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Research Article

Genetic variability studies for horticultural traits in muskmelon (*Cucumis melo* L.)

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Abstract

Genetic variability parameters were estimated for yield and yield attributing traits in twenty five genotypes of muskmelon during *kharif*, 2017 at College of Horticulture, Anantharajupeta, Andhra Pradesh in randomized block design with three replications. Analysis of variance revealed a highly significant difference for all the traits studied indicating a sufficient amount of variability exists in the genotypes. With respect to *per se* performance, the accession Suvarna was found to be better in performance for vine length and number of fruits per plant while maximum TSS, total sugars, fruit firmness and beta carotene was recorded by Alpuri-1. In general, no single accession was found to be a better *per se* performer for all the traits under study. High genotypic and phenotypic coefficient of variation coupled with heritability and genetic advance as per cent of mean were recorded for fruit firmness, β - carotene, yield per plant, fruit volume and number of fruits per plant.

Key words

Genetic variability, Heritability, PCV, GCV, Muskmelon

INTRODUCTION

Muskmelon (*Cucumis melo* L., $2n=2X=24$.) commonly known as *kharbooja* is one of the most important dessert cucurbits of India, which is probably originated in North Africa and Asia, while India is considered to be the secondary centre of diversity. It is a major crop of the riverbed, covering 80 per cent area of total muskmelon cultivation (Nandpuri, 1989). In India, muskmelon occupies an area of 54 thousand hectares with an annual production of about 1145 thousand metric tonnes during the year 2018-2019 (NHB, 2019) and majorly grown in the states of Punjab, Tamil Nadu, Uttar Pradesh, Maharashtra and Andhra Pradesh. In Andhra Pradesh, it is mostly grown in the river beds and along canals in Kadapa, Chittoor and Ananthapur districts (Singh, 1998). Varieties generally having a salmon or green colour flesh and netted rind are properly called muskmelon. The name itself describes the aroma of the ripe fruit. Muskmelons are nutrient-dense and provide a wide assortment of important vitamins and

minerals. They are a rich source of vitamin A, C, β - carotene, carbohydrates, sugars, proteins and traces of vitamin K, B₁, B₂, B₆ and niacin which makes muskmelon a nutrient dense food, meaning its nutritional benefits outweigh its calorie content (Anon, 2002). Besides its multiple uses, the lack of advanced varieties had contributed to very low productivity and quality of muskmelon in India. Indian muskmelon germplasm is a reservoir of genes for unique traits like fruit quality and resistance to biotic and abiotic stresses and these traits can be transferred to modern cultivars through hybridization. Some of the promising varieties released by ICAR- IHR, Bengaluru are Arka Jeet is an improvement over a local (IHR 103) collection from Lucknow which has excellent flavor with high TSS (13-16%) and rich in vitamin C (41.6 mg/100g), Arka Siri which has Tuscan cantaloupe background with high yielding capacity of 25 t/ha against Arka jeet of 17 t/ha and Pusa Madhurima a unique shaped melon variety with a high yield of 22.4 t/ha developed at IARI.

However there is a need to develop superior muskmelon varieties/ hybrids suited to different agro ecological conditions with specific end use. The success of conventional breeding is predominantly governed by the availability of desired genetic variability for the target traits (Ara *et al.*, 2009). Genetic resources permit the plant breeders to create novel plant gene combinations and select crop varieties more suited to the needs of diverse agricultural systems (Glaszmann *et al.*, 2010). To develop high yielding varieties for a systematic breeding programme in muskmelon, information on genetic variability is a basic pre-requisite. Wider the genetic variability more will be the chances of improvement through selection. However, the yield being a complex quantitative trait direct selection for yield may not result in successful crop improvement. Information on character association, direct and indirect effects of component traits on yield would greatly help in formulating the selection criteria and using them effectively in the crop improvement programme. Therefore, it is necessary to partition the observed variability into heritable and non-heritable components by calculating genetic parameters such as genotypic and phenotypic coefficient of variation, heritability and genetic advance.

The importance of genetic variability was recognized for the first time by a Russian scientist Vavilov (1951) who commended that a wide range of variability provides better scope for selecting a desirable genotype. The efficiency of selection depends on the nature and extent of genetic variability, degree of transmissibility of desirable characters (Golani *et al.*, 2007) and the actual expected genetic gain for the characters in a population. So, an insight into the magnitude of variability and the extent of heritability present in the gene pool of a crop species for desirable traits is of utmost importance to a plant breeder for starting a judicious plant breeding programme. Therefore, an attempt was made to study the genetic variability, heritability and genetic gain among different genotypes of muskmelon for various horticultural traits.

