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Correlation among growth, yield and quality attributes in the indigenous and exotic accessions of Cucumis *melo* L.

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Correlation among growth, yield and quality attributes in Cucumis *melo* L. were estimated using the randomized complete block design (RCBD). Ninety-six variable lines representing different melon types were used in this study. The correlation study in melon, number of fruits per vine exhibited significant and negative correlation with fruit weight, seed cavity length, rind thickness, fruit length and ascorbic acid content, whereas fruit weight had significant and positive correlation with seed cavity length, fruit length and dry matter content. However, rind thickness recorded positive and significant correlation with ascorbic acid content and shelf life. The total soluble solid content depicted positive and significant correlation with ascorbic acid content. However, it displayed negative and significant correlation with titrable acidity. Titrable acidity showed significant and negative correlation with ascorbic acid content, whereas ascorbic acid content recorded positive and significant correlation with shelf life. Days from sowing to marketable maturity displayed positive and significant correlation with days from sowing to last fruit harvest and fruit weight. However, days from sowing to last fruit harvest revealed positive and significant correlation with shelf life with fruit weight. Node at which first hermaphrodite flower appears displayed positive and significant correlation with fruit weight and titrable acidity. However, it depicted negative and significant correlation with total soluble solids content.

Key words: Ascorbic acid, correlation, melon

Introduction

Melon (*Cucumis melo* L. $2n = 2x = 24$) belongs to family Cucurbitaceae, subfamily *Cucurbitoideae* tribe *Melothrieae* and subtribe *Cucumerinae*. The center of origin of muskmelon is not known with certainty but as the wild species of *Cucumis* occur in Africa, it is likely that it originated in that continent. However, a recent study showed that melon is of Asian origin (Sebastian *et al.*, 2010). Melon is an important horticultural crop grown in temperate, subtropical and tropical regions of world. Information on the

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correlation and linkage among different horticultural characteristics is of primary importance in the field of crop improvement. Linkage relationships can be used to increase breeding efficiency by allowing earlier selection and reducing plant population size during selection (Staub, 1999). Most practical breeding programmes aim at developing a variety that has high level of expression for each of the desirable traits. Fruit growth, yield and quality attributes assumes a greater significance from consumers view points (Chada and Lal, 1993) in this crop. In order to combine an optimum balance of fruit quality traits without adversely affecting other economic traits in one variety, knowledge on character correlations in the base material to be used in the breeding programme is imperative. Accordingly, this study was undertaken in the eighty-eight accessions from Uttrakhand and Uttar Pradesh states of India representing four agro-ecological regions (six sub regions) and eight reference accessions from USA. These accessions belonging to a broad range of melon horticultural type (*cantalupensis, reticulatus and momordica).*

Material and methods

The study was conducted at the Department Vegetable Experimental Farm, Punjab Agricultural University, Ludhiana, during spring-summer season of 2009-2010. The soil type of the experimental field was sandy loam in nature. The mean annual rainfall is 704.5 mm per year and the annual mean maximum and minimum temperatures were 21.2-41.2 and 5.8-27.1 ^{o} respectively. Ninety-six accessions of melon (Table 1) including eighty-eight accessions from Uttrakhand and Uttar Pradesh states of India representing four agro-ecological regions (six sub regions) and eight reference accessions from USA were studied. These accessions belonging to a broad range of melon horticultural type (*cantalupensis, reticulatus and momordica).* Seeds of these accessions were sown in the polythene bags of 15 cm x 10 cm size and of 100-gauge thickness punched at the base and filled with a mixture of soil, well rotten farm yard manure and silt in equal proportions at two true leaf stage were transplanted in the field at a spacing of 3.0 m x 0.45 m.Ten plants of each accession were arranged in a randomized complete block design. In each replication, five plants of each accession were used for data recording for following traits viz., node at which first hermaphrodite flower appears, number of primary branches/vine, days from sowing to marketable maturity, days from sowing to last fruit harvest, number of fruits per vine, fruit weight (g), fruit Length (cm), fruit breadth (cm), seed cavity length (cm), seed cavity breadth (cm), rind thickness (mm), shelf life (days). These accessions were also evaluated for biochemical traits viz. Total soluble solids content (%), titrable acidity (%), ascorbic acid content (mg/100g of fruit weight) and dry matter content (%). Total soluble solids were measured from fruit juice using a hand refractometer. Ascorbic acid was quantified as described by Heinze *et al.* (1944). Titrable acidity (%) was determined by titration of a fruit juice sample with 0.05 N NaOH, using phenolphthalein as indicator.

