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Morphological Characterization of Mango (*Mangifera indica* L) Seedling Progenies for Flowering and Yield Contributing Traits

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ABSTRACT: Mango (*Mangifera indica*. L) is extremely important because of its high economic worth and significant contribution to agricultural exports at both the global and national levels. In the seedling population of mango, there is a lot of genetic variety. High heritability allows breeders to select plants based on phenotypic expression in agricultural development programmes. Studies were carried out on mango genotypes which flowers throughout the year at farmer's field, Coimbatore District, Tamil Nadu, during 2019-2021. Observations were recorded on various morphological parameters such as qualitative characters examined by comparison with (IPGRI). From the observations made, the mango genotypes expressed morphological variations from genotype to genotype. These morphological variations indicate that the progenies were showing wide variation among each other in the 25 mango genotypes studied. Plant variety registration, genotype identification, and tree improvement programmes will all benefit from the generated and documented descriptors.

Keywords: Mango; Polyembryony; Variation; Characterization; Improvement.

INTRODUCTION

Mango (*Mangifera indica* L.) is one of the choicest fruits in the world (Joshi *et al.,* 2013) It is a member of the Anacardiaceae family and one of the most important species in the family, as well as one of the most preferred fruit crops for human consumption in tropical and subtropical climates around the world (Vasugi *et al.,* 2012). Mango (*Mangifera indica*) is one of the most important fruit crops of the world due to its large fruit with a soft, sweet pulp. Due to its popularity and importance, *M. indica* is often named "King of fruits" for its luscious flavour and taste. The mango is among the widely grown tropical and subtropical fruit of the world and is a diploid fruit tree with 2n = 40 chromosomes (Kuhn *et al.,* 2017). Mango trees are evergreen trees that come in a variety of sizes and shapes. It has a deep taproot and numerous surface roots (Litz, 2009), a strong trunk (90 cm in diameter), and an umbrella-shaped crown that can grow to be 20-40 metres tall (Litz, 2009). The leaves are simple, alternate, and borne on 1-12.5cm long petioles. The leaves on flowering branches are 16-30 cm long and 3-7 cm wide, whereas the leaves on sterile branches can be up to 50 cm long. Young leaves are orange-red in colour, turning a beautiful dark green on the upper surface as they mature. The edges of the leaves are slightly curled. Flowers on mango trees are aromatic, pentameric, greenish-white or pinkish, tiny (3-5 mm long, 1-1.5 mm wide), and thickly borne on 30 cm tall stems (Litz 2009; Orwa 2009). Mango morphological differences have been thoroughly researched. (Gálvez-López *et al.,* 2010; Mohamed and Ahmed 2015).

The utilization of high producing genotypes rather than poor yielding indigenous genotypes is critical for commercial mango production success. As a result, improving the genetics of this crop is critical for developing high-yielding genotypes. The utilization of high producing genotypes rather than poor yielding indigenous genotypes is critical for commercial mango production success. As a result, improving the genetics of this crop is critical for developing high-yielding genotypes (Anumalla *et al.,* 2015). The first and most significant step in the description, classification, and characterization of germplasm collections is morphological characterization of trees and fruits (Verma *et al.,* 2006; Devi *et al.*, 2021).

When screening genotypes for a specific region, the evaluation of genotypes is crucial. Although a cultivar may exhibit a distinct personality when grown in one location, it may not be able to maintain that personality when grown in another. Mango's genetic diversity provides a variety of opportunities to manipulate desirable traits using genomic resources. For effective conservation and exploitation of genetic resources for crop improvement programmes, it is critical to assess genetic variation within natural populations and among breeding lines. Growers will be able to select the best suitable and high yielding variety for their region based on location specific evaluation of varieties. The evaluation of germplasm also aids in the selection of parents for breeding programmes to increase production (Singh *et al.,* 2021). In this study, the open pollinated progenies which were producing flowers throughout the year were observed and the morphological characterization was recorded.

MATERIALS AND METHODS

The current study took place in Farmer's field, Annur block, Coimbatore District, Tamil Nadu, between 2019 and 2021. There were 25 genotypes in the study. The average annual rainfall at the site is 546 mm. The average maximum and lowest temperatures are respectively 30.45°C and 20.34°C. Character descriptors were used to collect data on morphological (qualitative) characters (IPGRI 2006).

Descriptors. Descriptors were used to evaluate the requirements of Distinctiveness, Uniformity, and Stability. The descriptions describe a trait of the entire plant or a portion of it. These descriptors can be morphological, biochemical, molecular, or any other type of descriptor. Mainly three types of descriptors are recommended. In the present study the open pollinated seedling progenies which flowers throughout the year were subjected to DUS descriptors *viz.*, Different plant parts and traits, such as leaves, flowers and inflorescences, fruits, and general architecture, have been identified.