MATERIAL AND METHODS

An experiment was carried out during *khari*, 2017 in the College of Horticulture, Anantharajupeta, Andhra Pradesh, India. The experimental site was geographically located at 13° 59' North latitude and 79° 19' East longitude with an elevation of 162 m above mean sea level. The experimental material consists of 25 muskmelon genotypes that were evaluated under open field conditions in randomized

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

S.No	Genotype	Accession number	Source
1.	IC 321327	A ₄	NBPGR, Jodhpur, Rajasthan
2.	IC 321370	A ₁	NBPGR, Jodhpur, Rajasthan
3.	IC 321344	A ₂	NBPGR, Jodhpur, Rajasthan
4.	IC 321333	A ₃	NBPGR, Jodhpur, Rajasthan
5.	IC 315330-2	A ₅	NBPGR, Jodhpur, Rajasthan
6.	IC 315323	A ₈	NBPGR, Jodhpur, Rajasthan
7.	IC 321374	A ₁₁	NBPGR, Jodhpur, Rajasthan
8.	IC 321328	A ₁₅	NBPGR, Jodhpur, Rajasthan
9.	IC 315330	A ₁₆	NBPGR, Jodhpur, Rajasthan
10.	IC 321380	A ₁₇	NBPGR, Jodhpur, Rajasthan
11.	IC 321375	A ₂₁	NBPGR, Jodhpur, Rajasthan
12.	IC 321343	A ₂₀	NBPGR, Jodhpur, Rajasthan
13.	IC 321375-1	A ₁₉	NBPGR, Jodhpur, Rajasthan
14.	IC 321329-1	A ₂₂	NBPGR, Jodhpur, Rajasthan
15.	IC 321366	A ₁₀	NBPGR, Jodhpur, Rajasthan
16.	Papasa	A ₆	Vontimitta, Kadapa, Andhra Pradesh
17.	Sirangi	A ₇	Vontimitta, Kadapa, Andhra Pradesh
18.	Sharbathi	A ₁₂	Vontimitta, Kadapa, Andhra Pradesh
19.	Alpur-1	A ₁₃	Vontimitta, Kadapa, Andhra Pradesh
20.	Improved Sharbathi	A ₁₄	Vontimitta, Kadapa, Andhra Pradesh
21.	Suvarna	A ₁₈	Vontimitta, Kadapa, Andhra Pradesh
22.	Alpur Green	A ₂₃	Vontimitta, Kadapa, Andhra Pradesh
23.	KSP 1060	A ₂₄	Vontimitta, Kadapa, Andhra Pradesh
24.	Alpur orange	A ₂₅	Vontimitta, Kadapa, Andhra Pradesh
25.	Arka Jeet	A ₉	IIHR, Hesaraghatta, Bengaluru

block design with three replications. Each replication was grown in a single row of 8 m length with a spacing of 100 × 70 cm accommodating eight plants in each replication. The observations were recorded from five randomly selected plants in each genotype in each replication for different qualitative and quantitative traits. The analysis of variance for randomized block design (RBD) was done for each character as per Panse and Sukhatme (1961). Phenotypic co-efficient variation (PCV) and genotypic co-efficient variation (GCV) was calculated as per the formula suggested by Singh and Chaudhary *et al.* (1985). Heritability and the genetic advance were estimated using the formula suggested by Allard (1960). The list of genotypes was used for analysis are given in **Table 1**.

RESULTS AND DISCUSSION

Analysis of variance revealed highly significant differences among the genotypes for horticultural traits studied illustrating greater diversity in the existing genotypes (**Table 2 & 2a**). An inquisition of data in **Table 3** revealed the *per se* performance for different traits such as vine length (196.33 cm in IC 315330 to 368.67 cm in Suvarna), days to appearance of first pistillate flower (30.47 days in Arka Jeet to 42.07 days in Suvarna), node at which first pistillate flower appeared (3.60 in Alpur-1 to 6.47 in IC 321344), ratio of male to female flowers (9.20 in Suvarna to 19.43 in IC 321329-1), days to 50% flowering (26.00 days in Sharbathi to 35.67 days in Suvarna), node

