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Genetic studies in F_5 generation of muskmelon (*Cucumis melo* L.)

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Abstract
In F_5 generation, twenty four characters were studied for yield and its contributing characters in muskmelon, which was obtained from the cross IVMM-3 x Punjab Sunheri. The genetic variability, genotypic and phenotypic coefficient of variation, heritability, genetic advance and correlation analysis were undertaken for the study. The genotypic coefficient of variation was lower than the phenotypic coefficient of variations in all quantitative traits role of environment in the phenotypic expression of traits. The results showed high values for GCV and PCV for the characters like number of primary branches per vine, number of male flowers per vine, number of female flowers per vine, final vine length, average rind thickness, average fruit cavity, average weight of pulp per fruit, average weight of seed per fruit, sex ratio, number of fruits per vine, fruit yield per vine, average weight of fruit, TSS and acidity representing presence of substantial amount of variation. Analysis of variance showed significant variation for all the characters, indicating presence of sufficient variability in the material studied.

Keywords: F_5 generation, GCV, PCV, Correlation and *Cucumis melo* L

Introduction
The present investigation entitled, "Genetic studies in F_5 generation of muskmelon (*Cucumis melo* L.)" was conducted during *kharif* 2015 and summer 2016. The hybrid derivative IVMM-3 x Punjab Sunheri was evaluated for yield and yield contributing characters in F_5 generation. This investigation has highlighted the magnitude of variability, heritability, genetic advance and correlation coefficient in F_5 generations of muskmelon. Wide range of variability was observed in all quantitative characters for all the progenies of cross in F_5 generation. Phenotypic coefficient of variation (PCV) was higher than the respective genotypic coefficient of variation (GCV) for all the studied characters in F_5 generation indicating role of environmental in the phenotypic expression of the traits. All the, twenty four characters recorded high values of the GCV and PCV in both the F_5 generations for most of the characters *viz.* vine length, number of primary branches per vine, number of male flowers per vine, number of female flowers per vine, sex ratio, number of fruits per vine, fruit yield per vine, average weight of fruit, average rind thickness, average fruit cavity, average weight of pulp per fruit, average weight of seeds per fruit and TSS, which showed greater phenotypic and genotypic variability among the accessions and sensitiveness of the attributes for making further improvement by selection (Ramaswamy *et al*., 1977) [9].
High heritability coupled with high genetic advance as percent of mean was observed for most of the characters *i.e*., vine length, number of primary branches per vine, number of fruits per vine, fruit yield per vine, average weight of fruit, average pulp and rind thickness, average fruit cavity, average weight of pulp per fruit, average weight of seeds per fruit and TSS in most of the crosses of F_5 progenies, which indicates preponderance of additive gene action. These characters could be improved by pure line selection or mass selection method. High heritability combined with low genetic advance was observed for some of the traits for which simple selection would not be rewarding. More the less, they could be utilized as an inbred lines in the hybrid development programme.

Material and Methods
The observations were recorded on ten randomly selected plants from each plot. Observations were recorded on vine length (cm), number of primary branches per vine, days to first female flower appearance, numbers of male flower per vine, number of female flowers per vine, sex ratio, node at which first female flower appeared, days required for first harvest of fruit, number of fruits per vine, fruit yield per vine (kg), average weight of fruit (g), average length

of fruit (cm), average diameter of fruit (cm), average rind thickness (cm), average pulp thickness (cm), average fruit cavity (cm), average weight of pulp per fruit (gm), average weight of seed per fruit (gm), TSS (%), acidity (%), ascorbic acid (%), total Sugar (%), reducing sugar (%) and non reducing sugar (%). The observations were recorded by prescribed scientific method total soluble solids were determined by Zeiss Hand Refract meter. The total soluble sugars and acidity percentage were determined by methods of Dubios *et al* (1956) [4] and Ranganna (1976) [10]. ANOVA was analyzed by the method suggested by Panse and Sukhatme (1978) [7]. The correlation coefficient and path coefficient was analyzed by using methods of Wright (1921) [16] and Singh and Choudhary (1977).

