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Characterization of distinctiveness in existing genetic resources of long melon (*Cucumis melo* var. utilissimus L.) by using morphological markers

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ABSTRACT

The present investigation was carried out for successive two years during summer season of 2024 & 2025 to carry out characterization of 39 genotypes (27 F1 + 12 parents) including 1 check of long melon (*Cucumis melo var.* utilissimus L.) at Main Experimental Research Station, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh India. The seed materials for the present investigation comprised nine lines (NDLM-23-1, NDLM-23-2, NDLM-23-3, NDLM-23-4, NDLM-23-5, NDLM-23-6, NDLM-23-7, NDLM-23-8, NDLM-23-9), three tester (Kashi Santusthi, Punjab Long Melon, Kashi Vidhi) and 27 hybrids. The field experiment was laid out in a randomized block design with three replications and 16 morphological characters studied. The study highlights significant genetic diversity among long melon genotypes, which is crucial for breeding programs aimed at improving yield, quality, and resilience to various stresses. These findings demonstrate the potential for developing superior long melon varieties through targeted breeding strategies aligned with specific cultivation methods and market demands. Future investigations should prioritize testing these genotypes across a range of environmental conditions to ensure consistent performance. Additionally, the morphological traits of existing varieties were thoroughly characterized to confirm the uniqueness of the candidate variety, enabling their use as reference material for variety protection under the PPV&FR Act.

INTRODUCTION

Melon (*Cucumis melo* L.) belonging to the family Cucurbitaceae, is a highly diverse species exhibiting considerable morphological variation, particularly in fruit characteristics. Among its numerous species, *Cucumis melo* var. utilissimus, commonly known as long melon, is cytogenetically characterized by a diploid chromosome number of 2n = 2x = 24. This variety is referred to by several vernacular names, including *tar*, *kakri*, serpent melon, snake melon, oriental cucumber, snake cucumber, and Armenian cucumber, reflecting its elongated morphology and regional uses. Long melon holds significant horticultural value and is considered the second most important salad cucurbit vegetable, following cucumber in both consumption and cultivation. The genus *Cucumis* currently comprises more than 50 species (Parkash *et al.*, 2023) underscoring its taxonomic richness. However, due to the complex and often ambiguous classification within *C. melo* (Pitrat *et al.*, 2000) certain botanical varieties such as *C. melo* var. utlissimus necessitate distinct morphological and taxonomic characterization to facilitate accurate identification, breeding efforts and germplasm conservation. (Mohamed *et al.*, 2022). The genetic and phenotypic diversity of long melon (*Cucumis melo* var. utilissimus) has been explored through various morphological traits, including fruit size, shape, color, surface texture, taste, and internal composition (Stepansky *et al.*, 1999). However, relying solely on external morphological characteristics often proves insufficient for accurate differentiation among genotypes. Despite its significance, there is currently a limited body of research focused on the systematic characterization and evaluation of long melon germplasm. Traditional landraces of *C. melo var. utilissimus*, typically recognized by their elongated and slender fruit morphology, are increasingly at risk of genetic erosion. This is largely attributed to the growing preference among commercial producers for high-yielding, improved cultivars, which are replacing indigenous varieties in many regions. Given this context, comprehensive characterization and evaluation of long melon are essential to inform effective conservation strategies and ensure the sustainable utilization of its valuable genetic resources. In contrast to most melon types, which are typically sweet and exhibit different fruit length and width ratio while, snake melon (*Cucumis melo* var. utilissimus) produces non-sweet fruits that are significantly elongated, often displaying a length-to-width ratio of 4:1 or greater. The cultivars of long melon also show considerable

variation in the external appearance of immature fruits, which may present as light green, dark green, or a combination of both. In many cases, the elongation of the fruit far exceeds the 4:1 ratio, with individual fruits measuring over 50 cm in length and approximately 5 cm in diameter. (Merheb *et al.*,2020). The main objective of this research was to assess the extent of morphological variability among cultivated long melon (*Cucumis melo var. utilissimus*) genotypes and to examine the correlation between morphological, fruit and yield-associated traits. Comprehensive morphological characterization is essential to enhance the value of long melon genotypes for conservationists, plant breeders, and agricultural producers. In this context, evaluating the genetic diversity of local snake melon accessions is critical to support effective management, selection, and improvement strategies. Therefore, this study aimed to investigate the morphological diversity among 39 long melon genotypes/hybrids with the goal of generating practical information that can guide the selection of parental lines for use in future breeding programs. (Ali-Shtayeh *et al.*, 2015)

