Genetic Variability and Character Association in Muskmelon (*Cucumis melo* L.)

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Genetic variability, heritability (h^2), genetic advance, character association and path analyses were carried out in 35 accession of muskmelon (*Cucumis melo* L.). The observations were recorded on 13 characters. The high phenotypic (PCV) and genotypic (GCV) coefficience of variation was observed high for yield and fruit weight, while, the lowest phenotypic and genotypic coefficience of variation were observed for number of days to first female flower anthesis followed by number of day to 50% male flower anthesis and number of days to 50% female flower anthesis. High heritability along with high expected genetic advance were recorded for number of days to 50% female flower anthesis, TSS and number of days to first male flower anthesis. Yield has positive and significant correlation with fruit weight, fruit diameter, length, flesh thickness and rind thickness at both phenotypic and genotypic level. The fruit weight, fruit diameter, length, flesh thickness and rind thickness had positive correlation coefficient among themselves. Higher and positive direct effect on yield was exerted by fruit diameter followed by number of fruits, fruit weight and rind thickness. Direct selection based on fruit diameter and fruit weight results in an appreciable improvement for total yield. Besides direct selection for fruit yield, indirect selection through the fruit length and number of fruits should be considered for further improvement of yield.

Key words: *Cucumis melo*, Variability, Correlation, Path analysis

Muskmelon (*Cucumis melo* L.) belong to family cucurbitaceae is used as desert fruit and vegetable in variety of ways. Muskmelon is rich in quality and nutritive value. Evaluation of the available variability is prerequisite for planning the value added improvement programme. The germplasm, which maintain in heterogeneous environment may be genetically diverse and can provide a plenty of scope for screening the better genotype with specific traits. Knowledge on the nature and magnitude of variation provide a rational choice of character(s) on which selection can be exercised. The observed variability is a combined estimate of genetic and environmental factors, of which only former one is heritable. However the estimate of heritability alone does not provide an idea about the expected gain in next generation, therefore it has been considered in conjunction with genetic advance. Correlation and path analysis establish the extent of association between yield and its components and also bring out relative importance of their direct and indirect effects. This gives a clear understanding of their association with yield. Hence, the present study was carried out to assess the performance of various economic traits and to measure the extent of variability, heritability, expected genetic advance and interrelationship of yield components in muskmelon.

Materials and Methods

Thirty-five accessions of muskmelon were grown in Completely Randomized Blocks Design with three replications with row-to-row distance of 1.5 m and plant-to-plant distance of 40 cm during summer, 2001. Eight plants were maintained in each plot. All the cultural practices and fertilizers were given as per recommendations for proper growth and stand of the crop as and when required. The observations were recorded on five competitive plants for each treatment in each replication selected at random for number of days taken to first male flower anthesis, number of days taken to 50% male flower anthesis, number of days taken to first female flower anthesis, number of days taken to 50% female flower anthesis, number of node at which first female flower appears, number of fruits per plant, average fruit weight (kg), fruit diameter (cm), fruit length (cm), flesh thickness (cm), rind thickness (cm), total soluble solids (%) and yield per plant (kg). Data were averaged and analysed for standard statistical procedure followed for estimating the genotypic and phenotypic coefficient of variation (Burton, 1952), heritability (Hanson *et al.*, 1956) and genetic advance (Johnson *et al.*, 1955). Phenotypic and genotypic correlation coefficients were calculated following Al-Jibouri *et al.*, (1958) and path analysis following the method of Dewey and Lu (1959).

Results and Discussion

The mean performance of genotypes (Table 1) indicated widest range for number of days to first 50% female flower anthesis (43.33-56.00) followed by number of days to 50% male flower anthesis (40.00-52.00) and number of days to first male flower anthesis, while the narrowest range was observed for rind thickness (0.02-0.04) followed by average fruit weight (0.15-0.70)

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and yield per plant (0.25-1.49). The analysis of variance indicated highly significant variation among the genotypes for all characters (Table 2). This variability may be due to genetic constitution of the materials as well as environmental influences. The estimates of mean, range, phenotypic (PCV) and genotypic (GCV) coefficient of variation, heritability (h^2) and genetic advance is presented in table 3. Maximum mean value (43.33-56.00) was observed for number of days to 50% female flower anthesis with an average of 46.78. The minimum range