Results and discussions

In plant breeding, the degree of association of plant characters has always been useful for selection. The existence of association between different characters is usually determined by studying correlation existing between them. For this purpose, it is important to know the genetic correlation among different characters, which may provide information regarding the correlated response to selection. Phenotypic and genotypic correlation coefficients between different characters based on pooled data of two years (2009 and 2010) are presented in Table 2. The natural genetic variation for most of the yield attributes is considerable in this crop and there is a need to broaden the genetic base of the new varieties. Correlation study between fruit weight and their relative contribution to yield will be of value in planning a melon breeding programme (Chhonkar *et al.*, 1979).

Based on simple correlation fruit characters namely seed cavity length (0.753 and 0.775), fruit length (0.744 and 0.764), dry matter content (0.602 and 0.625) and fruit breadth (0.281 and 0.331) were found to be positively correlated with fruit weight. Therefore, it is obvious that fruit weight can be easily manipulated to the desired level through selection based on these characters. It was further noted that these characters were positively correlated among themselves also. This indicated that there is no hindrance in manipulating melon fruit size through breeding approaches. Given the negative correlation between fruit number per vine and average fruit weight, the development of genotypes capable of supporting moderate number of fruits along with maintaining commercially acceptable fruit size is desirable. Increasing the yield of melon through increasing the number of fruits alone with high TSS may be a challenge for breeder. Therefore, to increase fruit weight, seed cavity length, fruit length and fruit breadth can be used as selection indices.

Node at which first hermaphrodite flower appears and days from sowing to marketable maturity showed highly significant and positive correlation with fruit weight (0.694 and 0.720) and (0.325 and 0.424), respectively. As node at which first hermaphrodite flower appears and days from sowing to marketable maturity are characters of earliness, indicating association of fruit weight with these characters.

In melon, fruit quality assumes a great significance from consumer's point of view. Though TSS did not show positive and significant, correlation with the important traits the reason being large number of genotypes used and genetic divergence, but this trait is given utmost importance during selection in muskmelon. Thus, it could be concluded that although heavier fruits tend to have lower total soluble solids content but maintaining a desirable total soluble solids content with optimum fruit size should be objective of breeder (Singh and Ram, 2003).

Total soluble solids content displayed significant and positive correlation with ascorbic acid content both are important quality traits. Hence selection for these traits would bring about an improvement in melon quality. However, total soluble solids content and ascorbic acid content exhibited significant and negative correlation with titrable acidity. From this investigation it was clear that high acid containing genotypes do not accumulate the high level of total soluble solids content and combination of high acid and high sugar does not appear to occur in these genotypes. This compliments the findings of Stepansky *et al.* (1999b). However, independent genetic control of sugar and acid accumulation in sweet melon has been demonstrated (Burger *et al.*, 2003). Therefore, the combination of these two traits in melon opens up the possibility of breeding a unique tasting melon.

Table 1. Sources of melon accessions

S. No.	Accession	Zone	Sub zone	S. No.	Accession	Zone	Sub zone
1	MM-3833 *C. melo* var. *cantalupensis*	13	13.1	49	MM-3903 *C. melo* var. *cantalupensis*	9	9.2
2	MM-4004 *C. melo* var. *momordica*	9	9.2	50	MM-4253 *C. melo* var. *cantalupensis*	9	9.2
3	MM-3837 *C. melo* var. *cantalupensis*	13	13.1	51	MM-3885 *C. melo* var. *reticulatus*	13	13.1
4	MM-3917 *C. melo* var. *cantalupensis*	9	9.2	52	MM-4256 *C. melo* var. *cantalupensis*	4	4.3
5	MM-4005 *C. melo* var. *momordica*	9	9.1	53	MM- 4026 *C. melo* var. *cantalupensis*	9	9.1
6	MM-3839 *C. melo* var. *cantalupensis*	13	13.1	54	MM- 3909 *C. melo* var. *cantalupensis*	9	9.2
7	MM-3947 *C. melo* var. *cantalupensis*	9	9.2	55	MM-4267 *C. melo* var. *momordica*	4	4.3
8	MM-4013 *C. melo* var. *cantalupensis*	9	9.1	56	MM-4030 *C. melo* var. *cantalupensis*	9	9.1
9	MM-3843 *C. melo* var. *cantalupensis*	13	13.1	57	MM- 3901 *C. melo* var. *reticulatus*	9	9.2
10	MM-3955 *C. melo* var.	14	14.5	58	MM- 4268 *C. melo* var.	9	9.2

