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Genetic diversity in muskmelon *(Cucumis melo)*

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ABSTRACT

The present investigation was carried out during 2014-15 and 2015–16 at Horticultural Research Station, Ananthrajupet, DRYSRHU, Andhra Pradesh to assess the genetic diversity in muskmelon, *Cucumis melo.* Genetic divergence evaluated using Mahalanobis D^2 analysis revealed less to moderate diversity among fourty two genotypes. The cluster analysis of muskmelon exhibited a moderate clustering pattern and grouped genotypes into five distinct clusters with maximum of 37 genotypes in cluster I, two in cluster IV and one in each of cluster II, III and V. The highest inter-cluster distance (80.61) between Cluster III and IV indicating the genotypes of these clusters may give heterotic response and leads to better segregants. Among the morphological traits studied, fruit length (23.69%), pulp thickness (17.07%) and fruit girth (16.84%) contributed major share in the divergence of the genotypes which can be utilized for selection of individual genotypes for future crop improvement programme. Most of the genotypes accommodated into single cluster, probably they may share genetic similarity. The genotypes Papayee S-1, IC 321371, Kundan, Muskan and Arka Jeet, being divergent from others may serve as potential parents for breeding programmes.

Key words: Genetic divergence, Inter-cluster, Muskmelon, Segregant

Muskmelon (*Cucumis melo* L.) is hardly a vegetable and so named due to its delightful flavour of the ripe fruits (Musk means perfume and melon means apple shaped). Muskmelon is the most polymorphic species of the Cucurbitaceae family have a wide range of other forms, sizes, and flesh qualities, such as the Honey Dew, Casaba, and Persian types; and the most popular type of muskmelon which are small, oval and heavily netted are commonly called a cantaloupe. It is grown as a fruit vegetable almost worldwide from tropical to sub-tropical regions. It is a warm-season crop and thus tender and warmth loving with good source of dietary fiber, vitamins and minerals.

Consumer preference and market preference brought huge change in cultivation of muskmelon bringing lot of area under private hybrids with monoculture due to their high yielding, good quality and greater shelf life which stands for long distance transport to different parts of the country. With the introduction of muskmelon hybrids from private sector has led to monoculture affecting genetic erosion of the local traditional cultivars having typical musky flavour with melting texture and taste which is lacking in commercial hybrids. This is the hike time to conserve the traditional local germplasm and at the same time improvement in the quality and shelf life of traditional cultivars. High yield can be achieved either by improvising the production technologies or by developing genetically superior cultivars (Reddy *et al.* 2012).

Grouping or classification of genotypes based on suitable quantitative traits is quite imperative to understand the usable diversity existing among them. Selection of suitable parental lines to develop heterotic combinations can be facilitated by determining genetic divergence among them. In the present study, Mahalanobis's D^2 statistic technique has been applied to assess the diversity among 42 genotypes of muskmelon

MATERIALS AND METHODS

The field experiment was conducted at Horticultural Research Station, Anantharajupeta, Dr Y S R Horticultural University, Andhra Pradesh during summer season of 2014-15 and 2015-16 in a randomized block design with two replications. The details of genotypes were Allanagaram, Alpur(green), Alpur(1), Alpur (orange), Amul-9 from Kadapa, Arka Jeet from IIHR, Bengaluru, IC315312, IC315323, IC315325, IC315330, IC321326, IC321327, IC321328, IC321329, IC321333, IC321337, IC321338, IC321342, IC321343, IC321344, IC321366, IC321368, IC321370, IC321371, IC321372, IC321374 collections procured from NBPGR Regional Station, Jodhpur, Bobby (F_1), Kundan, Muskan from Known U seed (India) Pvt Ltd, Papayee (s-1), Papayee-III, Papasa, Papayee-II from Vontimitta, Kadapa, Sharabath, Sharabathe-e-nar, Sirangi from Donthampalli, Kadapa and NMMH-24 sourced from Namdhari Seeds, Bengaluru.

The improved lines of local germplasm were developed by Pureline selection method. The above genotypes

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were maintained under poly house through controlled hand pollination. The genotypes in each replication were planted on raised beds with a plot size of 2.1 m × 1.2 m accommodating 14 plants per replication. All the recommended package of practices were followed to raise a good crop. The observations were recorded on five randomly selected plants for characters, viz. number of fruits per vine, fruit length (mm), fruit girth (mm), fruit weight (g), TSS (%), cavity diameter (mm), pulp thickness (mm), number of seeds per fruit, 100 seed weight (g) and yield per plant (kg).

