



DUS characterization of muskmelon (*Cucumis melo*) varieties

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ABSTRACT

The present study was carried out for morphological characterization of twelve reference varieties of muskmelon (*Cucumis melo* L.) collected from ICAR institutes and SAUs to validate DUS testing guidelines using plant descriptors adopted from the DUS guidelines of PPV and FRA. Among 34 morphological characters studied, 19 were visually assessed and 15 were measured. The fruit shape in longitudinal section was expressed as ovate (MHY 5), elongated globe (Arka Rajhans), oblate (GMM 3, Kashi Madhu) and obovate (Durgapura Madhu). The rind colour of fruit have been grouped as yellow (Kashi Madhu), yellow green (Durgapura Madhu) and orange (Arka Jeet). The sutures on fruit surface were found to be absent in Arka Jeet, MHY 3 and present in Hara Madhu, Kashi Madhu varieties. With respect to netting on fruit surface the varieties have been grouped as absent of netting (Arka Jeet, MHY 5) and moderate netting (RM 50, Punjab Sunehri). The flesh colour was expressed as creamish white (Arka Jeet), grey orange (GMM 3), yellowish green (Durgapura Madhu), green (Hara Madhu) and orange (Kashi Madhu). Under results, no intra-varietal variation was observed for any of the visual characteristics examined. Further, the expression of characters in different varieties remained same for the three consecutive years confirming the uniformity and stability of the varieties for visual characteristics. The varieties were grouped into different categories for each character based on 34 descriptors which may be used as reference varieties. Identified 6 traits as grouping traits, viz. sex expression (at full flowering), fruit shape in longitudinal section, rind colour of fruit, sutures on rind, surface netting of fruit and fruit flesh colour. The morphological characterization of extant varieties was completed to establish distinctness of the candidate variety from all other varieties to utilize these varieties as reference material for protection of other varieties under PPV&FR Act.

Key words: Characterization, DUS, Muskmelon, Muskmelon varieties

The “Protection of Plant Varieties and Farmers’ Rights Act” (PPV&FR Act, 2001) was passed by the Government of India in 2001 with the objective of providing an effective system of protection against unlawful commercial exploitation of new plant varieties, the rights of farmers and plant breeders and to encourage the development of new varieties of plants. It has become imperative on the part of the Government of India to develop our own *sui-generis* (‘of their own kind’) system to provide a frame work for Plant Variety Protection and Farmers Right. The Protection of Plant Varieties and Farmers’ Rights Authority, New Delhi established by the Government has the responsibility of implementing the provisions of this Act. The examination of a new plant variety for establishment of distinctiveness, uniformity and stability is known as “Distinctiveness, Uniformity and Stability (DUS) test”. The success of DUS test trials rest on a set of general principles and specific guidelines. The evaluation of a variety for DUS generates a description of the variety using its relevant

morpho-physiological characteristics which have been recognized universally as undisputed descriptors for characterization and DUS testing of plant varieties. The use of morphological descriptors in sequential order is useful and convenient to differentiate the varieties from each other. A variety is identified on the basis of a set of characteristics differing from other known varieties of that species. A guideline to conduct DUS test is required for describing a variety, assessing the level of uniformity of characteristics and the stability of expression of those in different growing locations over the years. For the purpose of an objective comparison and uniform evaluation by the DUS testing personnel, example varieties are identified and included in the table of characteristics to exemplify the characteristic state of expression. These example varieties must exhibit the specific state of a characteristic without any ambiguity. A strict maintenance breeding for genetic purity of all the example varieties is warranted for a valid DUS testing for proper implementation of PPV&FR Act (Chakrabarty *et al.* 2012 and Singh *et al.* 2012). In India, the great variability exists in muskmelon genotypes and the true character expression in the example varieties assume a greater significance under PPV&FR Act, 2001 for

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Table 1 Example varieties validated for the state of the characteristics