Results and Discussion

The ANOVA showed significant variation for all the characters indicating presence of sufficient variability in the material studied (Table 1). Genotypic variance contributed a major proportion of total variance in characters like average weight of fruit (g), average fruit cavity (cm), average weight of pulp per fruit (gm), average weight of seed per fruit (gm), number of female flowers per vine, sex ratio, node at which first female flower appeared, days required for first harvest of fruit, number of fruits per vine, fruit yield per vine (kg), average length of fruit (cm), average diameter of fruit (cm), average rind thickness (cm), average pulp thickness (cm), average fruit cavity (cm), average weight of pulp per fruit (gm), average weight of seed per fruit (gm), TSS (%), acidity (%), ascorbic acid (%), total Sugar (%), reducing sugar (%) and non reducing sugar (%). suggesting that these characters were under the control of the genetic system whereas, characters like average weight of pulp per fruit (gm), average weight of seed per fruit (gm) and acidity (%) showed differences between genotypic and phenotypic variance, indicating that environment played an important role in expression of these traits (Table 1).

Vine growth characters

The vine length (cm) showed wide range in F_5 generation (189.32 to 239.15 cm) with an average 219.35 cm. The genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were observed as 12.67% and 12.99%, while environmental coefficient of variation ECV was 2.92% (Table 1). In F_5 generation for number of primary branches per vine was observed in the range (2.24-2.63) with mean value 2.52. Very close values were recorded for GCV (12.43%) and PCV (12.62%) with certain influence of environmental factors ECV (1.75%).

Flowering characters

Wide range of variability was observed in F_5 generation for days to first female flower appearance (34.00-42.38 days) with mean value 35.75 days (Table 1). The very close values were recorded for GCV (8.12%), PCV (8.18%) and ECV (1.58%) with noticeable influence of environmental factor. For number of male flowers per vine was ranged in between 73.01 to 85.22 with mean value 74.38. The close association of as GCV (10.93%) and PCV (10.95%) was observed with noticeable environmental variability ECV (0.85%). Flowering character number of female flowers per vine was ranged in between 11.32 to 13.84 with an average of 13.04. The genetic variability was contributed as GCV (5.84%) and PCV (6.12%) with certain presence of environmental factor ECV (1.81%).

For the sex ratio mean values were ranged 6.08 to 7.12 along with mean of 5.70. The genetic variability contributed as GCV (12.34%) and PCV (13.04%) with noticeable environmental variability ECV (4.21%). In case of F_5 generation this character showed wide range of variability (3.98 to 5.84) with an average 4.32. The close association of GCV (16.21%) and PCV (16.24%) were observed with certain presence of environmental factor ECV (0.68%).Whereas in case of F_6 generation it was ranged in between 4.01 to 5.41 with an average 4.12. The days required for first harvest of fruits was observed in wide range of 69.32 to 84.38 days with an average 76.35 days. The close association of GCV (5.97%) and PCV (6.02%) were observed with influence of environmental factor ECV (0.80%.).

Yield and its contributing character

In case of number of fruits per vine (Table 1) it was ranged between 2.86 to 3.28 per vine with an average of 3.12 per vine. The significant contribution of genetic variability *i.e.*, GCV (12.14%) and PCV (12.27%) were observed with environmental variability ECV (1.69%).

The data presented for the character fruit yield per vine showed wide range of 1.57-2.92 kg per vine with an average 2.74 kg per vine. The significant contribution of genetic variability GCV (21.58%) and PCV (21.75%) were observed along with environmental variability ECV (2.87%). In muskmelon, yield is correlated with several traits including days to anthesis, number of fruits per plant, average fruit weight, number of primary branches per plant, number of nodes on the main stem, stem length, internodal length and fruit shape index. The various workers worked with the muskmelon and found similar results of the present study they are in conformity with the findings of Abdalla and Aboul-Naser, 2002 [1]; Musmade *et al.*, 2008; Tomar *et al.*, 2008 [15]; Feyzian *et al.*, 2009 and Singh, 2001, respectively.