Table 1. Mean values of the 35 genotypes

Variety	Number of days to first male flower anthesis	Number of days to 50% male-flower anthesis	Number of days to first female flower anthesis	Number of days to 50% female flower anthesis	No. of node at which first female flower appear	No. of fruits per plant	Average fruit weight (kg)	Fruit diameter (cm)	Fruit length (cm)	Flesh thickness (cm)	Rind thickness (cm)	T.S.S. (%)	Yield per plant (kg)
VRM-5C	42.00	45.67	48.00	53.00	3.33	1.30	0.20	8.00	8.00	1.50	.20	6.20	0.26
MH-16-2	38.00	42.00	41.67	51.00	8.00	3.50	0.30	8.50	8.50	2.10	.20	5.17	0.80
VRM-17B	38.00	45.00	48.00	51.00	5.33	2.00	0.65	12.00	9.00	3.10	.20	7.17	1.30
MH-61-4	46.00	42.67	41.67	50.33	4.17	1.60	0.51	9.0	7.50	1.50	.20	3.73	1.17
MH-13A	38.00	41.00	47.00	49.33	3.67	2.00	0.70	10.5	9.00	2.50	.20	7.53	1.40
MH-14	38.00	41.67	46.00	49.67	7.33	1.30	0.52	10.0	8.00	2.00	.31	8.83	0.69
MH-2-1	39.67	44.00	46.00	46.00	6.00	2.00	0.42	9.0	8.50	3.00	.40	6.13	0.97
MH-2-4	42.67	46.00	50.00	46.00	5.00	2.00	0.32	7.0	7.50	1.50	.20	6.97	0.64
MH-5	38.00	48.00	44.00	49.67	7.50	2.00	0.25	5.5	5.20	1.50	.15	6.50	0.59
MH-5A	37.67	41.00	45.00	52.67	4.00	2.60	0.40	9.33	8.50	2.00	.21	8.00	1.03
MH-61(2)	39.00	46.00	44.33	49.00	5.13	2.80	0.60	11.0	10.50	2.53	.33	7.33	1.49
VRM-12	37.33	40.67	47.67	47.00	2.93	2.00	0.22	7.0	7.50	1.50	.11	5.00	0.43
VRM-17B-1	37.00	52.00	48.67	51.00	5.40	2.30	0.35	7.33	7.33	1.87	.21	5.00	1.10
VRM-20	38.00	44.00	46.00	43.33	4.50	2.30	0.20	7.0	6.00	1.50	.12	8.00	0.57
VRM-20-1	39.00	40.00	49.33	53.00	5.50	1.60	0.30	8.0	8.00	2.60	.20	5.17	0.60
VRM-32(1)	37.00	43.00	48.00	55.00	5.27	2.30	0.16	7.0	6.00	1.60	.15	5.50	0.6
VRM-32(2)	35.67	42.67	46.00	54.00	5.33	2.00	0.25	7.9	7.07	1.80	.20	4.00	0.50
VRM-32A	37.00	43.00	50.67	53.67	4.33	2.30	0.25	7.50	8.00	1.50	.02	6.33	0.61
MJ-1	37.33	42.00	47.00	54.00	5.00	2.00	0.30	10.0	8.00	1.560	.20	7.20	1.37
MJ-4	45.00	46.00	50.00	56.00	8.00	1.30	0.50	10.5	7.27	2.50	.14	8.40	0.63
MJ-8	38.00	42.00	46.00	53.00	5.67	2.30	0.20	8.0	7.00	1.50	.10	8.33	0.45
MJ-12	41.67	46.00	48.33	51.00	5.17	2.60	0.30	8.77	7.50	1.50	.14	7.00	0.76
MJ-25	38.00	42.00	47.67	53.00	5.17	2.30	0.20	6.5	6.00	1.50	.20	9.00	0.51
MJ-26	43.00	46.00	46.00	49.00	6.00	2.30	0.45	10.0	8.50	2.40	.20	7.50	1.11
MJ-31	47.00	48.00	50.00	56.00	5.83	2.00	0.37	9.5	6.00	2.10	.12	6.00	1.32
MM-1	38.00	42.00	46.00	48.33	4.50	2.80	0.38	8.0	7.00	2.00	.20	8.00	1.05
MM-4	38.00	41.67	46.00	48.00	4.00	3.83	0.45	9.0	10.00	2.50	.20	6.00	1.40
MM-7	42.00	46.00	45.00	50.00	3.67	3.40	0.15	6.0	5.50	1.50	.15	5.00	0.62
MM-10	43.00	46.00	47.00	51.00	3.83	2.53	0.18	7.0	6.00	1.50	.14	7.50	0.38
MM-20	39.00	44.00	46.00	50.33	4.00	3.00	0.20	7.47	6.50	1.80	.11	9.00	0.55
MM-25	42.00	46.00	45.33	51.33	5.50	1.50	0.18	6.00	6.00	1.50	.12	8.83	1.25
Bihar	42.00	45.00	46.00	47.00	4.33	1.30	0.62	11.50	9.00	2.50	.20	7.13	0.93
GZB-2	37.00	42.00	46.00	51.00	3.17	2.37	0.21	6.0	10.00	2.00	.20	8.07	0.57
Arkajeet	42.00	45.00	49.00	52.00	4.00	2.60	0.40	7.13	6.50	1.50	.14	8.00	1.28
Indira	37.00	42.00	48.00	52.00	4.67	2.60	0.50	9.00	8.50	2.00	.13	10.00	1.40
SEM	1.31	4.56	1.27	1.30	0.88	0.51	0.02	0.88	0.58	0.28	.01	0.48	0.22
C.D. at 5%	2.58	3.07	2.50	2.55	1.72	1.00	0.05	1.72	1.13	0.54	.03	0.95	0.43