The data was subjected to Wilk's criteria (Everitt and Punn 1991) to test the significance of pooled differences in mean values for all the ten characters. The genetic diversity was studied using Mahalanobis's (1936) D^2 statistic and clustering of genotypes was done according to Tocher's method (Rao 1952).

RESULTS AND DISCUSSION

Analysis of variance revealed the significant differences among genotypes for all characters under study. Based on D^2 statistics and Tocher's method, 42 muskmelon genotypes were grouped into 5 clusters with a variable number of entries revealing the presence of considerable amount of genetic diversity in the material. The intra-cluster distance was maximum (12.87) in cluster I (Table 1) which contains a maximum of 37 genotypes (Allanagaram, Alpur (GREEN), Alpur (1), Alpur (ORANGE), Amul-9, Bobby (F1), IC315312, IC315323, IC315325, IC315330, IC321326, IC321327, IC321329, IC321333, IC321337, IC321343, IC321338, IC321342IC321344, IC321366, IC321368, IC321370, IC321372, IC321374, IC321375, IC321376, IC321378, IC321379, IC321380, NMMH-24, Papayee-III, Papasa, Papayee-II, Sharabath, Sharabathe-e-nar, Sirangi) followed by cluster IV comprising two genotypes (Kundan and Muskan), whereas Clusters II (Papayee s-1), III (IC 321371) and V (Arka Jeet) had no intracluster distance as they have one genotype each. The five different clusters with respective cultivars indicate that Cluster III and IV are more diverse from rest of other clusters (80.61). These findings are in agreement to earlier reports of Choudhary and Ram (2003) and Rukam *et al.* (2008) in muskmelon.

The traits/characters contributing towards divergence among the genotypes were fruit length (23.69%) followed by pulp thickness (17.07%), fruit girth (16.84%), number of seeds per fruit (12.08%) and fruit weight (7.43%) (Table 2). However, yield per plant (0.58%) contributed minimum towards the divergence. Similar results were also reported in muskmelon by Musmade *et al.* (2008) and Luan *et al.* (2010).

Table 1 Average intra and intercluster distances for muskmelon genotypes

Cluster	1	2	3	4	5
1	12.87	22.30	23.40	46.71	31.90
2	22.30	0.00	5.78	65.72	50.15
3	23.40	5.78	0.00	80.61	36.51
4	46.71	65.72	80.61	5.87	78.12
5	31.90	50.15	36.51	78.12	0.00

The means of quantitative characters of the genotypes grouping in these five clusters were worked out in Table 3 and the data revealed that maximum cluster mean variation was observed for yield per plant (3.03 kg in cluster V to 5.29 kg in cluster I), average fruit weight (243.5 g in cluster V to 1902.98 g in cluster IV), number of fruits/vine (4.25 in cluster II to 12.48 in cluster V) and pulp thickness (14.69 mm in cluster V to 47.69 mm in cluster IV).

Cluster IV with two genotypes (Kundan and Muskan) recorded highest mean for fruit weight (1902.98 g), girth (153.03 mm), pulp thickness (47.69 mm) and TSS (9.77 ^{O}B). Genotypes in cluster I recorded maximum yield per plant (5.29 kg), cavity diameter (68.70 mm) and 100 seed weight (3.37 g). Further, maximum number of fruits per plant was observed in cluster V consisting of single genotype (Arka Jeet), number of seeds per fruit in cluster III (504.0) in IC321371 and fruit length in cluster II (181.89 mm) in Papayee (S-1).

The data on intercluster distances were used to select genetically diverse and agronomically superior genotypes (Musmade *et al.* 2008). The genotypes exceptionally good with one or more characters were seemed to be desirable. Inter-crossing of divergent groups would lead to greater opportunity for crossing over, which releases hidden potential variability by disrupting the undesirable linkages (Thoday 1960). The progeny derived from such diverse crosses are expected to have wide spectrum of genetic variability, providing a greater scope for isolating transgressive segregants in advanced generations. Hence, these genotypes might be used in a multiple crossing programme to recover transgressive segregants (Reddy *et al.* 2012).

However, the divergent clusters need not be of desirably high or low mean values for all the growth, earliness and fruit traits. Hence, apart from selecting genotypes from the clusters which have high intercluster distance for hybridization, one can also think of selecting parents based on extent of genetic divergence in respect to a particular character of interest (Kalloo and Sindhu 1982a).

