma (1998) and Moon *et al.* (2004) in muskmelon.

Both the additive and dominance gene effects were almost equally important in respect of fruit yield per vine. The both additive and dominance gene effects were significant in the crosses cross 3 (Hara Madhu x Punjab Sunehari), cross 4 (IVMM-3 x Pusa Madhuras) and cross 5 (IVMM-3 x Punjab Sunehari). The additive gene effects were greater than dominance gene effects in the same crosses. The additives x additive epistatic

Table 1 : Mean performance of parents, F_1's, F_2's and back crosses for five characters in muskmelon during summer and *Kharif* 2010-2011

Cross/	P_1		P_2		F_1		F_2		BC_1		BC_{2s}		S.E.±		C.D. (P=0.05)	
Characters	Summer	*Kharif*	Summer	*Kharif*	Summer	*Kharif*	Summer	*Kharif*	Summer	*Kharif*	Summer	*Kharif*	Summer	*Kharif*	Summer	*Kharif*
Length of fruit (cm)																
Cross 1	10.05	9.82	10.41	10.51	10.82	10.77	10.74	10.70	10.42	10.29	10.60	10.61	0.01	0.04	0.05	0.16
Cross 2	11.25	11.01	8.14	8.04	12.09	11.40	11.85	11.25	11.65	11.18	10.13	9.80	0.04	0.06	0.14	0.23
Cross 3	11.25	11.01	10.41	10.51	11.64	11.64	11.48	11.35	11.37	11.10	11.05	10.62	0.09	0.12	0.33	0.44
Cross 4	8.14	8.04	9.17	9.25	9.81	9.61	9.67	9.42	8.96	9.30	9.49	9.28	0.02	0.05	0.08	0.16
Cross 5	8.14	8.04	10.41	10.51	11.95	11.78	11.74	11.58	10.03	9.87	11.18	11.02	0.04	0.07	0.15	0.24
Diameter of fruit (cm)																
Cross 1	11.39	11.23	9.43	9.52	11.70	11.50	11.53	11.35	11.44	11.30	10.19	10.15	0.03	0.06	0.11	0.22
Cross 2	12.20	12.02	10.75	10.45	13.27	12.22	12.93	12.15	12.73	12.08	12.01	11.01	0.05	0.08	0.20	0.30
Cross 3	12.20	12.02	9.43	9.52	12.48	12.28	12.32	12.10	12.23	12.06	10.27	9.91	0.06	0.09	0.21	0.33
Cross 4	10.75	10.45	11.80	11.85	11.93	11.90	11.81	11.85	11.55	10.82	11.83	11.70	0.02	0.05	0.08	0.17
Cross 5	10.75	10.45	9.43	9.52	11.76	11.61	11.55	11.39	11.24	11.08	10.60	10.50	0.07	0.10	0.27	0.36
Pulp thickness (cm)																
Cross 1	2.21	2.09	1.84	1.79	2.23	2.13	2.22	2.10	2.22	2.08	2.01	1.92	0.02	0.05	0.09	0.20
Cross 2	2.07	1.99	1.97	1.87	2.56	2.10	2.42	2.07	2.31	2.00	2.27	1.95	0.02	0.05	0.08	0.18
Cross 3	2.07	1.99	1.84	1.79	2.26	2.15	2.11	2.04	2.08	2.00	1.85	1.80	0.03	0.06	0.09	0.21
Cross 4	1.97	1.87	1.71	1.65	2.20	2.09	2.17	2.08	2.13	2.04	2.01	1.92	0.03	0.05	0.11	0.19
Cross 5	1.97	1.87	1.84	1.79	2.60	2.42	2.48	2.31	2.30	2.15	2.23	2.09	0.02	0.05	0.09	0.18
Yield per vine (kg)																
Cross 1	1.90	1.70	1.70	1.50	2.20	1.77	2.00	1.60	1.98	1.51	1.94	1.70	0.07	0.10	0.24	0.35
Cross 2	1.80	1.40	1.75	1.45	2.79	1.90	2.50	1.80	2.20	1.85	2.20	1.45	0.07	0.10	0.25	0.35
Cross 3	1.80	1.40	1.70	1.50	2.22	1.88	2.07	1.40	1.90	1.60	1.80	1.43	0.08	0.11	0.29	0.41
Cross 4	1.75	1.45	1.50	1.25	2.23	1.70	2.05	1.74	1.85	1.50	1.78	1.40	0.05	0.07	0.19	0.27
Cross 5	1.75	1.45	1.70	1.50	2.80	2.32	2.60	2.05	2.15	1.77	2.24	1.71	0.05	0.08	0.19	0.28
Weight of fruit (g)																
Cross 1	780.00	770.00	583.00	542.30	798.00	773.00	778.00	764.30	782.00	771.70	590.00	654.00	0.74	0.77	2.70	2.82
Cross 2	686.00	658.30	621.00	607.30	880.00	775.00	777.00	740.00	688.00	680.50	634.00	615.20	3.60	3.63	13.09	13.17
Cross 3	686.00	658.30	583.00	542.30	730.00	687.70	706.00	661.50	692.00	660.00	626.00	570.50	2.89	2.92	10.51	10.56
Cross 4	621.00	607.30	578.00	550.00	704.00	681.00	671.00	659.00	660.00	643.00	637.00	622.00	1.18	1.21	4.31	4.33
Cross 5	621.00	607.30	583.00	542.30	930.00	855.00	848.00	775.00	775.00	708.70	758.00	692.00	0.27	0.29	0.98	1.06