Methods and materials

The study materials comprised genetically pure seed of 12 parents and their hybrids of long melon, *viz*. NDLM-23-1, NDLM -23-3, NDLM -23-4, NDLM -23-5, NDLM -23- 6, NDLM -
23-7, NDLM -23-8, NDLM -23-9, Kashi Santusthi, Punjab Long Melon, Kashi Vidhi and NDLM-23-1 x Kashi Santusthi, NDLM-23-1 x Punjab Long Melon, NDLM-23-1 x Kashi Vidhi, NDLM-23-2 x Kashi Santusthi, NDLM-23-2 x Punjab Long Melon, NDLM-23-2 x Kashi Vidhi, NDLM-23-3 x Kashi Santusthi, NDLM-23-3 x Punjab Long Melon, NDLM-23-
3 x Kashi Vidhi, NDLM-23-4 x Kashi Santusthi, NDLM-23-4 x Punjab Long Melon, NDLM-23-4 x Kashi Vidhi, NDLM-23-5 x Kashi Santusthi, NDLM-23-5 x Punjab Long Melon, NDLM-23-5 x Kashi Vidhi, NDLM-23-6 x Kashi Santusthi, NDLM-23-6 x Punjab Long Melon, NDLM-23-6 x Kashi Vidhi, NDLM-23-7 x Kashi Santusthi, NDLM-23-7 x Punjab Long Melon, NDLM-23-7 x Kashi Vidhi, NDLM-23-8 x Kashi Santusthi, NDLM-23-
8 x Punjab Long Melon, NDLM-23-8 x Kashi Vidhi, NDLM-23-9 x Kashi Santusthi, NDLM-23-9 x Punjab Long Melon, NDLM-23-9 x Kashi Vidhi. The seeds of all genotypes & crosses were sown with keeping a row to row 3 m and plant to plant spacing of 0.5 m in Randomized Block Design and replicated thrice. The experiments were carried out at Main Experimental Research Station, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh India. All recommended package of practices were followed to raise healthy crop for DUS characterization (Dey *et al*. 2004). All cultivars under study were observed for 16 DUS characters at specified stage of crop growth period when characters under study had full expression following the guidelines of Srivastava *et al*. (2001) and UPOV (2007). The observations for the assessment of distinctiveness and stability were made on 5 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. 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 parents and their hybrids, considerable variation was observed for all the important characters. The states of expression of a particular trait along with example genotypes of long melon are presented in Table 1. In the present study all the genotypes/crosses were observed monoecious sex expression with fertile pollens. The male sterility was found absent in all the genotypes/crosses. Based on leaf shape genotypes/crosses were grouped as Cordate, Palmately lobed, Palmately. Genotypes/crosses namely NDLM- 23-2, NDLM-23-5, NDLM-23-2 x Kashi Santusthi, NDLM-23-2 x Punjab Long Melon, NDLM-23-2 x Kashi Vidhi, NDLM-23-5 x Kashi Santusthi, NDLM-23-5 x Punjab Long Melon, NDLM-23-5 x Kashi Vidhi) showed cordate shape, palmately leaf shape was observed in NDLM-23-3, NDLM-23-7, NDLM-23-3 x Kashi Santusthi, NDLM-23-5 x Kashi Vidhi while other genotype/crosses had shown palmately lobed leaf shape. On the basis of leaf length genotypes/crosses were classified in three grouped *viz.*, short, medium and long. The genotypes NDLM-23-5, NDLM-23-2 x Kashi Santusthi, NDLM-23-2 x Punjab Long Melon, NDLM-23-5 x Kashi Vidhi expressed medium leaf blade length and all other genotypes/crosses showed long leaf blade length. The leaf blade width was classified into three stages like narrow, medium and broad. The genotypes NDLM-23-5, NDLM-23-2 x Kashi Santusthi, NDLM-23-2 x Punjab Long Melon and NDLM-23-2 x Kashi Vidhi and NDLM-23-5 x Kashi Vidhi exhibited narrow leaf blade length and medium leaf blade length showed by NDLM-23-1, NDLM-23-2, NDLM-23-4 x Kashi Santusthi, NDLM-23-5 x Punjab Long Melon, NDLM-23-7 x Punjab Long Melon genotypes/crosses and other all genotypes