Table 2. Analysis of variance

Source of Variance	d.f	Number of days to first male flower anthesis	Number of days to 50% male-flower anthesis	Number of days to first female flower-anthesis	Number of days to 50% female flower-anthesis	No. of node at which first female flower appear	No. of fruits per plant	Average fruit weight (Kg)	Fruit dia-meter (cm)	Fruit length (cm)	Flesh thick-ness (cm)	Rind thick ness (cm)	T.S.S. (%)	Yield per plant (Kg)
Replication	2	1.91	1.062	0.492	4.85	1.085	2.748	0.010	7.017	1.323	0.106	0.00303	1.267	0.293
Treatment	34	24.73**	20.027**	13.45**	36.0**	4.886**	1.124**	0.070**	8.275**	5.278**	0.692**	0.0141**	6.904**	0.4288**
Error	68	1.30	1.851	1.23	1.27	0.582	0.195	0.00062	0.582	0.251	0.057	0.00022	0.177	0.0361

* Significant at 5% probability level, ** Significant at 1% probability level.

Table 3. Range, mean, variability, heritability and genetic advance

Character	Range		Mean	Variability		Heritability	Genetic advance
	Min.	Max.		PCV	GCV		
No. of days to first male flower anthesis	35.67	47.0	39.66	7.61	7.05	85.70	5.33
No. of days to 50% male flower anthesis	40.00	52.00	43.97	6.40	5.60	76.60	4.44
No. of days to first female flower anthesis	41.67	50.67	46.78	4.92	4.31	76.80	3.64
No. of days to 50% female flower anthesis	43.33	56.00	50.79	7.08	6.72	90.10	6.65
No. of node at which first female flower appear	2.93	8.00	5.00	28.37	23.92	71.10	2.08
No. of fruits per plant	1.30	3.83	2.25	31.64	24.76	61.20	0.90
Average fruit weight (kg)	0.15	0.70	0.35	44.48	43.90	97.40	0.31
Fruit diameter (cm)	5.50	12.00	8.34	21.27	19.20	81.50	2.98
Fruit length (cm)	5.20	10.50	7.58	18.31	17.07	86.90	2.49
Flesh thickness (cm)	1.50	3.10	1.92	26.93	23.90	78.80	0.84
Rind thickness (cm)	0.02	0.40	0.18	38.79	37.88	95.40	0.14
TSS (%)	3.73	10.00	6.96	22.36	21.52	92.70	2.97
Yield per plant (kg)	0.25	1.49	0.83	49.14	43.49	78.40	0.66

