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Genetic Diversity and Correlation Coefficient Studies in Muskmelon (*Cucumis melo* L.)

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ABSTRACT

Background: Genetic diversity provides opportunity for plant breeders to develop new and improved cultivars with desirable characteristics, which include both farmer-preferred traits (yield potential and large seed, *etc.*) and breeder preferred traits (pest and disease resistance and photosensitivity, *etc.*). Yield being a complex quantitative character, direct selection for yield may not result in successful improvement. Information on character association and direct and indirect effects of component traits on yield would greatly help in formulating the selection criteria and using them effectively in crop improvement programme. Therefore present study was aimed to evaluate genetic diversity in 25 muskmelon genotypes.

Methods: 25 muskmelon genotypes were evaluated at Dr. Y.S.R Horticultural University, College of Horticulture, Anantharajupeta, during 2017-2018 in randomized block design with three replications. Genetic diversity among genotypes was estimated using Mahalanobis D^2 statistics.

Result: Cluster analysis revealed distinctive clustering pattern and grouped the genotypes in to seven clusters. cluster II was the largest comprising of eight genotypes, while cluster III, IV, VI, VII consist of only one genotype. Cluster VII and IV were found to be considerably different from the rest of the clusters. Genotypes falling in these clusters which are genetically more diverse, can be exploited in a hybridization programmes. Genetic variability in terms of correlation analysis were studied for yield and yield attributing traits. Fruit yield had a positive correlation with fruit volume, fruit diameter, number of fruits per plant, fruit weight and flesh thickness. While it had a negative correlation with days to appearance of first pistillate flower and days to first fruit harvest.

Key words: Correlation coefficient, Genetic divergence, Muskmelon, Yield attributes.

INTRODUCTION

Muskmelon is a cucurbitaceous vegetable crop that is grown all over the world notably in tropical and subtropical regions. It is endemic to tropical Africa with India is serving as secondary centre of diversity. Botanically and culinary it is fruit while biological and cultural similarity to other cucurbitaceous vegetable it's considered as vegetable. In India, muskmelon grows in an area of 54,000 hectares with annual production of about 1.26 million tonnes during the year 2018-2019 (NHB, 2019) and mostly grown in the states of Punjab, Tamil Nadu, Uttar Pradesh, Maharashtra and Andhra Pradesh. Muskmelon gets its name from the musky aroma it produces when ripe. Melons are a store house of health benefits and are also used as a salad. 100 gram fresh weight of the fruits contain 3.5 per cent carbohydrates, 0.6 per cent protein, 0.2 percent fat, 32 mg Ca, 26 mg vitamin C, 16 mg carotene,14 mg phosphorus, 1.4 mg iron. In addition, fruits contain more than 90 per cent water, folic acid and are loaded with many other human health promoting beneficial bioactive compounds (Lester and Hodges, 2008). Besides its multiple uses its production and productivity are very low because of lack of advanced varieties.

The major prominence in muskmelon breeding is on the development of high yielding varieties coupled with good fruit quality. For effective hybridization programme plant breeder has to know the information on genetic divergence among the available germplasm. Mahalanobis D^2 statistics is a convenient tool in quantifying the degree of genotypic divergence among the population and to assess the relative contribution of different components to the total divergence both at inter and intra-cluster levels (Murthy and Arunachalam, 1966; Das and Gupta, 1984). However in muskmelon yield being a complex quantitative character as it is determined by a large number of genes and extensively affected by environmental fluctuations. The correlation study

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indicates the degree of association of plant characters for improvement of yield as well as other important quality parameters in any breeding programme. Correlation studies helps to find out the level of interrelationship among various characters on which selection can be carried for genetic improvement. However correlation gives information only about the nature and extent of association between yield and yield attributing characters and it didn't provide any direct and indirect effects of different yield attributes on yield performance. As a result, the current research was carried out to identify all feasible component features for crop improvement through genetic diversity and character association studies.