/crosses had shown broad leaf blade width. The genotypes/crosses were also classified three shallow, intermediate and deep on the basis of depth of leaf lobe, narrow depth of leaf lobe expressed by NDLM-23-2, NDLM-23-3, NDLM-23-5 NDLM-23-2 x Kashi Santusthi, NDLM-23-2 x Punjab Long Melon, NDLM-23-2 x Kashi Vidhi, NDLM-23-5 x Kashi Santusthi, NDLM-23-5 x Punjab Long Melon, NDLM-23-5 x Kashi Vidhi) while other genotypes showed intermediate depth of leaf lobe. On the basis of leaf petiole length were categorized as short, medium and long, short petiole length exhibited by NDLM-23-2, NDLM-23-3, NDLM-23-5, NDLM-23-5, NDLM-23-2 x Kashi Santusthi, NDLM-23-2 x Punjab Long Melon, NDLM-23-2 x Kashi Vidhi, NDLM-23-5 x Kashi Santusthi, NDLM- 23-5 x Punjab Long Melon, NDLM-23-5 x Kashi Vidhi, NDLM-23-7 x Punjab Long Melon) and other genotypes/crosses observed as medium petiole length. In case of the flower observations NDLM-23-1, NDLM-23-4, NDLM-23-5, NDLM-23-6, Kashi Vidhi, NDLM-
23-1 x Kashi Vidhi, NDLM-23-2 x Kashi Vidhi, NDLM-23-4 x Kashi Santusthi, NDLM-23-
4 x Kashi Vidhi, NDLM-23-5 x Kashi Santusthi, NDLM-23-5 x Punjab Long Melon, NDLM-23-5 x Kashi Vidhi, NDLM-23-6 x Kashi Santusthi, NDLM-23-6 x Punjab Long Melon, NDLM-23-6 x Kashi Vidhi was observed light yellow flower colour and other genotypes flowers were dark yellow. In the genotypes/crosses observation the ovary length was studied based on three length ranges *viz.*, short, medium, and long. The genotypes NDLM-23-1, NDLM-23-2, NDLM-23-3, NDLM-23-4, NDLM-23-6, NDLM-23-15, NDLM-
23-8, NDLM-23-1 x Punjab Long Melon, NDLM-23-1 x Kashi Vidhi, NDLM-23-2 x Kashi Santusthi, NDLM-23-2 x Punjab Long Melon, NDLM-23-3 x Kashi Santusthi, NDLM-23-6 x Kashi Santusthi, NDLM-23-2 x Punjab Long Melon, NDLM-23-1 x Kashi Vidhi, NDLM- 23-8 x Kashi Santusthi, NDLM-23-1 x Kashi Vidhi, NDLM-23-9 x Kashi Santusthi had long ovary length and others genotypes/crosses had medium ovary length. In the case of morphological characters of fruit, fruit strips were absent, fruit taste was non-bitter and fruit creasing was present in all the genotypes/crosses except NDLM-23-5, NDLM-23-7, NDLM- 23-5 x Kashi Santusthi, NDLM-23-7 x Kashi Santusthi. Fruits were found creamy in colour (NDLM-23-2, NDLM-23-5, NDLM-23-7, NDLM-23-2 x Kashi Santusthi, NDLM-23-5 x Kashi Santusthi, NDLM-23-7 x Kashi Santusthi) and dark green (NDLM-23-3, NDLM-23-3 x Kashi Santusthi, NDLM-23-3 x Punjab Long Melon) and other genotypes/crosses had medium light green fruit colour. Fruit shape was expressed in three groups viz: Slightly elongated and elongated curve. The maximum genotypes had Elongated Curve fruit shape except slightly elongated NDLM-23-3, NDLM-23-5, NDLM-23-1 x Kashi Santusthi, NDLM-23-4 x Kashi Santusthi, NDLM-23-5 x Kashi Santusthi, NDLM-23-5 x Punjab Long Melon, NDLM-23-7 x Kashi Santusthi, NDLM-23-7 x Punjab Long Melon, NDLM-23-8 x Punjab Long Melon, NDLM-23-9 x Kashi Santusthi) The seed length and seed width were expressed as short and long. All the genotypes/crosses were short in width and also in case of seed length, had short length except (NDLM-23-8, Punjab Long Melon, Vidhi, NDLM-23-3 x Kashi Vidhi, NDLM-23-5 x Punjab Long Melon, NDLM-23-5 x Kashi Vidhi, NDLM-23-7 x Kashi Santusthi, NDLM-23-8 x Kashi Vidhi, NDLM-23-9 x Kashi Vidhi) had long seed length. The studies of Yousif *et al*. 2022, Merheb *et al*. 2020, Omari *et al*. 2018, Ali-Shtayeh *et al*. 2015, Ajuru *et al*. 2013 also described the variability in snake melon in respect of morphological, yield and yield contributing traits. It was further proposed that the characterization of germplasm based on economically significant traits would contribute to the effective

