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GENETIC VARIABILITY AND HERITABILITY ESTIMATES FOR YIELD AND YIELD COMPONENTS IN MUSKMELON (*CUCUMIS MELO* L.)

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ABSTRACT

Genetic variability for yield and its contributing traits was assessed in ninety-four muskmelon (*Cucumis melo* L.) genotypes during the *Summer* of 2024 at the Vegetable Research Block, College of Horticulture, Bengaluru, using a randomized complete block design with two replications. The analysis of variance revealed significant differences among genotypes for all fifteen growth and yield-related traits, reflecting the presence of wide variability. Traits such as shape index, rind thickness, sex ratio, number of fruits per vine, average fruit weight, fruit yield per vine and TSS recorded high heritability along with high genetic advance as a percentage of mean, suggesting the role of additive gene action and greater chances of improvement through direct selection. Moderate heritability combined with moderate genetic advance was observed for days to first male and female flowering as well as days to first harvest. On the other hand, characters like number of branches showed lower variability, indicating limited possibilities for genetic enhancement through selection.

Keywords: Variability, heritability, genetic advance, Coefficient of variance and Selection.

Introduction

Muskmelon (*Cucumis melo* L.), widely known in India as *Kharbuja*, is one of the most important fruit vegetables cultivated across the globe, particularly in tropical and sub-tropical regions. It is a diploid crop with a chromosome number of $2n = 2x = 24$. The species is believed to have originated in tropical Africa, while India is recognized as a secondary centre of diversity and domestication (Chadha and Lal, 1993). The fruits of muskmelon are highly prized for their sweetness and distinctive musky flavour, which make them popular as a dessert fruit. Beyond domestic consumption, muskmelon also holds strong export potential due to its consumer appeal and nutritional value. Its importance is further enhanced by its adaptability, diverse varietal groups and role in supporting both fresh market demand and agro-industrial use. Muskmelon occupies an area of 67,000 ha with an annual production of 1541 MT (Anon.,

2024a) in India. Despite its significance, commercial cultivation remains less remunerative due to low yield potential and sub-optimal fruit quality of existing open-pollinated cultivars. This highlights the need for genetic enhancement of muskmelon to develop cultivars with improved yield and quality attributes. Genetic variability forms the cornerstone of any crop improvement programme. The extent of variability present in a population determines the potential for selection and genetic gain. Evaluation of variability is often accompanied by the estimation of genetic parameters such as phenotypic and genotypic coefficients of variation, heritability and genetic advance. These parameters allow partitioning of observed variability into heritable and non-heritable components, thereby guiding breeders in identifying superior genotypes.

Phenotypic and genotypic variances provide insights into the magnitude of variability for different

traits, while heritability coupled with genetic advance offers a reliable measure of the effectiveness of selection. In muskmelon, substantial variability has been documented for traits such as fruit colour, shape, size and weight, which are directly linked to consumer preference and marketability. Considering this, the present investigation was undertaken to assess the nature and extent of genetic variability, heritability and genetic advance for growth and yield-related traits in muskmelon genotypes, with the aim of identifying promising lines for future crop improvement programmes. India harbors a wide diversity of melon (*Cucumis melo* L.) and its related species, representing a rich genetic reservoir with substantial variability for horticultural traits as well as resistance to insect pests and diseases (Roy *et al.*, 2011). This underlines the importance of systematic collection, conservation and evaluation of melon genetic resources to support future breeding and improvement programmes.

Effective utilization of melon genetic resources requires systematic evaluation for a wide range of traits. There is an urgent need to develop superior muskmelon varieties and hybrids that are well adapted to diverse agro-ecological conditions and tailored to specific consumer and market demands. The success of conventional breeding largely depends on the availability of sufficient and desirable genetic variability for targeted traits (Ara *et al.*, 2009). Genetic resources provide plant breeders with the opportunity to generate novel gene combinations and to identify varieties better suited to varied production systems (Glaszmann *et al.*, 2010).