Morphological characterization. The tree's height was measured from the ground to the topmost branching point and expressed in metres (m). The circumference of the trunk was measured at a height of 25 cm above ground level and given in centimetres (cm). The trunk height was measured from the base of the tree to the first branch's emergence and stated in metres (m). The mean canopy diameter in two directions (North-South and East-West) was calculated and expressed in centimetres (cm). Branching pattern (basal, intermediate, and top positions of branch origination from the stem were observed and documented); Based on the observations, the plant's growth habit was classified as erect, spreading, drooping, very vigorous, semi-vigorous, and dwarf. Crown shape (several crown shapes were discovered, including oblong, widely pyramidal, semi-circular, spherical, and others) and leaf density (density of foliage was observed and recorded as sparse, intermediate and dense).

Young leaf colour (the colour of the leaves was determined and tabulated based on visual observations as light green, light green with brownish tinge, light brick red, reddish brown, and deep coppery tan) and mature leaf colour (the colour of the mature leaf was observed and recorded as pale green, green, and dark green). Different leaf blade shapes were tabulated as elliptic, oblong, ovate, obovate, lanceolate, and oblanceolate; Leaf apex shape (different apex shapes were also observed and recorded as obtuse, acute, and acuminate); Leaf base shape (recorded as acute, obtuse, and round); Leaf margin shape (recorded as acute, obtuse, and (leaf margin were recorded as entire and wavy). The leaves' texture was noted and classified as coriaceous, chartaceous, or membranous.

Inflorescence density (flower density was observed and tabulated as sparse, medium, and dense); inflorescence colour (flower colour was observed and tabulated as whitish, yellowish green, yellow, light green, green with red patches, light orange, pink, dark pink, purple, light red, red, dark red, and crimson); inflorescence position (inflorescence position was observed and tabulated as axillary and terminal); inflorescence axi (recorded as conical, pyramidal and broadly pyramidal). Fruit colour (green, greenish yellow, yellow, green with red blush, yellow with red blush, and greenish with purple patches were seen and tabulated); Fruit form (round, oval, and oblong fruit shapes were observed and tallied); Fruit size (small, medium, large, and long) fruit beak type (perceptible, pointed, prominent, and mammiform) and fruit sinus type (tabulated as perceptible, pointed, prominent, and mammiform) (recorded as absent, shallow and deep).

RESULTS AND DISCUSSIONS

The key characteristics of descriptors are distinctness, homogeneity, and stability. The descriptors should be distinct, in the sense that the produced characters should distinguish each hybrid from the others, and the characters should not change after repeated propagation or at the end of each cycle (PPV&FRA, 2006). The descriptors should be stable; they should not vary between genotypes or under different environmental situations, and they should be uniform; each created descriptor should be consistent and unchanging. It was discovered that the Mango genotypes showed morphological differences from genotype to genotype based on the observations gathered. These morphological changes have the ability to distinguish mango genotypes from one another, therefore they can be developed as descriptors.

Tree characters. Tree height ranges between 2.3 and 6.7 m with the mean of 4.05 m. Annur-22 showed maximum height, where Annur-16 observed minimum height among the genotypes. Trunk circumference ranges between 34.21 and 51.23 cm with the mean of 41.49 cm. Annur-17 recorded maximum trunk circumference where Annur-13 recorded minimum trunk circumference (Table 1). The age of the tree, as well as nutritional and environmental conditions, determine the tree's height and circumference. Primary branch circumference varied among the mango genotypes (Table 1). Canopy spread were observed along East-west and North-south direction among the genotypes.

The tree's growth habit is a key factor in determining whether a genotype is best suited for low or high density planting. The semi-erect growth habit is ideal for dense planting. Among the genotypes, tree growth behaviours such as erect, spreading, and drooping were observed (Table 1). The crown shape of the tree is influenced by shade, environmental parameters and genetic make-up of the tree. Among the genotypes, there was a wide range of canopy morphologies. Semi-circular, oblong, broadly pyramidal and spherical crown shapes were observed. Thick, moderate, and sparse, types of foliage density were recorded in all mango genotypes. (Table 1). The diversity in leaf density among mango cultivars could be related to differences in genetic makeup, which supports the findings of Dhillon *et al.*, (2004).

Table 1: Morphological characterization in tree parameters.