quantification and systematic organization of genetic diversity. Earlier morphological characterization of tomato (Athinodorou *et al.,* 2021), Pea tomato (Salim *et al.,* 2020), cow pea (Rambabu et al.,2017), (Singh *et al.,* 2014) has been done for their application for distinctness, uniformity and stability testing. Varieties submitted for DUS testing are expected to exhibit a high degree of uniformity and stability in the expression of their traits, particularly for qualitative characteristics, which are typically less affected by environmental factors. To reduce the cost and complexity of DUS testing, especially important in cross-pollinated crops like muskmelon, it is beneficial to maintain a limited number of varieties. However, incorporating more than one example variety for a given characteristic state can be useful. This provides a backup in case a variety loses its ability to express a specific trait or fails to do so under certain environmental conditions. Reference varieties play a critical role in the DUS testing process, serving as benchmarks for comparing the trait expressions of candidate varieties. Any genetic impurity in these reference varieties could compromise the reliability of the test outcomes. Therefore, maintaining their genetic purity at the highest standard is essential to ensure valid and accurate DUS testing. Regular evaluations and updates of reference varieties across all DUS testing centers are recommended to preserve the relevance and accuracy of the variety sets. Given the high degree of cross-pollination in long melon, strict maintenance breeding practices for reference and example varieties are crucial. In some cases, it may be necessary to utilize alternative example varieties for conducting DUS tests, particularly in long melon, if the primary ones are no longer suitable. The varieties evaluated through DUS testing were classified into distinct groups based on specific traits, enabling their use as reference material. These varieties can also contribute to muskmelon breeding programs by offering desirable traits. Further genetic enhancement can be achieved by integrating beneficial genes from diverse or unadapted sources, especially those providing resistance to biotic and abiotic stresses. These testing guidelines are applicable to all types of long melon, including varieties, hybrids, and parental lines. In conclusion, the established DUS descriptors offer a reliable framework for identifying, classifying, and registering varieties under the PPV&FR Act, thereby supporting the protection of both farmers' and breeders' rights.