MATERIALS AND METHODS

The investigation was carried out in 2018 at Dr.Y.S.R Horticultural University, College of Horticulture, Anantharajupeta, southern agro climatic zone of Andhra Pradesh at an elevation of 162 m above mean sea level lying between the 13°59′North latitude and 79°19′East longitude. Among twenty five muskmelon genotypes used for analysis fifteen genotypes were obtained from NBPGR, Regional station, Jodhpur and nine local genotypes were procured from farmers of Vontimitta mandal, Kadapa district and one genotype from ICAR-IIHR, Bengaluru (Table 1). Under open field conditions twenty five genotypes were evaluated in randomized block design with three replications and in each replication each genotype was grown in a single row of 8 m length with a spacing of 100 × 70 cm accommodating eight plants in each replication. Genetic diversity for 25 muskmelon genotypes were assessed quantitatively for yield and yield attributing traits by using Mahalanobis D^2 statistics. Genotypic and phenotypic correlation coefficients were calculated using the method given by Johnson *et al*. (1955).

RESULTS AND DISCUSSION

Genetic divergence

25 genotypes of muskmelon were grouped into seven clusters on the basis of treating estimated D^2 values as the square of the generalized distance. Among the seven clusters cluster II was the largest comprising of eight genotypes, while cluster III,IV,VI,VII consist of only one genotype (Table 2). Intra and inter D^2 values among seven clusters were presented in Table 3. For selection of genotypes intercluster D^2 values has to be taken in to consideration. Genotypes belonging to cluster I and VII (4353.78), followed by cluster V and VI (2180.83) are genetically more divergent. For hybridization programme selection of parents from these diverse clusters will help in achieving novel recombinants in muskmelon. A wide range of variation was registered in the cluster means for all the characters studied. Cluster VII ranked first with respect to vne length (cm), internodal length, number of nodes, nodes at which first staminate flower appeared, fruit firmness, TSS, total sugars, β- carotene. Cluster IV ranked first with respect to days to appear first staminate flower appeared, days to first pistillate flower appeared, fruit volume, fruit length, fruit diameter, fruit weight, yield per plant, flesh thickness. Genotypes belonging to cluster VII and IV are genetically divergent and hybridization between these genotypes will produce desirable segregants. Several authors also reported greater diversity in the genotypes of muskmelon by assessing genetic divergence on the basis of quantitative traits by following Mahalanobis D^2 statistics (Prasad *et al*.,

Table 1: List of muskmelon genotypes selected for genetic divergence studies from different sources.

Genotype	Accession no.	Source
IC 321327	A_4	NBPGR, Jodhpur, Rajasthan
IC 321370	A_1	NBPGR, Jodhpur, Rajasthan
IC 321344	A_2	NBPGR, Jodhpur, Rajasthan
IC 321333	A_3	NBPGR, Jodhpur, Rajasthan
IC 315330-2	A_5	NBPGR, Jodhpur, Rajasthan
IC 315323	A_8	NBPGR, Jodhpur, Rajasthan
IC 321374	A_{11}	NBPGR, Jodhpur, Rajasthan
IC 321328	A_{15}	NBPGR, Jodhpur, Rajasthan
IC 315330	A_{16}	NBPGR, Jodhpur, Rajasthan
IC 321380	A_{17}	NBPGR, Jodhpur, Rajasthan
IC 321375	A_{21}	NBPGR, Jodhpur, Rajasthan
IC 321343	A_{20}	NBPGR, Jodhpur, Rajasthan
IC 321375-1	A_{19}	NBPGR, Jodhpur, Rajasthan
IC 321329-1	A_{22}	NBPGR, Jodhpur, Rajasthan
IC 321366	A_{10}	NBPGR, Jodhpur, Rajasthan
Papasa	A_6	Vontimitta, Kadapa andhra Pradesh
Sirangi	A_7	Vontimitta, Kadapa andhra Pradesh
Sharbathi	A_{12}	Vontimitta, Kadapa andhra Pradesh
Alpur-1	A_{13}	Vontimitta, Kadapa andhra Pradesh
Improved sharbathi	A_{14}	Vontimitta, Kadapa andhra Pradesh
Suvarna	A_{18}	Vontimitta, Kadapa andhra Pradesh
Alpur green	A_{23}	Vontimitta, Kadapa andhra Pradesh
KSP 1060	A_{24}	Vontimitta, Kadapa andhra Pradesh
Alpur orange	A_{25}	Vontimitta, Kadapa andhra Pradesh
Arka jeet	A_9	IIHR, Hessaraghatta, Bengaluru

Table 2: Clustering pattern of 25 muskmelon genotypes based on D^2 analysis.