Characteristics	State of expression	Example varieties	Type of assessment
Cotyledon: length (cm)	Short (<2.75)	Punjab Sunehri	MS
	Medium (2.75-3.25)	Arka Jeet	
	Long (>3.25)	RM 50, Pusa Madhuras	
Cotyledon: width (cm)	Narrow (<1.5)	Kashi Madhu, Durgapura Madhu	MS
	Medium (1.5-1.75)	GMM 3, RM 43	
	Broad (>1.75)	Pusa Madhuras	
Leaf blade: length (cm)	Short (<8)	RM 43	MS
	Medium (8-10)	Kashi Madhu	
	Long (>10)	MHY 3, Durgapura Madhu	
Leaf blade: width (cm)	Narrow (<11)	GMM 3, RM 43	MS
	Medium (11-13)	Kashi Madhu	
	Broad (>13)	Pusa Madhuras	
Leaf blade: depth of lobes (depth of terminal lobe)	Weak	MHY 3	VG
	Medium	GMM 3	
	Strong	RM 50	
Leaf blade: length of terminal lobe (cm)	Short (<2.5)		MS
	Medium (2.5-4.5)	Kashi Madhu	
	Long (>4.5)	RM 50	
Leaf blade: dentation of margin	Weak	RM 43	VG
	Strong	Kashi Madhu, RM 50	
Leaf blade: petiole length (cm)	Short (<7)	RM 43, Durgapura Madhu	MS
	Medium (7-9)	Pusa Madhuras, MHY 5	
	Long (>9)	RM 50, Hara Madhu	
Appearance of first perfect/ pistillate flower in 50% plants from date of sowing (days)	Early (<45)	Durgapura Madhu	MG
	Medium (45-50)	MHY 3, RM 43, Kashi Madhu	
	Late (>50)		
Sex expression (at full flowering)	Monoecious		VG
	Andromonoecious	Kashi Madhu, Pusa Madhuras, Hara Madhu, Durgapura Madhu	
	Others	-	
Male sterility	Absent	Kashi Madhu, Pusa Madhuras, Hara Madhu, Durgapura Madhu	VG
	Present	-	
Ovary: length (cm)	Short (<1)	Punjab Sunehri	MS
	Medium (1-1.5)	MHY 5	
	Long (>1.5)	Durgapura Madhu, RM 50	
Ovary: width (cm)	Narrow (<0.6)	Kashi Madhu	MS
	Medium (0.6-0.8)	Hara Madhu	
	Broad (>0.8)	MHY 5	
Ovary: pubescence	Sparse	Arka Jeet	VG
	Dense	Kashi Madhu	
Fruit: length (cm)	Short (<10)	Arka Jeet	MG
	Medium (10-15)	Pusa Madhuras	
	Long (>15)	Durgapura Madhu	
Fruit: diameter (cm)	Narrow (<9)	RM 43, Arka Jeet	MG
	Medium (9-12)	RM 50	
	Broad (>12)	GMM 3, Kashi Madhu	
Fruit: shape in longitudinal section	Ovate	MHY 5	VG
	Oval		
	Elongated globe	Arka Rajhans	
	Round		
	Oblate (Flat globe)	GMM 3, Kashi Madhu	

(Continued)

Table 1 (Continued)