Table 2 : Estimates of gene effects for different five characters in five crosses of muskmelon during summer and *Kharif* 2010-2011

Cross/	m		d		h		i		j		l		Type of
Characters	Summer	*Kharif*	Summer	*Kharif*	Summer	*Kharif*	Summer	*Kharif*	Summer	*Kharif*	Summer	*Kharif*	Epistasis
Length of fruit (cm)													
Cross 1	10.74**	10.70**	-0.58**	-0.63**	0.84**	0.77**	-0.04**	-0.05**	-0.72**	-0.76**	-0.32**	-0.22**	D
	(0.002)	(0.002)	(0.003)	(0.002)	(0.04)	(0.04)	(0.009)	(0.008)	(0.006)	(0.006)	(0.01)	(0.01)	
Cross 2	11.85**	11.25**	0.59**	0.53**	0.002	0.048	0.69**	0.57**	1.56	1.43	0.59**	0.73**	C
	(0.01)	(0.01)	(0.006)	(0.005)	(0.01)	(0.3)	(0.04)	(0.03)	(0.81)	(0.91)	(0.05)	(0.05)	
Cross 3	11.48**	11.35**	0.47**	0.42**	1.40**	1.23**	0.15**	0.09**	1.66	1.73	-1.00**	-0.67**	D
	(0.03)	(0.03)	(0.02)	(0.01)	(0.13)	(0.13)	(0.03)	(0.01)	(0.92)	(0.92)	(0.16)	(0.03)	
Cross 4	9.67**	9.42**	-0.38**	-0.43**	0.75**	0.71**	0.57**	0.53**	-0.33**	-0.37**	-2.91**	-2.82**	D
	(0.005)	(0.005)	(0.009)	(0.008)	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.04)	(0.04)	
Cross 5	11.74**	11.58**	-1.63**	-1.71**	3.78**	3.65**	3.20**	3.12**	-1.41**	-1.33**	-10.96**	-10.71**	D
	(0.01)	(0.01)	(0.01)	(0.01)	(0.04)	(0.04)	(0.04)	(0.04)	(0.01)	(0.01)	(0.06)	(0.06)	
Diameter of fruit (cm)													
Cross 1	11.53**	11.35**	-1.16**	-1.22**	1.20**	1.12**	1.43**	1.38**	-1.67	-1.72	-3.74**	-3.58**	D
	(0.005)	(0.005)	(0.004)	(0.003)	(0.02)	(0.02)	(0.02)	(0.02)	(0.91)	(0.91)	(0.03)	(0.03)	
Cross 2	12.93**	12.15**	0.36	0.31	0.68**	0.52**	0.39	0.32	0.64	0.56	-0.45**	-0.13**	D
	(0.01)	(0.01)	(0.27)	(0.21)	(0.04)	(0.04)	(0.44)	(0.44)	(0.51)	(0.51)	(0.06)	(0.06)	
Cross 3	12.32**	12.16**	0.79**	0.71**	-3.55**	-3.77**	-4.39**	-4.45**	1.56	1.62	3.93**	4.37**	D
	(0.01)	(0.01)	(0.004)	(0.003)	(0.04)	(0.04)	(0.03)	(0.02)	(0.92)	(0.92)	(0.05)	(0.06)	
Cross 4	11.81**	11.53**	-0.15**	-0.22**	2.83**	2.75**	1.88**	1.74**	0.23**	0.15**	-4.82**	-4.66**	D
	(0.005)	(0.005)	(0.008)	(0.007)	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.04)	(0.04)	
Cross 5	11.55**	11.39**	-0.31**	-0.26**	3.86**	3.64**	2.12**	2.03**	0.18**	0.24**	-6.89**	-6.45**	D
	(0.02)	(0.02)	(0.02)	(0.01)	(0.09)	(0.09)	(0.09)	(0.08)	(0.02)	(0.02)	(0.13)	(0.13)	
Pulp thickness (cm)													
Cross 1	2.22**	2.10**	0.48**	0.39**	-1.07**	-1.14**	-1.18**	-1.22**	0.49**	0.42**	2.35**	2.49**	D
	(0.008)	(0.008)	(0.005)	(0.004)	(0.03)	(0.03)	(0.03)	(0.02)	(0.006)	(0.005)	(0.003)	(0.03)	
Cross 2	2.42**	2.07**	0.50**	0.38**	-0.72**	-0.77**	-0.69**	-0.73**	0.51**	0.44**	1.83**	1.70**	D