Fruit characters (quantitative)

In fruit characters (Table 1) average weight of fruit showed a wide range of variation 584.12-915.17 g with mean of 847.12 g weight of fruit. The close values of GCV (16.09%) and PCV (16.27%) were observed with certain presence of environmental factor ECV (2.42%). The average length of fruit was observed in wide range of 9.12 cm to 12.09 cm with an average 11.48 cm. The close association of GCV (12.61%) and PCV (12.63%) were observed with certain presence of environmental factor ECV (0.35%).

Average diameter of fruit was ranged from 10.35 cm to 13.23 cm with an average 12.18 cm. The close association of GCV (7.25%) and PCV (7.29%) were observed with ECV (0.21%). Average pulp thickness (cm) was observed in wide range of 1.87 cm to 2.95 cm with an average 2.63 cm. The close association of GCV (12.98%) and PCV (13.01%) was observed with certain presence of environmental factor ECV (0.95%).

Average fruit cavity (cm^2) was observed in wide range of 32.82 cm to 43.55 cm with their average 41.32 cm. The close association of GCV (9.01%) and PCV (9.02%) were observed with low influence of environmental factor ECV (0.32%). The average weight of pulp per fruit (g) was observed in wider range of 424.34 to 672.31 g with mean value of 612.32 g. The significant genetic variability GCV (23.14%) and PCV (23.35%) were observed with noticeable environmental variability ECV (3.24%). The average weight of seed per fruit

(g) was ranged in between 10.12 to 12.21 g with an average 11.18 g. The close association of GCV (10.25%) and PCV (10.27%) were observed with certain presence of environmental factor ECV (0.81%). The results are quite close to those of Zalapa *et al.*, 2006; Reddy *et al.*, 2007; Musmade *et al.*, 2008 and Feyzian *et al.*, 2009.

Fruit characters (qualitative)

The total soluble solids (°Brix) content of fruit is an important qualitative character in muskmelon (Table 1). In case of F_5 generation it shows a wide range of variation 11.31 to 12.54°Brix with mean of 12.14°Brix. The close association of GCV (10.76%) and PCV (11.23%) were observed with ECV (3.37%). The acidity (%) was ranged in F_5 generation in between 1.17 to 1.32% with an average 1.21%. The close association of GCV (10.21%) and PCV (11.72%) were observed with certain presence of environmental factor ECV (5.78%). In case of F_5 generation the ascorbic acid (mg/100g) content was ranged from 24.31 to 25.59 mg/100g with an average 25.09 mg/100g. The GCV (9.17%) and PCV (9.20%) were observed with noticeable influence of environmental factor ECV (3.11%).

In total sugar content (%) was ranged in between 9.23 to 9.81% with mean value of 9.52%. The genetic variability contributed as GCV (4.02%) and PCV (4.07%) with environmental variability ECV (0.62%) were recorded. In case of reducing sugar content (%) was ranged in between 6.95 to 7.31% with an average 7.05%. The close association of GCV (7.71%) and PCV (7.93%) were observed with certain presence of environmental factor (ECV 0.33%). The moderate value was obtained for heritability (67.98%).

Non reducing sugar content in F_5 generation (Table 1) was ranged from 1.97% to 2.48% with an average 2.45%. The close association of GCV (6.84%) and PCV (6.94%) were observed with influence of environmental factor ECV (1.18%) These findings are in agreement with those of earlier researchers Lippert and Hall, 1982 [5]; Dhaliwal *et al.*, 1996 [3]; Somkuwar *et al.*, 1997 [13]; Abdalla and Aboul-Naser, 2002 [1]; Yadav and Ram, 2002 [17]; Choudhary *et al.*, 2003 [2], Taha *et al.*, 2003 [14]; Singh and Lal, 2005 [11]; Mehta *et al.*, 2009 [6]; Rad *et al.*, 2010 [8] have also explored the association of yield components with yield in muskmelon.

Table 1: Mean, range, GCV, PCV, ECV, heritability, genetic advance and per cent mean of genetic advance of two parents and F_5 population of cross IVMM-3 x Punjab Sunheri.