For muskmelon improvement, precise information on genetic variability is fundamental to designing efficient breeding programmes. A broader genetic base increases the prospects of achieving progress through selection. However, as yield is a complex quantitative trait influenced by multiple components, direct selection for yield alone is often ineffective. Instead, understanding the associations among traits, along with the direct and indirect contributions of yield components, can help in establishing effective selection criteria. Partitioning observed variability into heritable and non-heritable components through genetic parameters such as genotypic and phenotypic coefficients of variation, heritability and genetic advance provides critical insight for identifying superior genotypes and guiding future improvement strategies.

Materials and Methods

The field experiment was carried out during the summer of 2024 at the Vegetable Research Block, College of Horticulture, Bengaluru. A randomized complete block design (RCBD) with two replications was adopted, using a set of 94 muskmelon genotypes. Each entry was represented by ten plants, planted at a spacing of 2.0 m between rows and 1.0 m between plants. Data were collected from three randomly chosen plants per genotype on eighteen traits related to growth and yield. The recorded characters included days to first male and female flowering, number of primary branches per vine, fruit weight, fruits per vine, fruit yield per vine, fruit shape index, flesh thickness, rind thickness, cavity diameter, and total soluble solids, among others.

The total variation among the ninety-four genotypes for each quantitative trait was analyzed using analysis of variance (ANOVA) to partition the effects due to genotypes, replications and error, following the procedure of Panse and Sukhatme (1967). Estimates of genetic variability parameters, including genotypic and phenotypic coefficients of variation (GCV and PCV), were calculated according to Burton (1953) and categorized as suggested by Subramaniyan and Memon (1973). Broad-sense heritability was computed using the formula described by Hansen *et al.* (1956). The expected genetic advance (GA) and genetic advance expressed as a percentage of the mean were derived following the method outlined by Johnson *et al.* (1955).

Results and Discussion

The variance analysis demonstrated significant differences among the ninety-four genotypes for all fifteen growth and yield traits studied (Table 1). In every case, the phenotypic coefficient of variation (PCV) was greater than the genotypic coefficient of variation (GCV) (Table 2), highlighting the role of environmental factors in influencing trait expression. These results confirm the presence of considerable genetic variability in muskmelon for most morphological and yield-associated traits, which is fundamental for effective selection. The observed diversity offers scope for breeders to identify promising genotypes and exploit them in future crop improvement programs.

Table 1: Analysis of variance (mean sum of squares) for different characters in muskmelon

Sl. No	Character	Mean sum of squares		
		Replication (2)	Genotypes (94)	Error
1	Days to first male flower appearance	1.14	2.90*	0.60
2	Days to first female flower appearance	12.26	2.55*	1.22
3	Node at first male flower appearance	16.29	0.97*	0.22
4	Node at first female flower appearance	1.68	0.12*	0.20
5	Number of primary branches per vine	10.61	0.28	0.33
6	Days to first harvest	1.10	7.40*	1.95
7	Sex ratio	2.93	15.59*	0.92
8	Number of fruits per vine	2.35	3.56*	0.38
9	Average fruit weight	69332.48	170499.07*	4218.39
10	Fruit yield per vine	4.20	1.25*	0.20
11	Shape index	0.02	0.49*	0.01
12	Flesh thickness	0.09	0.44*	0.02
13	Rind thickness	0.23	1.70*	0.04
14	Cavity diameter	3.09	4.33*	0.33
15	Total soluble solids.	0.07	10.57*	0.13

*Significance at 0.1% level values.

Table 2: Genetic Variability and Variance Components for Yield and Growth Traits in Muskmelon