of mean value (0.02-0.04 cm) with an average of 0.18 cm was recorded for rind thickness. High magnitude of phenotypic coefficient of variance than the genotypic values indicated considerable influence of environment on the expression of the characters. The maximum phenotypic coefficience of variation (PCV) was observed for yield, rind thickness, fruit weight and number of fruits, while the lowest phenotypic coefficience of variation were observed for number of days to first female flower anthesis followed by number of day to 50% male flower anthesis and number of days to 50% female flower anthesis. Moderate phenotypic coefficient of variation was exhibited by flesh thickness, TSS (total soluble solids) and fruit diameter. Similar results have been reported by Prasad and Prasad (1978a). Whereas, high genotypic coefficient of variation observed for yield, fruit weight and flesh thickness. The lowest value of genotypic coefficience of variation were observed for number of days to first female flower anthesis followed by number of day to 50% male flower anthesis and number of days to 50% female flower anthesis. These results are in conformity with the findings of Singh *et al.*, (1989). Average genotypic coefficient of variability recorded for number of fruits, flesh thickness and TSS.

Heritability values ranged from 61.20% to 97.40% for the characters under study. The highest heritability was noted for fruit weight, rind thickness, TSS and number of days to germination. The above estimates gave an indication that substantial genetic improvement can be achieved in this character (Kalloo *et al.*, 1983). The medium heritability was noted for fruit length and diameter, flesh thickness, number of days to first male flower anthesis and yield. Whereas, lowest heritability was noted for number of days to 50% male flower anthesis, number of days to first female flower anthesis, number of node at which first male flower appears and fruits per plant (Prasad and Singh, 1992). The value of expected genetic advance was highest for number of days to 50% female flower anthesis, followed by number of days to first male flower anthesis and number of days to 50% male flower anthesis. However, low value of genetic advance was recorded for rind thickness, flesh thickness, fruit weight, yield and fruits per plant (Mangal *et al.*, 1981). High heritability along with high expected genetic advance were recorded for number of days 50% female flower anthesis, TSS and number of days to first male flower anthesis (Pandey *et al.*, 2002). The magnitude of high heritability coupled with moderately low genetic advance was observed for fruit weight, rind thickness, flesh thickness, fruit length, and yield, which may be due to dominance and inter-allelic interaction (Kalloo *et al.*, 1983).

Genotypic correlation coefficient was higher than their corresponding phenotypic correlation coefficience for most of the characters except number of days to first male flower anthesis, number of fruits and TSS (Table 4). A perusal of data revealed that yield has positive and significant correlation with fruit weight, fruit diameter and length, flesh thickness and rind thickness at both phenotypic and genotypic level. The fruit weight, fruit diameter and length, flesh thickness and rind thickness had positive correlation coefficient among themselves (Vijay, 1987). Higher and positive direct effect (at the genotypic level) on yield was exerted by fruit diameter followed by number of fruits, fruit weight and rind thickness (Table 5). All above discussed characters also showed positive correlation with yield. This indicated that direct selection based on fruit diameter and fruit weight results in an appreciable improvement for total yield. However, number of days to 50% male flower

Table 4. Estimates of genotypic and phenotypic correlation coefficients

Characters	Number of days to first male flower anthesis	Number of days to 50% male flower anthesis	Number of days to first female flower-anthesis	Number of days to 50% female flower-anthesis	Number of node at which first female-flower appear	Number of fruits per plant	Average fruit weight (Kg)	Fruit diameter (cm)	Fruit length (cm)	Flesh thickness (cm)	Rind thickness	T.S.S. (%)	Yield per plant
	1	2	3	4	5	6	7	8	9	10	11	12	13
1		0.450 0.352*	0.093 0.084	0.101 .093	0.079 0.060	-0.295 -0.243	0.127 0.124	0.146 0.141	-0.253 -0.199	-0.031 -0.016	-0.083 -0.049	-0.079 -0.054	0.056 0.016
2			0.225 0.178	-0.008 0.022	0.251 0.190	-0.077 -0.071	-0.049 -0.039	-0.110 -0.069	-0.321 -0.290*	-0.74 -0.058	-0.049 -0.043	-0.081 -0.051	0.003 0.017
3				0.303 0.271	-0.094 -0.101	-0.318 -0.201	-0.046 -0.54	0.015 0.064	-0.129 -0.076	-0.011 0.017	-0.356 -0.298*	0.167 0.120	-0.056 -0.066
4					0.215 0.162	-0.156 -0.086	-0.090 -0.103	0.063 0.230	-0.111 -0.070	-0.066 -0.065	-0.229 -0.196	-0.053 -0.043	-0.049 -0.015
5						-0.236 -0.122	0.144 0.136	0.149 -0.267	-0.121 -0.146	0.270 0.210	0.233 0.180	-0.060 0.040	-0.026 -0.027
6							-0.198 -0.147	-0.114 0.882**	0.069 0.637	-0.012 -0.082	-0.121 -0.075	0.040 -0.021	0.280 0.206
7								0.797 0.703**	0.580 0.656**	0.755 0.646**	0.456 0.438**	-0.030 0.127	0.799 .694**
8									0.556 0.496**	0.772 0.590**	0.403 0.375**	0.116 0.068	0.725 0.560
9										0.677 0.572**	0.498 0.452**	0.023 0.029*	0.523 .433**
10											0.591 0.493**	0.020 0.020	0.567 0.402*
11												-0.085 -0.085	0.340 0.308*
12													0.033 0.032