Cluster	No. of genotypes in cluster	Genotypes
I	6	IC321370, IC 321375, IC321380, IC321329-1, IC321366, Sharbathi
II	8	IC 315330-2, IC 321343, Papasa, IC 315330, KSP1060, Alpur Orange, Sirangi, IC 321374
III	1	IC 321344
IV	1	Improved Sharbathi
V	7	IC 321327, IC 315323, IC 321333, Arka Jeet, Suvarna, IC 321375-1, IC 321328
VI	1	Alpur green
VII	1	Alpur-1

Table 3: Inter and Intra-cluster distances of muskmelon genotypes for various morphological traits using euclidean^2 distance.

Cluster	I	II	III	IV	V	VI	VII
I	366	670.5	689.47	3823.89	824.54	1441.21	4353.78
II		618.98	1491.9	1355.7	1267.08	1161.7	3823.89
III			0	608.32	811.23	2158.5	4975.66
IV				0	848.07	2792.79	5707.67
V					763.03	2180.83	5282.95
VI						0	1926.2
VII							0

2004, Singh and Dhillon. 2006 and Singh and Lal. 2005). These results are in accordance with the findings of More and Seshadri (2002); Yadav *et al*. (2005), Singh and Lal (2005), Tomar *et al*. (2008), Mehta *et al*. (2012) and Rahman *et al*. (2016) in muskmelon.

Correlation coefficient analysis

The prevailing relationships between characters are generally governed by phenotypic and genotypic correlations. Phenotypic correlation is defined as the correlation between two variables, which includes both the genotypic and environmental effects. Genotypic correlation on the other hand is the intrinsic association between two variables and it may be due to the linkage or pleotropic action of genes or both. In the present study character association between yield and 17 yield attributing traits disclosed that genotypic correlation were higher in magnitude compared to phenotypic correlation suggesting a strong inherent relationships between genotypes and also narrow differences were observed between phenotypic and genotypic correlations indicates that environmental effect was little and results were presented in Table 4.

Fruit yield per plant showed positive and significant correlation genotypically and phenotypically with fruit volume (0.57G,0.56P), fruit diameter (0.30G, 0.30P), number of fruits per plant (0.65G,0.64P), fruit weight (0.64G,0.64P) and flesh thickness (0.33G,0.33P), indicates that these traits are important in selection programme for yield and selection based on the above mentioned traits will result in the further improvement of muskmelon while significantly negative correlation was observed for days to appearance of first pistillate flower and days to first fruit harvest. Production of F_1 hybrids for high yield coupled with days to appearance of first pistillate flower and days to first fruit harvest is difficult. These results are in accordance with the reports of Yadav and Ram (2002), Choudhari *et al*. (2003) and Mehta *et al*. (2009) in muskmelon and Choudhary *et al*. (2012) in watermelon.

Vine length is one of the most important growth attribute because it largely determines the photosynthetic area, flower and fruit bearing surface and if vine length is more they will accommodate more number of flowers and fruits which ultimately leads to higher fruit production. It shows positive and significant correlation with TSS (0.49G, 0.39P), total sugars (0.42G, 0.36P), days to first fruit harvest (0.29G, 0.21P) and fruit firmness (0.30G,0.24P). Similar results were reported by Abusaleha and Dutta (1989), Khan *et al*. (2016) in pointed gourd. Days to appearance of first pistillate flower, node number of first pistillate flower, ratio of male to female flowers, days to first fruit harvest, node number of first fruit set were considered to be indicators for earliness. Days to appear of first pistillate flower recorded significantly positive correlation with node at which the first pistillate flower appeared (0.28 g, 0.20P), days to first fruit harvest (0.77G, 0.46P). Early flowering gives early harvest and better yields as well as augments the fruiting time of the plant. Taha *et al*. (2003) also reported a positive association of earliness with fruit yield in muskmelon.