In the present study large number of genotypes allocated to single cluster which shows less diverse nature among those for the morphological traits. Yadav *et al.* (2005) reported in muskmelon that diverse genotypes with other genotypes fall into separate solitary clusters. Crossing between genotypes of such diverse solitary clusters could give desirable transgressive segregants.

Development of broad based heterotic populations

Most of the available genotypes are genetically related. As a result, level of realized yield heterosis has been limited. Therefore, development of heterotic groups is expected to realize maximum heterosis. Heterosis relies more on exploitation of diverse yield influencing loci which act as good combiners in hybrid development (Singh and

Table 2 Mean performance of muskmelon genotypes

Genotype	Number of fruits per vine	Fruit length (mm)	Fruit girth (mm)	Fruit weight (g)	TSS (Brix)	Cavity diameter (mm)	Pulp thickness (mm)	Number of seeds/ fruit	100 seed weight (g)	Yield per plant (kg)
Allanagaram	4.35	147.18	150.90	1360.00	4.83	86.11	28.26	439.00	2.89	5.92
Alpur (Green)	5.81	144.85	119.11	860.00	7.75	79.17	23.70	448.00	2.34	5.11
Alpur (1)	6.34	133.85	115.15	910.00	7.33	58.32	31.36	360.00	3.84	5.76
Alpur (Orange)	5.81	165.98	110.99	1005.00	6.47	55.84	25.25	349.00	3.63	5.87
Amul-9	4.42	117.76	107.84	805.65	6.84	66.97	29.70	471.50	2.77	2.03
Arka Jeet	12.48	76.21	97.32	243.50	7.48	58.48	14.69	318.50	3.10	3.03
Bobby (F_1)	8.53	116.27	109.58	767.50	12.53	54.27	31.66	580.50	2.29	5.28
IC315312	6.38	108.15	105.47	660.00	5.59	63.74	25.36	436.50	3.64	4.06
IC315323	5.61	109.33	112.68	685.00	5.42	69.87	21.38	471.50	3.37	3.91
IC315325	7.13	104.14	110.37	761.65	5.59	75.70	33.49	434.50	3.83	5.01
IC315330	3.76	102.02	102.95	963.00	6.05	64.11	21.35	423.50	2.87	3.72
IC321326	6.88	101.58	116.24	755.00	9.12	77.23	25.95	499.50	3.14	5.34
IC321327	6.19	147.52	145.86	1835.00	3.30	74.80	28.34	684.00	2.78	11.70
IC321328	3.98	99.50	105.35	821.00	4.00	60.01	21.57	259.50	3.48	3.16
IC321329	6.71	148.26	133.58	1305.00	5.05	80.51	34.97	330.00	3.95	8.73
IC321333	6.40	120.24	106.66	703.35	3.83	37.23	24.85	394.00	3.24	4.10
IC321337	5.57	115.10	104.45	735.00	3.73	74.98	22.16	431.00	2.74	4.19
IC321338	4.56	110.74	128.18	901.35	4.53	56.58	27.70	445.50	3.66	4.15
IC321342	5.62	82.30	99.80	515.00	4.78	57.70	22.96	452.50	3.02	2.86
IC321343	4.16	67.01	85.68	530.00	7.60	63.10	20.92	471.00	3.44	2.22
IC321344	6.67	104.20	122.82	805.00	5.74	66.51	26.50	436.50	3.88	5.35
IC321366	3.91	142.08	146.45	1485.00	5.03	82.99	24.25	484.50	3.36	5.73
IC321368	5.17	99.35	110.80	1021.00	4.90	83.48	25.19	470.00	2.99	5.29
IC321370	5.12	128.51	144.33	1118.35	3.25	77.10	25.29	160.55	3.48	5.92
IC321371	6.58	150.81	85.82	535.00	5.13	65.63	24.24	504.00	2.59	3.52
IC321372	5.27	115.20	131.30	1243.35	2.70	75.36	31.36	404.00	3.95	6.44
IC321374	5.40	96.70	111.57	660.00	3.75	73.30	19.30	403.00	3.37	3.62
IC321375	5.82	150.80	118.82	1100.00	6.04	71.16	31.27	398.50	4.48	6.73
IC321376	8.40	134.55	120.06	986.65	3.75	60.00	19.28	543.00	3.09	9.02
IC321378	6.29	92.29	112.71	576.65	5.88	54.34	24.77	336.50	3.83	3.63
IC321379	4.85	115.20	112.28	808.35	6.86	72.02	25.30	317.00	3.15	3.97
IC321380	6.58	182.58	128.46	1416.65	5.00	47.09	33.47	398.00	4.61	9.33
Kundan	4.21	154.45	141.94	1685.00	8.89	55.11	48.83	413.50	2.85	4.38
Muskan	4.47	162.56	164.12	2120.95	10.65	62.70	46.55	341.00	3.07	6.05
NMMH-24	5.83	100.46	137.84	1101.00	6.73	77.49	29.18	437.50	3.33	5.12
Papayee (s-1)	4.25	181.89	107.70	1008.35	7.82	62.09	25.57	482.00	3.02	4.10
Papayee-III	4.89	176.25	114.16	1008.30	6.67	69.45	26.38	417.00	3.12	4.91
Papasa	4.16	180.92	112.43	1210.00	7.30	59.79	28.45	409.00	3.68	5.08
Papayee-II	4.90	157.88	107.01	748.30	7.31	61.50	27.92	446.00	3.49	3.70
Sharabath	4.58	146.78	139.02	1313.35	4.78	83.30	27.59	451.50	3.18	5.91
Sharabathe-e-nar	4.66	151.07	143.57	1491.15	6.96	95.55	37.27	387.00	3.44	6.87
Sirangi	5.65	171.11	116.80	1088.35	7.85	75.41	29.02	433.00	3.44	6.23
Mean	5.67	128.89	119.00	991.73	6.06	67.76	27.44	423.16	3.32	5.17
C V	25.47	13.86	11.94	26.02	31.29	17.46	14.10	19.93	21.96	44.85
S E	1.02	12.63	10.05	182.46	1.34	8.36	2.74	59.65	0.52	1.64