number of first fruit set (3.39 in IC 321328 to 10.27 in IC 321374), days to first fruit harvest (59.07 days in Arka Jeet to 79.67 days in IC 321328), the number of fruits per plant (2.00 in IC 321343, IC 321329-1 and Alpur green to 6.60 in Suvarna), yield per plant (1.20 kg in IC 321370 to 6.98 kg in Improved Sharbathi), days to first fruit harvest (59.07 days in Arka Jeet to 79.67 days in IC 321328), fruit volume (354.20 cm³ in KSP 1060 to 1.54 kg in Improved Sharbathi), fruit length to width ratio (0.83 in IC 321370 to 2.49 in Papasa), flesh thickness (6.49 mm in Suvarna to 18.68mm in Improved Sharbathi), fruit firmness (1.48 kg/cm² in IC 321374 to 7.53 kg/cm² in Alpur- 1) total soluble solids (5.25 °Brix in IC 321327 to 12.09 Brix in Alpur-1), titrable acidity (0.02% in Alpur-1 to 0.19% IC 321344), total sugars (7.06% in IC 321375 to 12.87% in Alpur-1), ascorbic acid (12.68 mg/ 100g in Arka Jeet to 21.13 mg/100 gm in IC 321374) and β- carotene (1.30 µg/g in IC 321328 to 8.37 µg/g in Alpur- 1), had revealed substantial variability observed in yield and yield attributing traits in muskmelon. Furthermore, data revealed for variation of vine length due to strong apical dominance, for the earliness of flowering happened due to the higher capacity to make available assimilates to the apex during the sensitive phase before initiation and for a ratio of male to female flowers due to maternal changes influenced by various environmental factors. In general, no single accession was found to be a better mean performer for all the characters under this study. These results are in accordance with the reports of

Table 2. Analysis of variance for various structural and economic traits in muskmelon

Parameters / Source of Variance	df	Mean sum of squares								
		Vine length	Days to 50% flowering	Days to appearance of first pistillate flower	Node at which first pistillate flower appears	Ratio of male to female flowers	Node number of first fruit set	Days to first fruit harvest	Number of fruits per plant	Yield per plant
Genotypes	24	6866.1**	22.63**	26.10 **	1.74**	33.59**	10.23**	96.70**	4.75**	5.48**
Replications	2	111.21	1.0	0.89	0.25	2.93	0.20	2.94	0.14	0.03
Errors	48	722.21	2.55	5.12	0.20	1.05	0.63	13.59	0.04	0.08
Total	74	7699.54	26.18	32.11	2.19	37.57	11.06	113.23	4.93	5.59

df: degree of freedom; ** Significance at 1% level of significance

Table 2a. Analysis of variance for fruit and nutritional traits in muskmelon

Parameters / Source of Variance	df	Fruit weight	Fruit length/ width ratio (L/W)	Flesh thickness	Fruit volume	Fruit firmness	TSS	Titrable acidity	Total sugars	Ascorbic aci	Beta carotene
Genotypes	24	0.22**	0.594**	28.04**	284889.74**	4.59**	8.27**	0.004**	7.66**	14.80**	12.94**
Replications	2	0.01	0.01	0.29	236.48	0.03	0.04	0.00	0.07	0.25	0.04
Errors	48	0.005	0.01	0.54	1419.67	0.02	0.12	0.00	0.09	0.13	0.01
Total	74	0.235	0.614	28.87	286545.37	4.64	8.43	0.004	7.82	15.18	12.99

df: degree of freedom; ** Significance at 1% level of significance

Prasad *et al.* (2004), Rakhi and Rajamony (2005), Burger *et al.* (2006), Lotti *et al.* (2008), Ohashi *et al.* (2009), Dhillon *et al.* (2009), Dwivedi *et al.* (2010), Fergany *et al.* (2011), Potekar *et al.* (2014), Venkatesan *et al.* (2016), Reddy *et al.* (2013), Janghel *et al.* (2018) and

Ansari *et al.* (2020) in muskmelon, Rahman *et al.* (2002) in snake gourd, Ahmed *et al.* (2005) in bottle gourd, Shah *et al.* (2017) in cucumber, Bharathi *et al.* (2011) and Rajawat *et al.* (2017) in a pointed gourd.