Sl. No	Character	Range	Grand Mean	PCV (%)	GCV (%)	h ² (%)	Genetic advance	GA as per cent of mean (%)
1	Days to first male flower appearance	28.83-35.17	30.93	4.28	3.46	65.66	1.79	5.78
2	Days to first female flower appearance	29.83-36.00	32.27	4.25	2.52	35.24	1.00	3.09
3	Node at first male flower appearance	2.33- 6.17	4.07	18.90	15.07	63.58	1.01	24.76
4	Node at first female flower appearance	2.33-7.17	5.40	17.97	15.92	78.45	1.57	29.05
5	Number of primary branches per vine	3-5	4.06	14.65	3.81	6.76	0.08	2.04
6	Days to first harvest	70.50- 79.67	74.69	2.90	2.21	58.28	2.60	3.48
7	Sex ratio	1.98-13.24	9.79	29.33	27.66	88.88	5.26	53.71
8	Number of fruits per vine	1.17-8	4.45	31.51	28.32	80.79	2.33	52.44
9	Average fruit weight	94.17- 1396.50	538.94	52.55	49.20	87.65	511.40	94.89
10	Fruit yield per vine	0.48-5.31	2.16	39.43	33.58	72.53	1.27	58.92
11	Shape index	0.81-2.90	1.37	36.39	35.74	94.89	0.98	71.73
12	Flesh thickness	0.80-3.15	1.77	27.22	26.05	91.58	0.91	51.35
13	Rind thickness	1.50-5.90	2.55	36.57	35.76	95.65	1.84	72.05
14	Cavity diameter	3.25-10.25	6.04	25.26	23.39	85.76	2.70	44.62
15	TSS	5- 13.50	9.35	24.74	24.43	97.53	4.65	49.70

GCV- Genotypic coefficient of Variation

PCV- Phenotypic coefficient of Variation

GA-Genetic advance

GAM- Genetic advance as percent of Mean

h²- Broad sense heritability

The higher phenotypic coefficient of variation (PCV) than genotypic coefficient of variation (GCV) was observed for all traits indicates the influence of environment on trait expression. PCV includes both genetic and environmental variance, while GCV reflects only the genetic portion. The difference between PCV and GCV values determines the extent of environmental effect. Traits with a narrow difference are less influenced by environment and more reliable for selection. Wider differences revealed traits highly affected by environmental factors. Thus, effective breeding should consider both genetic variability and environmental interaction.

In our present study, high PCV and GCV (>20%) were observed (Table 2) for number of fruits per vine, average fruit weight, fruit yield per vine, shape index, flesh thickness, rind thickness, cavity diameter and TSS. These findings were in compliance with Reddy and Shanthi (2013) for TSS in muskmelon, Kamagoud *et al.* (2018) in pickling melon and Bhimappa and Choudhary (2017), Reddy *et al.* (2013) and Choudhary *et al.* (2011) in muskmelon for average fruit weight. Higher estimates of PCV and GCV values indicated the presence of large genetic variability in the germplasm and offer better chance for the improvement of these traits through selection.

Moderate PCV and GCV node at first male flower appearance and node at first female flower appearance which were similar to Reddy *et al.* (2013) for fruit length in muskmelon. Lower estimates of PCV and GCV (<10%) were calculated for days to first male flower and days to first female flower opening (8.86, 7.4). This finding is in agreement with Bhimappa and Choudhary (2017), Reddy *et al.* (2013) and Choudhary *et al.* (2011) for days to first female anthesis in muskmelon. Low values of coefficient of variations for both phenotypic and genotypic traits revealed least variability for these traits and therefore, selection for these attributes will be ineffective and therefore these traits can be improved through heterosis breeding.

Larger difference between PCV and GCV were observed for the trait node at first male flower appearance (18.90 15.07), average fruit weight (52.55, 49.20) and number of fruits per vine (31.51, 28.32) which illustrated the role of environmental factors in determining these traits. While, minimum difference between PCV and GCV values were found for total soluble solids (24.74, 24.43), shape index (36.39, 35.74), days to first harvest (2.90, 2.21), rind thickness (36.57, 35.76), days to first male flower appearance

(4.28,3.46) and GCV higher than PCV observed in the trait number of branches (3.81, 14.65). These findings were in accordance with the results reported by Bhimappa and Choudhary (2017) Samadia (2007) and Tomar *et al.* (2008).

High heritability estimate (>60%) was observed for days to first male flower appearance, node at first male flower appearance and node at first female flower appearance, sex ratio, number of fruits per vine, average fruit weight, fruit yield per vine, shape index, flesh thickness, rind thickness, cavity diameter and TSS. Similar outcomes were also reported by, Priyanka (2019); Reddy and Shanthi (2013) in muskmelon and Rakhi and Rajamony (2006) in culinary melon for TSS; Choudhary *et al.* (2011) for flesh thickness and Bhimappa and Choudhary (2017) for fruit length in muskmelon. Moderate estimates of heritability (30-60%) were obtained for days to first female flower appearance, days to first harvest. This result is in conformity with Priyanka (2019) in muskmelon for days to first female flower anthesis. Low heritability estimate was (<30%) was estimated for number of branches which was found similar to that of Priyanka (2019) in muskmelon.