	cantalupensis				*reticulatus*		
11	MM-4018 *C. melo* var. *cantalupensis*	9	9.1	59	MM-3962 *C. melo* var. *momordica*	14	14.5
12	MM-3849 *C. melo* var. *cantalupensis*	13	13.1	60	MM-4270 *C. melo* var. *cantalupensis*	9	9.2
13	MM-3956 *C. melo* var. *cantalupensis*	14	14.5	61	MM-4276 *C. melo* var. *cantalupensis*	9	9.2
14	MM-4021 *C. melo* var. *cantalupensis*	9	9.1	62	MM-3963 *C. melo* var. *cantalupensis*	13	13.2
15	MM-3851 *C. melo* var. *cantalupensis*	13	13.1	63	MM-4271 *C. melo* var. *reticulatus*	9	9.2
16	MM-3961 *C. melo* var. *cantalupensis*	14	14.5	64	MM-4277 *C. melo* var. *reticulatus*	9	9.2
17	MM-4057 *C. melo* var. *cantalupensis*	9	9.1	65	MM- 4282 *C. melo* var. *cantalupensis*	9	9.2
18	MM-3855 *C. melo* var. *cantalupensis*	13	13.1	66	MM-4278 *C. melo* var. *cantalupensis*	9	9.2
19	MM-4066 *C. melo* var. *reticulatus*	9	9.2	67	MM-3965 *C. melo* var. *cantalupensis*	14	14.5
20	MM-4059 *C. melo* var. *reticulatus*	9	9.1	68	MM-4283 *C. melo* var. *cantalupensis*	9	9.2
21	MM-3856 *C. melo* var. *cantalupensis*	13	13.1	69	MM-4279 *C. melo* var. *reticulatus*	9	9.2
22	MM-4067 *C. melo* var. *cantalupensis*	9	9.2	70	MM-3966 *C. melo* var. *reticulatus*	14	14.5
23	MM-4063 *C. melo* var. *cantalupensis*	9	9.2	71	MM-3981 *C. melo* var. *cantalupensis*	9	9.1
24	MM-4098 *C. melo* var. *cantalupensis*	13	13.1	72	MM-3968 *C. melo* var. *reticulatus*	14	14.5
25	MM-4068 *C. melo* var. *cantalupensis*	9	9.2	73	MM-4305 *C. melo* var. *cantalupensis*	9	9.2
26	MM-4065 *C. melo* var. *reticulatus*	9	9.2	74	MM-3982 *C. melo* var. *momordica*	9	9.1
27	MM-3859 *C. melo* var. *cantalupensis*	13	13.1	75	MM-3973 *C. melo* var. *cantalupensis*	9	9.1
28	MM-3860 *C. melo* var. *reticulatus*	13	13.1	76	MM-3983 *C. melo* var. *cantalupensis*	9	9.1
29	MM-4409 *C. melo* var. *cantalupensis*	9	9.1	77	MM-3974 *C. melo* var. *momordica*	9	9.1
30	MM-3864 *C. melo* var. *cantalupensis*	13	13.1	78	MM-4342 *C. melo* var. *cantalupensis*	9	9.2
31	MM- 4091 *C. melo* var. *momordica*	9	9.2	79	MM-3985 *C. melo* var. *cantalupensis*	9	9.1
32	MM- 3866 *C. melo* var. *cantalupensis*	13	13.2	80	MM-3976 *C. melo* var. *reticulatus*	9	9.1
33	MM- 3868 *C. melo* var. *cantalupensis*	13	13.2	81	MM-3986 *C. melo* var. *cantalupensis*	9	9.1
34	MM-3857 *C. melo*	9	9.2	82	MM-3977 *C. melo* var.	9	9.1

	var. *cantalupensis*				*reticulatus*		
35	MM-4243 *C. melo* var. *cantalupensis*	4	4.3	83	MM-3998 *C. melo* var. *momordica*	9	9.1
36	MM-5736 *C. melo* var. *momordica*	13	13.1	84	MM-3979 *C. melo* var. *cantalupensis*	9	9.1
37	MM-3874 *C. melo* var. *cantalupensis*	13	13.1	85	MM-4002 *C. melo* var. *cantalupensis*	9	9.1
38	MM-4247 *C. melo* var. *momordica*	9	9.2	86	MM-3994 *C. melo* var. *momordica*	9	9.1
39	MM-3881 *C. melo* var. *cantalupensis*	13	13.1	87	MM-3980 *C. melo* var. *cantalupensis*	9	9.1
40	MM-4248 *C. melo* var. *cantalupensis*	9	9.2	88	MM-4003 *C. melo* var. *cantalupensis*	9	9.1
41	MM-4250 *C. melo* var. *cantalupensis*	9	9.2	89	AR-hales *C. melo* var. *reticulatus*		
42	MM-3850 *C. melo* var. *cantalupensis*	13	13.1	90	Dulce-B.B *C. melo* var. *reticulatus*	USA	
43	MM-3887 *C. melo* var. *momordica*	13	13.1	91	Gulf coast *C. melo* var. *reticulatus*		
44	MM-4251 *C. melo* var. *cantalupensis*	9	9.2	92	Gulf stream *C. melo* var. *reticulatus*		
45	MM-3858 *C. melo* var. *cantalupensis*	13	13.1	93	Jucumba *C. melo* var. *reticulatus*		
46	MM- 3889 *C. melo* var. *cantalupensis*	13	13.1	94	Rocky ford *C. melo* var. *reticulatus*		
47	MM-4252 *C. melo* var. *reticulatus*	4	4.3	95	Hannahs choice *C. melo* var. *reticulatus*		
48	MM-3884 *C. melo* var. *cantalupensis*	13	13.1	96	Chujac *C. melo* var. *reticulatus*		