Table 3. Estimates of mean, range and genetic variability parameters for 19 horticultural traits in muskmelon

S.No	Parameters	Mean±SEm	Range		Variance		Coefficient of variation		Heritability (Broad sense %)	Genetic advance	GAM
			Mini.	Maxi.	Genotypic (rg)	Phenotypic (rp)	Genotypic %	Phenotypic %			
1	Vine length (cm)	267.63±15.52	196.33	368.67	2047.96	2770.18	16.91	19.66	73.9	80.16	29.95
2	Days to appearance of first pistillate flower	36.72±1.31	30.47	42.07	6.99	12.22	7.20	9.48	57.7	4.13	11.27
3	Node at which first pistillate flower appears	4.88±0.26	3.60	6.47	0.51	.72	14.69	17.37	71.5	1.25	25.69
4	Ratio of male to female flowers	13.54±0.59	9.34	19.43	10.85	11.89	24.33	25.47	91.2	6.48	47.85
5	Days to 50% flowering	30.31±0.72	26.00	35.67	6.69	9.25	8.68	10.21	72.4	4.53	15.22
6	Node number of first fruit set	6.38±1.31	3.93	10.27	3.19	3.83	28.03	30.70	83.4	3.36	52.72
7	Number of fruits/plant	3.43±0.12	2.00	6.60	1.57	1.62	36.49	37.03	97.1	2.54	74.10
8	Yield per plant	3.01±	1.20	6.98	1.80	1.88	44.65	45.67	95.6	2.70	89.92
9	Days to first fruit harvest (cm)	73.17±2.13	59.07	79.67	27.03	41.30	7.19	8.78	67.1	8.88	12.14
10	Fruit volume (cm ³)	705.21±21.75	354.20	1438.67	94490.02	95909.70	43.58	43.92	98.5	628.52	89.13
11	Fruit length/width ratio (L/W)	1.30±0.08	0.83	2.49	0.19	0.21	33.65	35.35	90.6	0.85	65.99
12	Fruit weight (kg)	0.89±0.04	0.44	1.54	0.073	0.078	30.28	31.39	93.1	0.537	60.20
13	Flesh thickness (mm)	11.48±0.42	6.49	18.68	9.16	9.71	26.83	27.15	94.4	6.60	52.81
14	Fruit firmness (g/cm ²)	2.56±0.09	1.48	7.53	1.52	1.54	48.22	48.63	98.3	2.52	98.48
15	TSS (°Brix)	6.95±0.20	5.25	12.09	2.71	2.84	23.71	24.26	95.5	3.32	47.73
16	Titrate acidity (%)	0.10±0.01	0.02	0.19	0.001	0.002	38.53	39.78	93.8	0.076	76.89
17	Total sugars (%)	8.51±0.18	7.06	12.87	2.52	2.62	18.67	19.03	96.3	3.2	37.74
18	Ascorbic acid (mg/100g)	16.82±0.21	12.69	21.20	4.89	5.02	13.14	13.33	97.3	4.49	26.71
19	Beta carotene (µg/g)	4.33±0.08	1.30	8.37	4.3	4.32	47.91	48.00	99.6	4.26	98.49

GAM: Genetic advance expressed as percentage of mean

Among the various parameters of variability the estimates of PCV and GCV were high (>20%) for characters such as fruit firmness, β-carotene, yield per plant, fruit volume, titrate acidity, number of fruits per plant, fruit length to width ratio, fruit weight, the node number of first fruit set, flesh thickness, the ratio of male to female flowers and TSS indicating a wide range of variation and more

scope for improvement through selection. In this study, PCV was higher than consistent GCV for all traits which might be due to the interaction of genotypes with the environment to some degree or due to the higher influence of environmental factors in the expression of the traits (Singh and, 2005). Moderate phenotypic and genotypic coefficient of variation were recorded for

traits like vine length, the node at which the first pistillate flower appeared, total sugars, ascorbic acid suggested considerable variation present in the population and importance may be given during the selection programme for these traits. Low phenotypic and genotypic coefficient variation was recorded for days to 50% flowering, days to the appearance of first pistillate flowers, days to first fruit harvest. The differences between PCV and GCV were narrow indicating the low environmental influences in the expression of these traits (Prasad *et al.*, 2004, Rakhi and Rajamony 2005 and Tomar *et al.*, 2008 in muskmelon). However, it is difficult to determine the virtual amount of heritable and non-heritable components of variations present in the population with the coefficients of variation alone. Estimation of heritability and genetic advance would augment this parameter. These results are in accordance with the reports of Kumar *et al.* (2013) in sponge gourd and Chaudhari *et al.* (2017) in pumpkin.