Number of fruits per vine, fruit weight, fruit volume, fruit length, fruit diameter, fruit firmness and flesh thickness were considered as fruit traits in muskmelon. Highly positive and significant correlation exhibited by number of fruits per vine with yield (0.65G, 0.64P) but it did not show any remarkable correlation with vine length, node number of first fruit set, fruit weight and fruit volume, but all these characters has to be taken into the consideration while selecting the genotypes in muskmelon for further crop improvement. Characters like fruit weight, fruit length (0.36G, 0.33P) and fruit diameter (0.25G, 0.23P) showed significantly positive correlation with fruit volume. Correlation between fruit weight and their corresponding contribution to yield will be of esteem in arranging a melon breeding programme (Chhonkar *et al*, 1979). Traits like fruit volume (0.83G,0.79P), fruit length (0.53G,0.49P) and flesh thickness(0.54G,0.50P) were positively correlated with fruit weight. Based on these characters fruit weight can be easily manipulated upto the chosen level through selection. Fruit firmness exhibited positive and significant correlation with flesh thickness (0.25G, 0.25P), TSS(0.55G,0.54P), total sugars(0.47G,0.45P) and β-carotene (0.31G,0.31P). While, it was negatively correlated with titrable acidity (-0.41G,-0.40P) and ascorbic acid (-0.48G,-0.47P). Flesh thickness showed significant and negative correlation with TSS(-0.29G,-0.27P), total sugars (-0.30G,-0.29P) and β-carotene (-0.26G,-0.25P). These results are in accordance with the reports of Kumar *et al*. (2013) in Sponge gourd.

From consumer's point of view fruit quality has significance in melon. Total Soluble Solids content exhibited significant positive correlation with vine length (0.49G,0.39P), fruit firmness (0.55G,0.54P), total sugars (0.95G,0.91P) and

Table 4: Phenotypic (P) and genotypic (G) correlation coefficients among 17 yield and yield attributes in genotypes of muskmelon.

Character		1	2	3	4	5	6	7	8	9	10
Vine length cm, (1)	P	1.00	0.10	0.05	0.00	0.21	0.07	-0.09	-0.19	-0.03	-0.08
	G	1.00	0.13	0.05	0.00	0.29*	0.08	-0.08	-0.28	-0.04	-0.07
Days to appear first	P		1.00	0.20	0.04	0.46**	-0.32**	0.00	-0.36**	0.11	-0.44**
pistillate flower (2)	G		1.00	0.28*	0.11	0.77**	-0.44**	0.02	-0.50**	0.16	-0.57**
Node at which first	P			1.00	0.10	0.09	0.09	0.14	0.00	0.16	0.02
pistillate flower appears (3)											
	G			1.00	0.07	0.16	0.11	0.15	0.02	0.19	0.01
Node number of first fruit (4)	P				1.00	0.03	0.13	-0.04	-0.03	-0.11	0.10
	G				1.00	0.06	0.14	-0.06	-0.02	-0.13	0.11
Days to first fruit harvest (5)	P					1.00	-0.05	0.10	-0.08	-0.12	-0.20
	G					1.00	-0.06	0.09	-0.16	-0.15	-0.24*
Fruit volume, cm^3 (6)	P						1.00	0.33**	0.23	-0.09	0.79**
	G						1.00	0.36**	0.25*	-0.10	0.83**
Fruit length, cm (7)	P							1.00	-0.12	-0.14	0.49**
	G							1.00	-0.14	-0.15	0.53**
Fruit diameter, cm (8)	P								1.00	0.12	0.20
	G								1.00	0.11	0.21
Fruits/plant (9)	P									1.00	-0.15
	G									1.00	-0.14
Fruit weight, kg (10)	P										1.00
	G										1.00