	(0.006)	(0.006)	(0.004)	(0.003)	(0.02)	(0.02)	(0.02)	(0.02)	(0.007)	(0.006)	(0.03)	(0.02)	
Cross 3	2.11**	2.04**	0.32**	0.25**	-0.47**	-0.49**	-0.43**	-0.48**	0.34**	0.35**	1.29**	1.32**	D
	(0.01)	(0.01)	(0.009)	(0.008)	(0.04)	(0.04)	(0.04)	(0.04)	(0.01)	(0.01)	(0.05)	(0.05)	
Cross 4	2.17**	2.08**	0.12**	0.08**	-1.53**	-1.61**	-1.00**	-1.05**	0.01	-0.005	2.00**	2.01**	D
	(0.008)	(0.008)	(0.008)	(0.006)	(0.03)	(0.02)	(0.03)	(0.02)	(0.01)	(0.01)	(0.04)	(0.04)	
Cross 5	2.48**	2.31**	0.11**	0.09**	-0.93**	-0.96**	-0.49**	-0.54**	0.12**	0.13**	1.31**	1.28**	D
	(0.008)	(0.008)	(0.004)	(0.003)	(0.03)	(0.03)	(0.03)	(0.03)	(0.007)	(0.007)	(0.03)	(0.03)	
Yield per vine (kg)													
Cross 1	2.00**	1.88**	0.18	0.12	0.47**	0.38**	0.12**	0.15**	0.62	0.59	-0.89**	-1.06**	D
	(0.01)	(0.002)	(0.12)	(0.15)	(0.06)	(0.01)	(0.06)	(0.01)	(0.32)	(0.37)	(0.10)	(0.02)	
Cross 2	2.50**	1.80**	0.48	0.44	0.60**	0.66**	-0.40	-0.42	0.49	0.46	-0.05	-0.21	D
	(0.01)	(0.01)	(0.31)	(0.28)	(0.07)	(0.07)	(0.66)	(0.66)	(0.61)	(0.61)	(0.11)	(0.8)	
Cross 3	2.67**	1.40**	0.60**	0.57**	0.55**	0.41**	0.33**	0.19**	1.01	0.97	-0.37**	-0.16**	D
	(0.02)	(0.007)	(0.007)	(0.006)	(0.10)	(0.01)	(0.10)	(0.03)	(0.61)	(0.61)	(0.11)	(0.05)	
Cross 4	2.55**	1.54**	-0.37**	-0.33**	-0.30**	-0.27**	-0.32**	-0.26**	-0.24**	-0.20**	-0.13	-0.05	C
	(0.007)	(0.002)	(0.005)	(0.005)	(0.04)	(0.01)	(0.03)	(0.01)	(0.02)	(0.006)	(0.66)	(0.62)	
Cross 5	2.30**	2.05**	-0.69**	-0.54**	0.16**	0.01**	0.22**	0.15**	-0.29**	-0.17**	-0.29**	-0.13**	D
	(0.002)	(0.01)	(0.01)	(0.006)	(0.03)	(0.06)	(0.02)	(0.05)	(0.01)	(0.006)	(0.07)	(0.07)	
Weight of fruit (g)													
Cross 1	778.00**	764.30**	7.40**	7.33**	-142.62**	-147.52**	-142.60**	-142.72**	26.42**	26.34**	161.65**	171.45**	D
	(0.37)	(0.37)	(0.28)	(0.26)	(1.71)	(1.70)	(1.61)	(1.60)	(0.37)	(0.36)	(2.21)	(2.20)	
Cross 2	777.00**	740.00**	15.97**	15.83**	-23.60**	-19.50**	6.75**	6.62**	6.72	6.62	2.60**	12.80**	D
	(1.49)	(1.49)	(0.18)	(0.16)	(6.00)	(6.00)	(1.06)	(1.06)	(6.25)	(6.24)	(0.05)	(6.05)	
Cross 3	706.00**	661.50**	42.25**	42.10**	10.00**	15.50**	7.50*	7.41*	62.75**	65.25**	20.00**	29.00**	C
	(3.34)	(0.80) **	(0.47)	(0.45)	(3.73)	(3.73)	(3.33)	(3.33)	(0.50)	(0.48)	(5.00)	(5.00)	
Cross 4	671.00**	659.00**	-85.40**	-85.50**	-171.95**	-169.75**	-114.40**	-114.54**	-101.15**	-101.04**	83.10**	78.70**	D
	(0.09)	(0.09)	(0.07)	(0.06)	(0.65)	(0.65)	(0.41)	(0.41)	(0.50)	(0.48)	(1.11)	(1.12)	
Cross 5	848.00**	775.00**	-144.75**	-144.88**	-105.11**	-105.41**	-31.16**	-31.24**	-135.00**	-132.50**	104.44**	103.84**	D
	(0.01)	(0.02)	(0.05)	(0.06)	(0.13)	(0.20)	(0.09)	(0.18)	(0.11)	(0.12)	(0.30)	(0.38)	