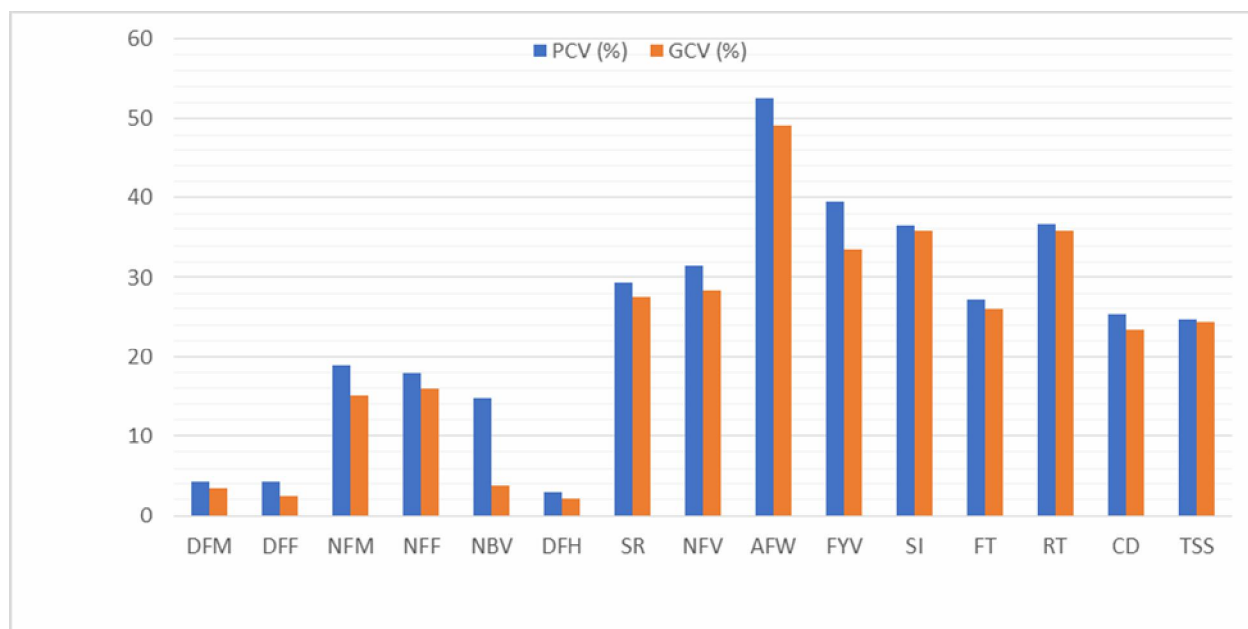


Fig. 1: Graphical representation of GCV (%) and PCV (%) for different characters in muskmelon

Note:

DFM- Days to first male flower appearance
DFF- Days to first female flower appearance
NFM- Node at first male flower appearance
NFF- Node at first female flower appearance
NBV- Number of primary branches per vine

SR- Sex ratio
DFH- Days to first harvest
NFV- Number of fruits per vine
AFW- Average fruit weight
FYV- Fruit yield per vine

SI- Shape index
FT- Flesh thickness
RT- Rind thickness
CD- Cavity diameter
TSS- Total soluble solids