Fig, Fruit Colour, Fruit Shape, Fruit Strips

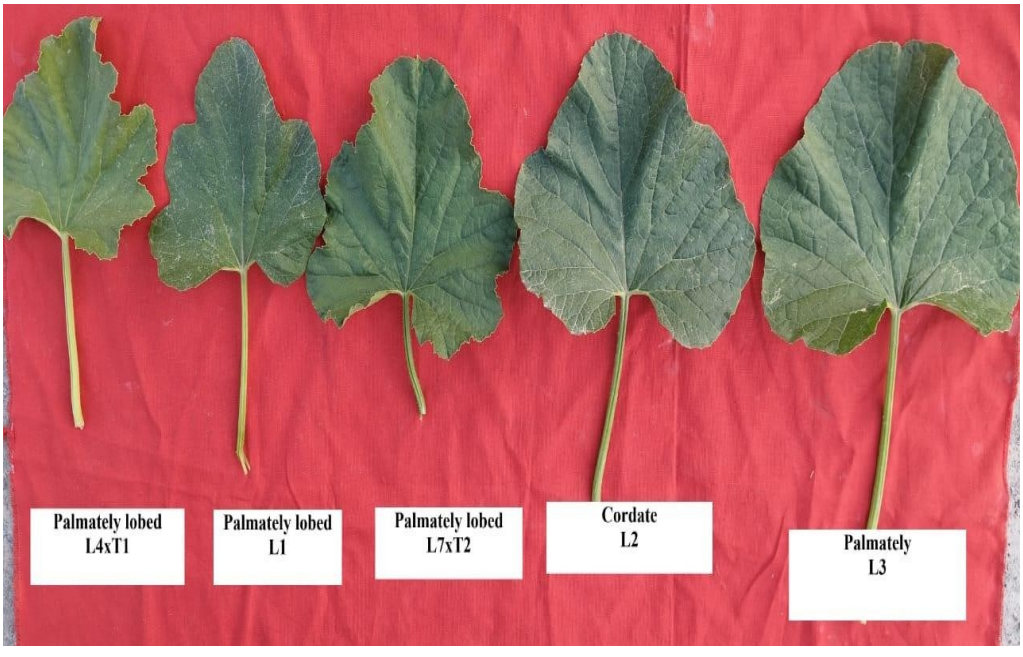

Fig. Leaf Length, Leaf Width, Leaf Shape

Table 1: Description of morphological DUS descriptors for Sixteen Long Melon genotypes and hybrids

Genotype/ Hybrids	Morphological Characters															
	Leaf Length	Leaf Width	Leaf Shape	Depth of Leaf Lobe	Petiole Length	Flower Colour	Ovary Length	Fruit Colour	Fruit Shape	Fruit Strips	Fruit Taste	Fruit Creasing	Seed Length	Seed Width	Sex Expression	Male Sterility
NDLM-23-1	Long	Medium	Palmately lobed	Inter-mediate	Medium	Light Yellow	Long	Light Green	Elongated Curve	Absent	Non Bitter	Present	Short	Short	Monocious	Absent
NDLM-23-2	Long	Medium	Cordate	Shallow	Short	Dark Yellow	Long	Creamy	Elongated Curve	Absent	Non Bitter	Present	Short	Short	Monocious	Absent
NDLM-23-3	Long	Broad	Palmately	Shallow	Medium	Dark Yellow	Long	Dark Green	Slightly Elongated	Absent	Non Bitter	Present	Short	Short	Monocious	Absent
NDLM-23-4	Long	Broad	Palmately lobed	Inter-mediate	Medium	Light Yellow	Long	Light Green	Slightly Elongated	Absent	Non Bitter	Present	Short	Short	Monocious	Absent
NDLM-23-5	Medium	Narrow	Cordate	Shallow	Short	Light Yellow	Medium	Creamy	Slightly Elonagted	Absent	Non Bitter	Absent	Short	Short	Monocious	Absent
NDLM-23-6	Long	Broad	Palmately lobed	Inter-mediate	Medium	Light Yellow	Long	Light Green	Elongated Curve	Absent	Non Bitter	Present	Short	Short	Monocious	Absent
NDLM-23-7	Long	Broad	Palmately	Inter-mediate	Short	Dark Yellow	Long	Creamy	Elongated Curve	Absent	Non Bitter	Absent	Short	Short	Monocious	Absent
NDLM-23-8	Long	Broad	Palmately lobed	Inter-mediate	Medium	Dark Yellow	Long	Light Green	Elongated Curve	Absent	Non Bitter	Present	Long	Short	Monocious	Absent
NDLM-23-9	Long	Broad	Palmately lobed	Inter-mediate	Medium	Dark Yellow	Medium	Light Green	Elongated Curve	Absent	Non Bitter	Present	Short	Short	Monocious	Absent
Kashi Santusthi	Long	Broad	Palmately lobed	Inter-mediate	Medium	Dark Yellow	Medium	Light Green	Slightly Elongated	Absent	Non Bitter	Present	Short	Short	Monocious	Absent
Punjab Long Melon	Long	Broad	Palmately lobed	Inter-mediate	Medium	Dark Yellow	Medium	Light Green	Elongated Curve	Absent	Non Bitter	Present	Long	Short	Monocious	Absent
Kashi Vidhi	Long	Broad	Palmately lobed	Inter-mediate	Medium	Light Yellow	Medium	Light Green	Elongated Curve	Absent	Non Bitter	Present	Short	Short	Monocious	Absent
NDLM-23-1 x Kashi Santusthi	Long	Broad	Palmately lobed	Inter-mediate	Medium	Dark Yellow	Medium	Light Green	Slightly Elongated	Absent	Non Bitter	Present	Short	Short	Monocious	Absent
NDLM-23-1 x Punjab Long Melon	Long	Broad	Palmately lobed	Inter-mediate	Medium	Dark Yellow	Long	Light Green	Elongated Curve	Absent	Non Bitter	Present	Short	Short	Monocious	Absent
NDLM-23-1 x Kashi Vidhi	Long	Broad	Palmately lobed	Inter-media	Medium	Light Yello	Long	Light Gree	Elongated Curve	Absent	Non Bitte	Present	Short	Short	Monocious	Absent