The transfer of characters from parents to offspring is known as heritability. It is one of the important components in quantitative genetics because it determines the response to selection. Heritability in the broad sense is the ratio of genotypic variance to the total variance in a non-segregating population. High estimates of heritability in a broad sense ranged from 67.1 - 99.6 per cent. The high magnitude of heritability (>60%) was observed for characters such as β -carotene (99.6%), fruit volume (98.5%), fruit firmness (98.3%), ascorbic acid (97.3%), the number of fruits per plant (97.1%), total sugars (96.3%), TSS (95.5%), flesh thickness (94.4%), titrable acidity (93.8%), fruit weight (93.1%), ratio of male to female flowers (91.2%), fruit length to width ratio (90.6%), node number of first fruit set (83.4%), days to 50% flowering (72.4%), vine length (73.9%), node at which first pistillate flower appeared (71.5%), days to first fruit harvest (67.1%) which indicates that these traits were under genetic control and they were least influenced by the environment, hence selection based on these phenotypic performances will be reliable. However, these traits may not be useful for further improvement through selection, because broad sense heritability is based on genetic variance which includes both fixable (additive) and non fixable (dominance and epistatic) variances (Lush, 1949; Rakhi and Rajamony, 2005; Taha *et al.*, 2007 in muskmelon, Basavarajeshwari *et al.*, 2014 and Idahosa *et al.*, 2010 in cowpea). Days to the appearance of first pistillate flower recorded moderate value of heritability indicating the role of non-additive gene action which includes dominance and epistasis.

Genetic advance expressed as a percentage of the mean (GAM) ranged from 11.27 per cent (days to pistillate flower appearance) to 98.49 per cent (β -carotene). The estimates for genetic advance as per cent of mean were high (>20%) for characters such as β -carotene (98.49%), fruit firmness (98.48%), yield per plant (89.92%), fruit volume (89.13%), titrable acidity (76.89%), the number of fruits per plant (74.10%), fruit length to width ratio (65.99%), fruit weight (60.20%), node number

of first fruit set (52.72%), ratio of male to female flowers (47.85%), TSS (47.73%), total sugars (37.74%), node at which first pistillate flower appeared (25.60%) which indicated the role of additive gene action, therefore simple selection based on the phenotypic performance of these traits may be effective. Similar results were reported by Bhimappa and Choudhary (2018), Janghel *et al.* (2018) in muskmelon, Bhawana *et al.* (2010) and Veena *et al.* (2012) in cucumber. Whereas days to 50% flowering (15.54%), days to pistillate flower appearance (11.27%) and days to first fruit harvest (12.14%) recorded moderate values of GAM indicating the role of non-additive gene action.

In general, high heritability accompanied with a high genetic advance in a trait suggests that the inheritance of such trait is governed mainly by additive gene effects and therefore simple selection based on the phenotypic performance of these traits may be effective. Horticultural traits like node at which first pistillate flower appeared, the ratio of male to female flowers, the node number of first fruit set, the number of fruits per plant, yield per plant, fruit volume, fruit length to width ratio, fruit weight, flesh thickness, fruit firmness, TSS, titrable acidity, total sugars, ascorbic acid and β -carotene exhibited high heritability accompanied with high genetic advance. Similar results reported by Tomar *et al.* (2008), Potekar *et al.* (2014) and Janghel *et al.* (2018) in muskmelon, Bhawana *et al.* (2010) and Veena *et al.* (2012) in cucumber. Thus, the expression of these traits is predominantly governed by additive gene effects and therefore selection based on phenotypic performance will be useful to improve these characters in future.

Hence, the present investigation concluded that 25 genotypes of muskmelon provide a wide range of variability and this genetic background can be used for further selection to improve yield and yield attributes traits in muskmelon. Some accessions like Suvarna was found to be better in performance for vine length and number of fruits per plant, Improved Sharbathi for yield per plant, fruit volume and fruit weight and Alpur-1 for TSS, the number of nodes, total sugars and fruit firmness and β -carotene. Those traits which performing high heritability accompanied with high genetic advance may be concluded that phenotypic expression of these traits is controlled by additive genes, hence need to be given more emphasis during selection. Breeders should adopt both additive and non-additive gene effects simultaneously for developing new varieties and hybrids.

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