Sr. No.	Character	Mean	Range	GCV (%)	PCV (%)	ECV (%)	h^2 (bs) (%)	GA	GAM (%)
1.	Vine length (cm)	219.35	189.32-239.15	12.67	12.99	2.92	94.96	55.23	25.24
2.	No. of primary branches per vine	2.52	2.24-2.63	12.43	12.62	1.75	98.06	0.69	27.42
3.	Days to first female flower appearance	35.75	34.00-42.38	8.12	8.18	1.58	96.32	5.98	16.71
4.	Numbers of male flower per vine	74.38	73.01-85.22	10.93	10.95	0.85	99.51	17.19	23.15
5.	Number of female flowers per vine	13.04	11.32-13.84	5.84	6.12	1.81	93.36	2.73	20.91
6.	Sex ratio	5.70	6.08-7.12	12.34	13.04	4.21	89.63	1.52	23.81
7.	Node at which first female flower appeared	4.32	3.98-5.84	16.21	16.24	0.68	99.84	1.47	33.37
8.	Days required for first harvest of fruit	76.35	69.32-84.38	5.97	6.02	0.80	98.27	9.60	12.61
9.	No. of fruits per vine	3.12	2.86-3.28	12.14	12.27	1.69	98.17	0.78	25.00
10.	Fruit yield per vine (kg)	2.74	1.57-2.92	21.58	21.75	2.87	98.29	1.15	42.02
11.	Average weight of fruit(g)	847.12	584.12-915.17	16.09	16.27	2.42	97.80	274.26	32.41
12.	Average length of fruit (cm)	11.48	9.12-12.09	12.61	12.63	0.35	99.92	2.73	23.85
13.	Average diameter of fruit (cm)	12.18	10.35-13.23	7.25	7.29	0.21	99.93	1.71	14.07
14.	Average rind thickness (cm)	0.25	0.19-0.28	14.97	15.18	2.32	97.63	0.09	36.25
15.	Average pulp thickness (cm)	2.63	1.87-2.95	12.98	13.01	0.95	99.47	0.67	25.01
16.	Average fruit cavity (cm)	41.32	32.82-43.55	9.01	9.02	0.32	99.91	7.59	18.41
17.	Average weight of pulp per fruit (gm)	612.32	424.34-672.31	23.14	23.35	3.24	98.10	269.58	44.10
18.	Average weight of seed per fruit (gm)	11.18	10.12-12.21	10.25	10.27	0.81	99.41	2.31	21.72
19.	T.S.S. (%)	12.14	11.31-12.54	10.76	11.23	3.37	91.18	2.89	23.82
20.	Acidity (%)	1.21	1.17-1.32	10.21	11.72	5.78	75.86	0.21	17.41
21.	Ascorbic acid (%)	25.09	24.31-25.59	9.17	9.20	3.11	75.06	4.51	18.01
22.	Total Sugar (%)	9.52	9.23-9.81	4.02	4.07	0.62	97.67	0.79	8.31
23.	Reducing sugar (%)	7.05	6.95-7.31	7.71	7.93	0.33	67.98	0.57	8.01
24.	Non reducing sugar (%)	2.45	1.97-2.48	6.84	6.94	1.18	97.14	0.33	13.42

Conclusion

A good range of variability was observed for all twenty four traits of muskmelon in cross IVMM-3 x Punjab Sunheri of F_5 generation. The genotypic coefficient of variation was lower than the phenotypic coefficient of variations in all quantitative traits role of environment in the phenotypic expression of traits were recorded high values of genotypic coefficient of variation and phenotypic coefficient of variations for most of the character *viz*., final vine length, number of primary branches per vine, number of male flowers per vine, number of female flowers per vine, sex ratio, number of fruits per vine, fruit yield per vine, average weight of fruit, average rind thickness, average fruit cavity, average weight of pulp per fruit, average weight of seed per fruit, total soluble solids (°Brix) and acidity indicating presence of substantial amount of genetic variation for these characters, which can be effectively exploited in future crop improvement. Thus, it can be advocated that number of fruits per plant and total soluble solids deserve more weightage for effective selection of genotypes to improve fruit yield in muskmelon.

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