* Significant at 5% probability level, ** Significant at 1% probability level

Table 5. Direct (diagonal) and indirect effects of different traits on yield (Genotypic)

Characters	Number of days to first male flower anthesis	Number of days to 50% male flower anthesis	Number of days to first female flower-anthesis	Number of days to 50% female flower-anthesis	Number of node at which first female-flower appear	Number of fruits per plant	Average fruit weight (Kg)	Fruit diameter (cm)	Fruit length (cm)	Flesh thickness (cm)	Rind thickness	T.S.S. (%)	Genetic correlation coefficient with yield
	1	2	3	4	5	6	7	8	9	10	11	12	13
1	**0.046**	-0.050	0.044	0.001	0.000	-0.260	0.083	0.146	0.045	0.026	-0.030	0.004	0.056
2	0.021	**-0.111**	0.107	0.000	0.001	-0.068	-0.032	-0.110	0.057	0.063	-0.018	0.004	0.003
3	0.004	-0.025	**0.476**	0.004	0.000	-0.280	-0.030	-0.002	0.023	0.010	-0.130	-0.009	-0.056
4	0.005	0.001	0.144	**0.014**	0.001	-0.137	-0.059	0.064	0.019	0.056	-0.084	0.003	-0.049
5	0.004	-0.028	-0.045	0.003	**0.004**	-0.208	0.094	0.231	0.021	-0.231	0.085	-0.002	-0.026
6	-0.014	0.009	-0.151	-0.002	-0.001	**0.880**	-0.129	-0.267	-0.012	0.010	-0.044	0.001	-0.280
7	0.006	0.005	-0.022	-0.001	0.001	-0.174	**0.651**	0.883	-0.112	-0.644	0.167	-0.007	0.799
8	0.007	0.012	-0.001	0.001	0.001	-0.235	0.575	**1.001**	-0.116	-0.659	0.148	-0.005	0.725
9	-0.012	0.036	-0.061	-0.002	-0.001	0.061	0.415	0.656	**-0.176**	-0.578	0.182	-0.001	0.560
10	-0.001	0.008	-0.005	-0.001	0.001	-0.010	0.492	0.773	-0.119	**-0.853**	0.216	-0.001	0.567
11	-0.004	0.005	-0.169	-0.003	0.001	-0.107	0.297	0.403	-0.088	-0.504	**366**	0.004	0.340
12	-0.004	0.009	0.080	-0.001	0.000	-0.019	0.083	0.105	-0.004	-0.017	-0.031	**-0.052**	0.033

* Significant at 5% probability level, ** Significant at 1% probability level. Genotypic residual effect – 0.0606

anthesis, fruit length, flesh thickness and TSS was exerted negative direct effect on yield. From the results of this investigation, it is concluded that besides direct selection for fruit yield, indirect selection through the fruit length and number of fruits per plant should be considered for further improvement of yield in muskmelon. Few genotypes MH-6I-2, MH-13A, MM-4, Indira, MJ-1, MJ-31, VRM-17B and Arka Jeet were found promising in order as for as yield and other above mentioned important yield contributing traits are concerned. Thus, by exploiting the above listed genotypes, there is good scope of improvement through selection in many of the economic traits by making judicious use of the available information gathered from the study.

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