Character		11	12	13	14	15	16	17	Yield
Vine length cm, (1)	P	0.24*	-0.21	0.39**	-0.27*	0.36**	-0.27*	0.07	-0.10
	G	0.30**	-0.24*	0.49**	-0.34**	0.42**	-0.31**	0.07	-0.10
Days to appear first pistillate	P	-0.25*	-0.47**	-0.07	-0.05	-0.07	0.31**	-0.06	-0.28*
flower(2)	G	-0.35**	-0.65**	-0.05	-0.09	-0.07	0.40**	-0.09	-0.34**
Node at which first pistillate	P	-0.38**	-0.12	-0.03	0.06	-0.01	0.10	-0.13	0.11
flower appears (3)	G	-0.46**	-0.17	-0.01	0.05	-0.01	0.10	-0.16	0.12
Node number of first fruit (4)	P	-0.06	0.13	-0.16	0.14	-0.24*	0.11	0.17	-0.06
	G	-0.06	0.15	-0.16	0.17	-0.28*	0.13	0.18	-0.08
Days to first fruit harvest (5)	P	-0.21	-0.03	-0.38**	0.18	-0.44**	0.39**	-0.35**	-0.27*
	G	-0.24*	-0.03	-0.44**	0.18	-0.51**	0.48**	-0.44**	-0.32**
Fruit volume, cm^3 (6)	P	0.11	0.38**	-0.10	-0.02	-0.11	-0.24*	-0.28*	0.56**
	G	0.11	0.38**	-0.11	-0.02	-0.11	-0.25*	-0.29*	0.57**
Fruit length, cm (7)	P	-0.06	0.16	-0.20	-0.11	-0.07	-0.12	0.11	0.21
	G	-0.05	0.18	-0.21	-0.13	-0.08	-0.15	0.12	0.23
Fruit diameter, cm (8)	P	-0.09	0.57**	-0.30**	0.34**	-0.19	-0.02	-0.27*	0.30**
	G	-0.09	0.61**	-0.33**	0.35**	-0.21	-0.02	-0.28*	0.30**
Fruits/plant (9)	P	-0.14	-0.11	-0.01	-0.04	0.05	-0.03	-0.41**	0.64**
	G	-0.14	-0.12	-0.01	-0.05	0.05	-0.03	-0.42**	0.65**
Fruit weight, kg (10)	P	0.12	0.50**	-0.04	-0.13	-0.05	-0.27*	-0.07	0.64**
	G	0.12	0.54**	-0.06	-0.15	-0.05	-0.27*	-0.07	0.64**
Fruit firmness, kg/ cm^2 (11)	P	1.00	0.25*	0.54**	-0.40**	0.45**	-0.47**	0.31**	-0.24*
	G	1.00	0.25*	0.55**	-0.41**	0.47**	-0.48**	0.31**	0.002
Flesh thickness, mm (12)	P		1.00	-0.27*	0.17	-0.29*	-0.13	-0.25*	0.33**
	G		1.00	-0.29*	0.18	-0.30**	-0.13	-0.26*	0.33**
TSS , °brix (13)	P			1.00	-0.59	0.91	-0.60	0.44**	-0.01
	G			1.00	-0.63	0.95	-0.63	-0.45**	-0.02
Titrable acidity % (14)	P				1.00	-0.61**	0.31**	-0.33**	-0.12
	G				1.00	-0.64**	0.34**	-0.35**	-0.14
Total sugars %, (15)	P					1.00	-0.65**	0.44**	0.04
	G					1.00	-0.67**	0.45	0.04
Ascorbic acid mg/100 G, (16)	P						1.00	-0.16	-0.27*
	G						1.00	-0.16	-0.28*
Beta carotene µg/G, (17)	P							1.00	-0.40**
	G							1.00	-0.41**

β- carotene (-0.45G, 0.44P), while it was negatively correlated with titrable acidity(-0.63G,-0.59P) and ascorbic acid(-0.63G,-0.60P) indicates that genotypes having high level of TSS content displays low acid levels (Stepansky *et al*. 1999). However, Burger *et al*., (2003) reported independent genetic control of sugar and acid accumulation in muskmelon. Therefore combination of these two traits in melon opens up the possibility of breeding a unique tasting melon.

CONCLUSION

Alpur-1 genetically more diverse from the rest of the genotypes in this study hence it can be used as parent in hybridization programme for further crop improvement. Total Soluble Solids (TSS), fruit firmness and total sugars exhibited positive correlation with yield. Therefore these traits were considered in muskmelon breeding programme.

Conflict of interest: None.

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