				te		w		n			r					
NDLM-23-2 x Kashi Santusthi	Medium	Narrow	Cordate	Shallow	Short	Dark Yellow	Long	Creamy	Elongated Curve	Absent	Non Bitter	Present	Short	Short	Monocious	Absent
NDLM-23-2 x Punjab Long Melon	Medium	Narrow	Cordate	Shallow	Short	Dark Yellow	Long	Light Green	Elongated Curve	Absent	Non Bitter	Present	Short	Short	Monocious	Absent
NDLM-23-2 x Kashi Vidhi	Long	Narrow	Cordate	Shallow	Short	Light Yellow	Medium	Light Green	Elongated Curve	Absent	Non Bitter	Present	Short	Short	Monocious	Absent
NDLM-23-3 x Kashi Santusthi	Long	Broad	Palmately	Inter-mediate	Medium	Dark Yellow	Long	Dark Green	Elongated Curve	Absent	Non Bitter	Present	Short	Short	Monocious	Absent
NDLM-23-3 x Punjab Long Melon	Long	Broad	Palmately lobed	Inter-mediate	Medium	Dark Yellow	Medium	Dark Green	Elongated Curve	Absent	Non Bitter	Present	Short	Short	Monocious	Absent
NDLM-23-3 x Kashi Vidhi	Long	Broad	Palmately	Intermediate	Medium	Dark	Medium	Light	Elongated	Absent	Non	Present	Long	Short	Monocious	Absent

						Yellow		Green	Curve		Bitter					
NDLM-23-4 x Kashi Santusthi	Long	Medium	Palmately lobed	Inter-mediate	Medium	Light Yellow	Medium	Light Green	Slightly Elongated	Absent	Non Bitter	Present	Short	Short	Monocious	Absent
NDLM-23-4 x Punjab Long Melon	Long	Broad	Palmately lobed	Inter-mediate	Medium	Dark Yellow	Medium	Light Green	Elongated Curve	Absent	Non Bitter	Present	Short	Short	Monocious	Absent
NDLM-23-4 x Kashi Vidhi	Long	Broad	Palmately lobed	Inter-mediate	Medium	Light Yellow	Medium	Light Green	Elongated Curve	Absent	Non Bitter	Present	Short	Short	Monocious	Absent
NDLM-23-5 x Kashi Santusthi	Long	Medium	Cordate	Shallow	Short	Light Yellow	Medium	Creamy	Slightly Elongated	Absent	Non Bitter	Absent	Short	Short	Monocious	Absent
NDLM-23-5 x Punjab Long Melon	Long	Medium	Cordate	Shallow	Short	Light Yellow	Medium	Light Green	Slightly Elongated	Absent	Non Bitter	Present	Long	Short	Monocious	Absent
NDLM-23-5 x Kashi Vidhi	Medium	Narrow	Cordate	Shallow	Short	Light Yellow	Medium	Light Green	Elongated Curve	Absent	Non Bitter	Present	Long	Short	Monocious	Absent
NDLM-23-6 x Kashi Santusthi	Long	Broad	Palmately lobed	Inter-mediate	Medium	Light Yellow	Long	Light Green	Elongated Curve	Absent	Non Bitter	Present	Short	Short	Monocious	Absent
NDLM-23-6 x Punjab Long Melon	Long	Broad	Palmately lobed	Inter-mediate	Medium	Light Yellow	Long	Light Green	Elongated Curve	Absent	Non Bitter	Present	Short	Short	Monocious	Absent
NDLM-23-6 x Kashi Vidhi	Long	Broad	Palmately lobed	Inter-mediate	Medium	Light Yellow	Long	Light Green	Elongated Curve	Absent	Non Bitter	Present	Short	Short	Monocious	Absent
NDLM-23-7 x Kashi Santusthi	Long	Broad	Palmately lobed	Inter-mediate	Medium	Dark Yellow	Medium	Creamy	Slightly Elongated	Absent	Non Bitter	Absent	Long	Short	Monocious	Absent
NDLM-23-7 x Punjab Long Melon	Long	Medium	Palmately lobed	Inter-mediate	Short	Dark Yellow	Medium	Light Green	Slightly Elongated	Absent	Non Bitter	Present	Short	Short	Monocious	Absent
NDLM-23-7 x Kashi Vidhi	Long	Broad	Palmately lobed	Inter-mediate	Medium	Dark Yellow	Medium	Creamy	Elongated Curve	Absent	Non Bitter	Present	Short	Short	Monocious	Absent
NDLM-23-8 x Kashi Santusthi	Long	Broad	Palmately lobed	Inter-mediate	Medium	Dark Yellow	Long	Light Green	Elongated Curve	Absent	Non Bitter	Present	Short	Short	Monocious	Absent
NDLM-23-8 x Punjab Long Melon	Long	Broad	Palmately lobed	Inter-mediate	Medium	Dark Yellow	Medium	Light Green	Slightly Elongated	Absent	Non Bitter	Present	Short	Short	Monocious	Absent
NDLM-23-8 x Kashi Vidhi	Long	Broad	Palmately lobed	Inter-mediate	Medium	Dark Yellow	Long	Light Green	Elongated Curve	Absent	Non Bitter	Present	Long	Short	Monocious	Absent
NDLM-23-9 x Kashi Santusthi	Long	Broad	Palmately lobed	Inter-mediate	Medium	Dark Yellow	Long	Light Green	Slightly Elongated	Absent	Non Bitter	Present	Short	Short	Monocious	Absent
NDLM-23-9 x Punjab Long Melon	Long	Broad	Palmately lobed	Inter-mediate	Medium	Dark Yellow	Medium	Light Green	Elongated Curve	Absent	Non Bitter	Present	Short	Short	Monocious	Absent
NDLM-23-9 x Kashi Vidhi	Long	Broad	Palmately lobed	Inter-mediate	Medium	Dark Yellow	Medium	Light Green	Elongated Curve	Absent	Non Bitter	Present	Long	Short	Monocious	Absent
Thar Sheetal	Long	Broad	Palmately lobed	Inter-mediat	Medium	Dark Yellow	Medium	Light Green	Elongated Curve	Absent	Non Bitter	Present	Short	Short	Monocious	Absent