Table 3 Cluster mean for characters of muskmelon genotypes

Cluster	No. of fruits per vine	Fruit length (mm)	Fruit girth (mm)	Fruit weight (g)	TSS	Cavity diameter (mm)	Pulp thickness (mm)	No. of seeds per fruit	100 seed weight (g)	Yield per plant (kg)
1	5.57	126.69	118.95	974.59	5.80	68.70	26.83	424.69	3.37	5.29
2	4.25	181.89	107.70	1008.35	7.82	62.09	25.57	482.00	3.02	4.10
3	6.58	150.81	85.82	535.00	5.13	65.63	24.24	504.00	2.59	3.52
4	4.34	158.50	153.03	1902.98	9.77	58.91	47.69	377.25	2.96	5.21
5	12.48	76.21	97.32	243.50	7.48	58.48	14.69	318.50	3.10	3.03

Dhillon 2006). So heterotic grouping helps in increase of proportion of favourable alleles and also genetic diverse nature of such population.

High cluster mean value for number of fruits per vine observed in cluster V with genotype Arka Jeet and high fruit weight and T S S and low seeds per fruit observed in cluster IV with genotypes Kundan and Muskan. The crosses involving genotypes between these two clusters could result in superior progeny population for fruit yield and fruit quality. The genotypes in four clusters, viz. Papayee S-1, IC 321371, Kundan, Muskan and Arka Jeet, being diverse from others may serve as potential parents for breeding programmes. They indicate their independent identity and importance due to various unique characters possessed by them (Rukam *et al.* 2008 and Reddy *et al.* 2017).

Contribution of different traits to diversity in muskmelon genotypes indicates that fruit length (23.69) provide the highest contribution to diversity, followed by pulp thickness (17.07) and fruit girth (16.84). Thus, these three characters need more attention for improvement of muskmelon. The results of the present study point out a positive contribution of genetic divergence and yield components and this can be of considerable aid in selecting for yield and other economic traits. The more divergence observed for these characters offering greater scope while making selection of horticultural superior genotypes of muskmelon (Indraja *et al.* 2018).

In the present study, cluster III and IV recorded the largest statistical distance indicating maximum divergence. Since wide diversity exists between the genotypes belong to cluster III and V, the crosses between these genotypes may result in substantial segregation for quantitative traits studies and help in further selection for overall improvement of muskmelon in Rayalaseema conditions of Andhra Pradesh. At the same time most of the genotypes were accommodated into single cluster because of probable genetic similarity among them for different yield traits. Variability exists among the genotypes for fruit characters like fruit size, fruit color, fruit shape and shelf life. These genotypes have to be thoroughly evaluated under different environmental conditions to see wide adaptability.

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