* and ** indicate significance of values at P=0.05 and 0.01, respectively (C- Complimentary, D- Duplicate)

interaction were found significant in all the crosses except cross 2 (Hara Madhu x IVMM-3). Duplicate types of gene interaction were also observed in entire cross combinations while complementary gene interaction was observed in cross 4 (IVMM-3 x Pusa Madhuras). Similar results were reported by Chadha *et al.* (1972); Dhaliwal *et al.* (1996); Munshi and Verma (1998); Arvindkumar (2004); Zalpa *et al.* (2006) and Tomar *et al.* (2008) in muskmelon and Singh *et al.* (2000) in bottle gourd. The importance of pure line selection for this trait having additive gene effects at significant level and heterosis breeding where non-additive gene effects found pre dominant effect may be exploited.

Additive (d) and dominance (h) were found to be significant in all the crosses for weight of fruit in both summer and *Kharif* season. The relative contribution of additive gene effects to the mean effect was higher than that of the dominance gene effects in the cross 3 (Hara Madhu x Punjab Sunehari) and cross 5 (IVMM-3 x Punjab Sunehari) in both summer and *Kharif* season. All the estimates of six parameter model showed that in all the crosses except cross 2 (Hara Madhu x IVMM-3). Additive x additive and dominance x dominance interaction was significant in all the crosses except cross 2 (Hara Madhu x IVMM-3). The dominance x dominance interaction exhibited high magnitude followed by additive x additive and additive x dominance. Complementary type of interaction was observed in cross 3 (Hara Madhu x Punjab Sunehari). The character could be exploited through heterosis breeding as well as selection. Similar results were confirmed by Arvindkumar (2004) and Zalpa *et al.* (2006) in muskmelon, Sirohi *et al.* (1986) in bottle gourd, Sanandia *et al.* (2010) in sponge gourd.

Conclusion:

The present work made it possible to indicate the better combination like Durgapur Selection x Punjab Sunehari, Hara Madhu x Punjab Sunehari and IVMM-3 x Punjab Sunehari for commercial exploitation of hybrid vigour. Analysis of gene effects revealed to know the nature and magnitude of gene effects for yield and its contributing characters, which may help in formulating a suitable breeding programme and to select genetic stocks with considerable promise for further selections of desirable muskmelon cultivars with high yield. Therefore, improvement in muskmelon, heterosis breeding, recurrent and reciprocal recurrent selections would be effective.

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