Table-2 Descriptor guidelines for long melon morphological traits

Character	Ranges of expression		References
Leaf lobes	Shallow Intermediate Deep	:	IPGRI 2003
Leaf blade length	Short (< 8) Medium (8-10) Long (>10)	:	PPV&FRA (DUS Guidelines)
Leaf blade Width	Narrow (<11) Medium (11-13) Broad (>13)	:	PPV&FRA
Leaf petiole length	Short (3 cm) Medium (approx 10cm) Long (approx.15 cm)	:	IPGRI 2003
Sex type	Monocious	:	
Leaf sahpe	Cordate, Palmate, Palmately Lobed		Ellahy *et. al.* 2022
Flower colour	Yellow Dark-yellow	:	IPGRI 2003
Ovary length	Short (<1) Medium (1- 3) Long (>3)	:	DUS (PPV& FRA) melon
Fruit shape	Slightly Elongate Elongated curve	:	DUS guideline cucumber
Fruit colour	Green Light green Pale green whitish	:	Yousif et al.,2022
Fruit length	-	:	Yousif et al., 2022
Fruit taste	Non sweet (bitter) Sweet low (Non bitter	:	Ali- Shtayeh *et al.*, 2015
Fruit creasing	Absent present	:	DUS guideline cucumber
Seed: length (cm)	Short (<1)	:	DUS (PPV& FRA) melon
	Long (>1)		
Seed width(cm)	Narrow (<0.4) Broad (>0.4)	:	DUS (PPV& FRA) melon guideline

CONCLUSION

The research revealed considerable genetic diversity among the 39 evaluated long melon genotypes. Such variability is essential for breeding initiatives focused on developing improved long melon cultivars with enhanced yield potential, superior quality and greater tolerance to environmental stresses. To ensure the development of stable and high-performing varieties, it is important to evaluate these genotypes across diverse environmental conditions. Including more than one reference variety for a particular trait expression is advisable, especially in cases where the original variety may lose the ability to express a trait consistently or fails to do so under specific climatic or regional conditions. Nonetheless, ensuring the genetic purity of these reference varieties through rigorous maintenance breeding practices remains a fundamental requirement.

Conflict of interest

Authors declare no conflict of interest.

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