Characteristics	State of expression	Example varieties	Type of assessment
Fruit: rind colour	Obovate	Durgapura Madhu	VG
	Cylindrical		
	Creamy white		
	Yellow	Kashi Madhu	
	Yellow Green	Durgapura Madhu	
	Orange	Arka Jeet	
Fruit: patches	Others		VG
	Absent	Arka Jeet, MHY 3	
Fruit: peduncle at maturity	Present	Kashi Madhu, GMM 3	VG
	Slipable	Kashi Madhu	
Fruit: shape at peduncle end	Non-slipable	Hara Madhu	VG
	Pointed	Durgapura Madhu	
	Rounded	Hara Madhu, Pusa Madhuras	
Fruit: shape at blossom end	Truncate	Kashi Madhu	VG
	Pointed	Durgapura Madhu	
	Intermediate	-	
Fruit: diameter of blossom end scar (cm)	Truncate	Kashi Madhu	MS
	Small (<1)	Arka Jeet, Durgapura Madhu	
	Medium (1-2)	Pusa Madhuras	
Fruit: surface	Large (>2)	Kashi Madhu	VG
	Smooth	Arka Jeet, MHY 3	
Fruit: sutures	Grooved	RM 43, Kashi Madhu	VG
	Absent	Arka Jeet, MHY 3	
Fruit: suture colour	Present	Hara Madhu, Kashi Madhu	VG
	Creamy	Arka Rajhans	
	Green	Kashi Madhu, Hara Madhu	
Fruit: surface netting	Others	-	VG
	Absent	Arka Jeet, MHY 5	
	Moderate	RM 50, Punjab Sunehri	
Fruit: flesh thickness at position of maximum fruit diameter (cm)	Dense	-	MS
	Thin (<2)	Arka Jeet	
	Medium (2-3)	MHY 5	
Fruit: flesh colour	Thick (>3)	GMM 3	VG
	Creamish white	Arka Jeet	
	Grey orange	GMM 3	
	Yellowish green	Durgapura Madhu	
	Green	Hara Madhu	
Fruit: flesh texture	Orange	Kashi Madhu	VS
	Mealy	Hara Madhu	
	Intermediate		
Fruit : flavour	Crispy	Kashi Madhu	VG
	Mild	Arka Rajhans	
	Medium	Kashi Madhu, Durgapura Madhu	
	Strong	-	
Seed: length (cm)	Short (<1)	Kashi Madhu, Hara Madhu	MS
	Long (>1)	Pusa Madhuras	
Seed: width(cm)	Narrow (<0.4)	Durgapura Madhu	MS
	Broad (>0.4)	Pusa Madhuras	
Seed: colour	Creamy white	Kashi Madhu, Arka Jeet	VG
	Yellowish	Durgapura Madhu, Hara Madhu	

*Grouping trait, MG (Measurement by a single observation of a group of plants or parts of plants), MS (Measurement of a number of individual plants or parts of plants), VG (Visual assessment by a single observation of a group of plants or parts of plants) and VS (Visual assessment by observations of individual plants or parts of plants).

their protection on a set of relevant characteristics prescribed in the 'Minimal Descriptors of Vegetable crops' for muskmelon by Srivastava *et al.* (2001) and International Union for the Protection of New Varieties of Plants (UPOV), 2006. Therefore, the present study carried out with the objective to 'validate DUS testing guidelines of the example varieties of muskmelon for the states of expression of various characteristics'.

MATERIALS AND METHODS

The study materials comprised genetically pure seed of 12 extant varieties of muskmelon, viz. Arka Jeet, Arka Rajhans, MHY 3, MHY 5, RM 43, RM 50, Durgapura Madhu, Kashi Madhu, Pusa Madhuras, GMM 3, Punjab Sunehri and Hara Madhu. The seeds of all extant varieties were sown with five rows of 5.6m length keeping a row to row and plant to plant spacing of 2.5m and 0.8m respectively in Randomized Block Design and replicated thrice. The experiments were carried out at three locations namely ICAR-Central Institute for Arid Horticulture (ICAR-CIAH), Bikaner (Rajasthan), ICAR-Indian Institute of Vegetable Research (ICAR-IIVR), Varanasi (UP) and ICAR-Indian Institute of Horticultural Research (ICAR-IIHR), Bengaluru (Karnataka) for three consecutive years from 2011 to 2013. All recommended package of practices were followed to raise healthy crop for DUS characterization.

All cultivars under study were evaluated for 34 DUS characters at specified stage of crop growth period when characters under study had full expression following the guidelines of Srivastava *et al.* (2001), IPGRI (2003) and UPOV (2006). The observations for the assessment of distinctiveness and stability were made on 10 plants or parts of plants from each replication selected randomly. The assessment of uniformity of characteristics in the plot as a whole was done visually by a single observation of a group of plants or parts of plants. The observations on the cotyledon were made just before the development of the first true leaf. All observations on the leaf were recorded on fully developed but not old leaves, preferably between the 5th and 8th node when the plant had at least one fruit set while the observations on the fruit traits were made on 1st or 2nd well developed mature fruit. Observations on the ovary were recorded on the day of anthesis. All observations on width were recorded at the maximum point of width of the part concerned. All observations on the seeds were made on fully developed, matured and dry seeds, after washing and drying.