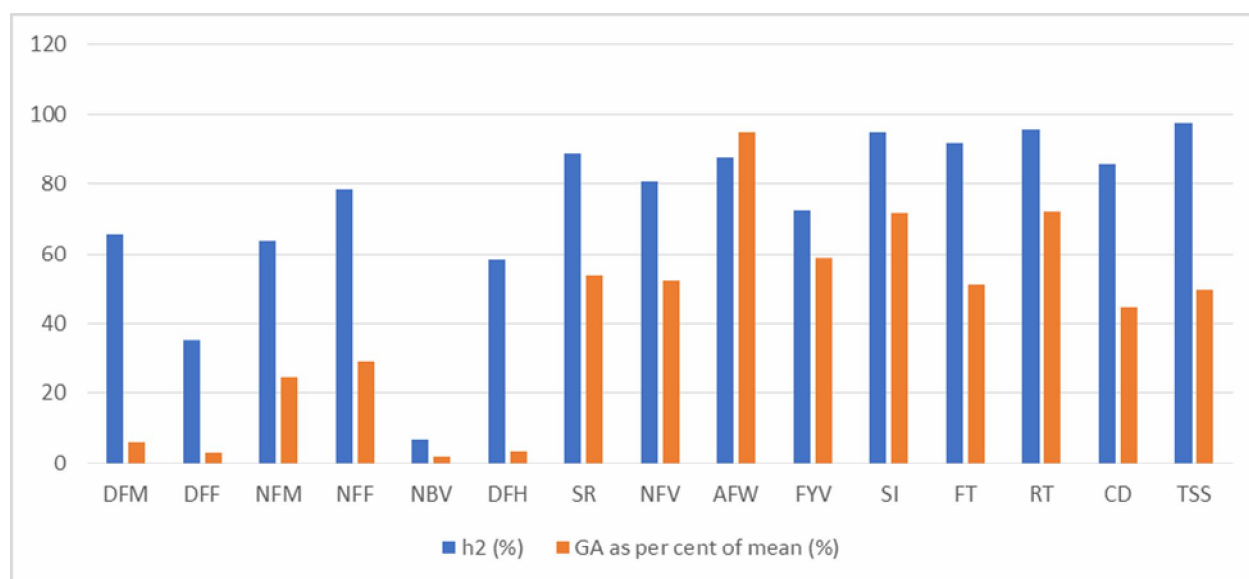


Fig. 2: Graphical representation of h² (%) and Genetic advance (GA) as per cent of mean (%) for different characters in muskmelon

Note:

DFM- Days to first male flower appearance	SR- Sex ratio	SI- Shape index
DFF- Days to first female flower appearance	DFH- Days to first harvest	FT- Flesh thickness
NFM- Node at first male flower appearance	NFV- Number of fruits per vine	RT- Rind thickness
NFF- Node at first female flower appearance	AFW- Average fruit weight	CD- Cavity diameter
NBV- Number of primary branches per vine	FYV- Fruit yield per vine	TSS- Total soluble solids

Considerable variation was observed in the genetic advance as a percentage of the mean across the evaluated traits in muskmelon, indicating varying degrees of selection effectiveness. Traits such as rind thickness (72.05%), shape index (71.73%), fruit yield per vine (58.92%), sex ratio (53.71%), number of fruits per vine (52.44%) and flesh thickness (51.35%) exhibited high genetic advance as a percentage of mean along with high heritability. Similar to earlier reports of Reddy *et al.* (2013) and Reddy and Shanthi (2013) Bhimappa and Choudhary (2017) and Choudhary *et al.* (2011) in muskmelon. This indicates that these traits are under strong additive genetic control and selection for such traits is likely to be highly effective and rewarding.

High heritability coupled with high genetic advance as percent of mean was observed for traits like shape index, rind thickness, sex ratio, number of fruits per vine, average fruit weight, fruit yield per vine and TSS, indicating the predominance of additive gene action and potential for effective selection. Moderate heritability with moderate genetic advance was noted in traits like days to first male and female flower appearance and days to first harvest.

Traits such as the number of primary branches exhibited low genetic variability, indicating limited

potential for improvement through direct selection. In contrast, several studies have reported high heritability combined with high genetic advance as a percentage of the mean for traits like fruit length, fruit girth, fruit weight, number of fruits per plant and fruit yield per plant (Kadi and Sambhaj, 2003; Iathet and Piluek, 2006; Samadia, 2007; Tomar *et al.*, 2008; Choudhary *et al.*, 2011; Ibrahim and Ramdan, 2013; Potekar *et al.*, 2014; Bhimappa *et al.*, 2017; Mishra *et al.*, 2017; Saha *et al.*, 2018; Pasha *et al.*, 2019; Torkadi *et al.*, 2019). Similarly, flesh thickness was consistently associated with high heritability and high genetic advance (Kadi and Sambhaj, 2003; Janghel *et al.*, 2018), while for primary branches per plant, such results were reported by Mali *et al.* (2015).

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