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Table 2. Estimates of coefficients of correlation between different characters of melon

Character		**Node at which first hermaphrodite flower appears**	**Number of primary branches/ vine**	**Days from sowing to marketable maturity**	**Days from sowing to last fruit harvest**	**Number of fruiits per vine**	**Fruit weight (g)**	**Fruit length (cm)**	**Fruit breadth (cm)**	**Seed cavity length (cm)**	**Seed cavity breadth (cm)**	**Rind thickness (mm)**	**Total soluble solids content (%)**	**Titrable acidity (g anhydrous citric acid/100ml fruit juice)**	**Ascorbic acid content (mg/100 g of fruit weight)**	**Dry matter content (%)**
Number of primary branches/ vine	P	0.576														
	G	0.590														
Days from sowing to marketable maturity	P	0.337	0.145													
	G	0.445	0.196													
Days from sowing to last fruit harvest	P	0.130	-0.073	0.335*												
	G	0.207	-0.078	0.453*												
Number of fruits per vine	P	-0.056	0.089	-0.043	0.072											
	G	-0.100	0.093	-0.081	0.158											
Fruit weight (g)	P	0.694*	0.300	0.325*	0.123*	-0.408*										
	G	0.720*	0.312	0.424*	0.201**	-0.479*										
Fruit length (cm)	P	0.517	0.602*	0.216	-0.047	-0.370*	0.744*									
	G	0.537	0.645**	0.277	-0.058	-0.440*	0.764*									
Fruit breadth (cm)	P	0.223	0.190	-0.154	-0.074	-0.066	0.281	0.430								
	G	0.264	0.231	-0.222	-0.169	-0.071	0.331	0.467								
Seed cavity length (cm)	P	0.517	0.567	0.242	-0.042	-0.409*	0.753*	0.955*	0.369*							
	G	0.531	0.586	0.300	-0.071	-0.478*	0.775*	0.981*	0.392*							
Seed cavity breadth (cm)	P	0.270	0.191	0.059	0.005	0.124	0.149	0.183	0.433*	0.206*						
	G	0.275	0.194	0.087	0.063	0.126	0.154	0.190	0.543*	0.217*						

Rind thickness (mm)	P	-0.251	-0.655*	0.032	0.055	-0.304*	0.081	-0.267	-0.150	-0.220*	-0.038					
	G	-0.281	-0.720*	0.054	0.091	-0.445*	0.082	-0.296	-0.151	-0.247*	-0.040					
Total soluble solids content (%)	P	-0.755*	-0.632*	-0.186	-0.110	-0.192	-0.290	-0.264	-0.154	-0.250*	-0.130*	0.516				
	G	-0.810*	-0.677*	-0.255	-0.159	-0.206	-0.329	-0.286	-0.177	-0.264*	-0.140*	0.616				
Titrable acidity (g anhydrous citric acid/100ml fruit juice)	P	0.625**	0.530	0.160	0.064	0.138	0.181	0.128	0.120	0.112	0.153*	-0.415	-0.744*			
	G	0.739*	0.632	0.193	0.210	0.196	0.218	0.153	0.142	0.133	0.187*	-0.527	-0.972*			
Ascorbic acid content (mg/100 g of fruit weight)	P	-0.526	-0.698*	-0.112	-0.066	-0.281*	-0.158	-0.323	-0.198	-0.289*	-0.163*	0.660*	0.726*	-0.607*		
	G	-0.594	-0.792*	-0.144	-0.155	-0.387*	-0.172	-0.369	-0.257	-0.332*	-0.187*	0.774*	0.872*	-0.760*		
Dry matter content (%)	P	-0.061	-0.161	0.008	0.023	0.084	0.602**	0.024	0.178	0.056	0.141*	0.007	0.111	-0.169	0.054	
	G	-0.039	-0.216	0.010	0.114	0.232	0.625**	0.043	0.184	0.062	0.213*	0.037	0.189	-0.236	0.068	
Shelf life (days)	P	0.119	-0.477	0.147	0.199*	-0.142	0.298	-0.168	-0.072	-0.134	0.058*	0.618*	0.243	-0.192	0.433*	0.108
	G	0.121	-0.520	0.216	0.350*	-0.218	0.329	-0.179	-0.073	-0.135	0.061**	0.695*	0.254	-0.224	0.479*	0.163

* Significant at 5% (CD 0.1153), ** Significant at 1 % (CD 0.1508).