RESULTS AND DISCUSSION

Among the 12 muskmelon varieties, considerable variation was observed for all the important characters. The states of expression of a particular trait along with example varieties of muskmelon are presented in Table 1. Among the morphological traits, identified 6 traits as grouping traits, viz. sex expression (at full flowering), fruit shape in longitudinal section, rind colour of fruit, sutures on rind, surface netting of fruit and fruit flesh colour. In

the present study, Durgapura Madhu showed early female flowering behavior, whereas MHY 3, RM 43 and Kashi Madhu showed medium flowering behavior. All the 12 varieties under study had andromonoecious sex expression with fertile pollens. The ovary length was expressed as short (Punjab Sunehri), medium (MHY 5) and long (Durgapura Madhu, RM 50). On the basis of fruit length, muskmelon varieties have been grouped into three categories, viz. short (Arka Jeet), medium (Pusa Madhuras) and long (Durgapura Madhu). The fruit shape in longitudinal section was expressed as ovate (MHY 5), elongated globe (Arka Rajhans), oblate (GMM 3, Kashi Madhu) and obovate (Durgapura Madhu). The rind colour of fruit have been grouped as yellow (Kashi Madhu), yellow green (Durgapura Madhu) and orange (Arka Jeet). The sutures on fruit surface were found to be absent in Arka Jeet, MHY 3 and present in Hara Madhu, Kashi Madhu varieties. With respect to netting on fruit surface the varieties have been grouped as absent of netting (Arka Jeet, MHY 5) and moderate netting (RM 50, Punjab Sunehri). The flesh colour was expressed as creamish white (Arka Jeet), grey orange (GMM 3), yellowish green (Durgapura Madhu), green (Hara Madhu) and orange (Kashi Madhu). The seed colour was observed to be creamy white (Kashi Madhu, Arka Jeet) and yellowish (Durgapura Madhu, Hara Madhu). The studies of Vijay (1987), Lal and Singh (1997), Pandey *et al.* (2005), Pandey *et al.* (2009) and Choudhary *et al.* (2012) also described the variability in *Cucumis* species in respect of morphological, yield and yield contributing traits. They also proposed that the characterization of germplasm in respect of economic traits, which would help in the quantification and organization of genetic diversity. Earlier morphological characterization of bell pepper (Sood *et al.* 2011), cabbage (Singh *et al.* 2012), rice (Chakrabarty *et al.* 2012) and French bean (Singh *et al.* 2014) has been done for their application for distinctness, uniformity and stability testing.

All varieties are expected to be highly uniform and stable in expression of the characteristics at a particular state. It is applicable for the qualitative characteristics which are least influenced by environmental conditions. The varieties should be less in number to reduce cost of DUS testing and for easy maintenance of the set of varieties which involve high cost due to cross pollination of muskmelon. More than one example variety for a state of expression of a characteristic is desirable in case the variety deteriorates for the given characteristic and/or it does not express in some growing condition and areas. The reference varieties are of utmost importance in DUS testing for comparing characteristic states of the candidate varieties. Any chance of impurity of seed in the set of reference varieties would lead to wrong or invalid DUS test result. Therefore, maintenance of genetic purity to the highest level in the reference varieties is a basic requirement for the successful conduct of DUS test. It is also suggested that a periodical review of all varieties be undertaken at all the DUS test centres to validate the set of varieties.

Muskmelon being highly cross pollinated crop a strict maintenance breeding of the reference varieties, including the example varieties, and use of alternate example varieties for conduct of DUS testing in muskmelon, if needed, are also suggested.

The varieties characterized for DUS were grouped into different categories for each character which could be used as reference varieties. These varieties can be used in the varietal improvement programme of muskmelon for desirable traits. Genetic improvement of desirable varieties can also be done through gene combinations from unadapted sources having resistance against biotic and abiotic stresses. These test guidelines apply to all varieties, hybrids and parental lines of muskmelon including *C. melo* L. subsp. *cantalupensis* and *C. melo* L. subsp. *reticulatus*. It is concluded that the developed DUS descriptors can be effectively used for identification and grouping of varieties and comparing candidate varieties for registration under PPV&FR Act to protect the right of farmers and plant breeders.

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