Genotypes	Tree height (m)	Trunk circumference (cm)	Canopy Spread (cm) (East-West)	Canopy Spread (cm) (North -South)	Tree growth habit	Crown Shape	Foliage Density
Annur-1	3.6	40.17	222.61	265.32	Spreading	Semi-circular	Dense
Annur-2	3.8	36.60	217.00	215.00	Spreading	Broadly pyramidal	Intermediate
Annur-3	3.5	37.70	219.64	251.00	Spreading	Broadly pyramidal	Intermediate
Annur-4	3.6	42.77	214.33	193.66	Spreading	Broadly pyramidal	Intermediate
Annur-5	3.2	40.07	233.67	218.66	Spreading	Semi-circular	Dense
Annur-6	3.5	39.40	234.66	217.63	Spreading	Broadly pyramidal	Intermediate
Annur-7	3.6	39.77	233.32	213.00	Spreading	Spherical	Intermediate
Annur-8	3.8	41.17	235.21	245.72	Spreading	Semi-circular	Dense
Annur-9	3.9	42.65	245.12	255.34	Spreading	Spherical	Intermediate
Annur-10	3.8	47.32	250.36	245.20	Spreading	Spherical	Dense
Annur-11	2.6	40.12	201.20	211.66	Spreading	Oblong	Sparse
Annur-12	2.5	35.23	195.12	187.66	Drooping	Spherical	Sparse
Annur-13	2.8	34.21	196.36	200.04	Drooping	Oblong	Sparse
Annur-14	2.9	36.45	188.32	184.32	Spreading	Oblong	Sparse
Annur-15	2.4	41.55	192.30	196.33	Spreading	Semi-circular	Sparse
Annur-16	2.3	38.94	195.34	204.15	Spreading	Oblong	Sparse
Annur-17	6.6	51.23	317.45	325.20	Erect	Broadly Pyramidal	Intermediate
Annur-18	6.4	42.26	245.36	233.60	Erect	Oblong	Intermediate
Annur-19	6.1	44.36	225.65	230.66	Erect	Oblong	Intermediate
Annur-20	5.3	47.40	213.45	225.32	Erect	Semi-circular	Intermediate
Annur-21	3.8	48.92	224.67	230.70	Erect	Spherical	Intermediate
Annur-22	6.7	43.33	235.80	230.41	Spreading	Spherical	Intermediate
Annur-23	6.4	41.20	238.74	220.60	Spreading	Broadly pyramidal	Intermediate
Annur-24	4.8	44.36	225.66	226.12	Spreading	Spherical	Intermediate
Annur-25	3.5	40.17	223.50	224.10	Spreading	Spherical	Intermediate

Leaf characters. The leaf colour varied from genotype to genotype, and there was a difference between immature and mature leaves within the varietal. Similar findings were found by Fivaz (2008) and Christopher *et al.*, (2017). They also discovered that immature or young leaves are net carbon importers at first, only contributing to the shoot's carbon economy as the shoot matures.

High variability was observed in leaf blade shape *i.e.*, elliptic, oblong and oblanceolate. Leaf apex shape showed acute and acuminate in the observed genotypes. Leaf base shape *i.e.*, acute and obtuse observed in the genotypes. Entire Leaf margin and membranous leaf texture was observed in all the genotypes (Table 2).

Table 2: Morphological characterization in Leaf parameters.

Genotypes	Young leaf colour	Mature leaf colour	Leaf blade shape	Leaf apex shape	Leaf base shape	Leaf margin	Leaf texture
Annur-1	Light green	Green	Oblong	Acuminate	Obtuse	Entire	Membranous
Annur-2	Light green	Green	Elliptic	Acuminate	Obtuse	Entire	Membranous
Annur-3	Light green	Green	Oblong	Acuminate	Obtuse	Entire	Membranous
Annur-4	Light green	Green	Elliptic	Acuminate	Obtuse	Entire	Membranous
Annur-5	Light green with brown tinge	Green	Oblanceolate	Acuminate	Obtuse	Entire	Membranous
Annur-6	Light green	Green	Oblanceolate	Acuminate	Acute	Entire	Membranous
Annur-7	Light green with brown tinge	Green	Oblanceolate	Acuminate	Acute	Entire	Membranous
Annur-8	Light green with brown tinge	Green	Oblanceolate	Acuminate	Obtuse	Entire	Membranous
Annur-9	Light green	Green	Oblanceolate	Acuminate	Obtuse	Entire	Membranous
Annur-10	Light green	Green	Oblanceolate	Acuminate	Obtuse	Entire	Membranous
Annur-11	Light green with brown tinge	Light Green	Oblong	Acute	Acute	Entire	Membranous
Annur-12	Light green with brown tinge	Light Green	Elliptic	Acute	Acute	Entire	Membranous
Annur-13	Light green with brown tinge	Light Green	Elliptic	Acute	Acute	Entire	Membranous
Annur-14	Light green with brown tinge	Light Green	Elliptic	Acute	Acute	Entire	Membranous
Annur-15	Reddish brown	Dark Green	Elliptic	Acute	Acute	Entire	Membranous
Annur-16	Light green	Dark Green	Oblanceolate	Acute	Obtuse	Entire	Membranous
Annur-17	Light green	Dark Green	Oblanceolate	Acuminate	Obtuse	Entire	Membranous
Annur-18	Light green	Dark Green	Oblanceolate	Acuminate	Obtuse	Entire	Membranous
Annur-19	Light green	Dark Green	Oblanceolate	Acuminate	Acute	Entire	Membranous
Annur-20	Light green	Dark Green	Oblanceolate	Acuminate	Acute	Entire	Membranous
Annur-21	Light green	Dark Green	Oblanceolate	Acuminate	Obtuse	Entire	Membranous
Annur-22	Light green	Dark Green	Oblanceolate	Acuminate	Obtuse	Entire	Membranous
Annur-23	Light green	Dark Green	Oblanceolate	Acuminate	Obtuse	Entire	Membranous
Annur-24	Light green	Dark Green	Oblanceolate	Acuminate	Obtuse	Entire	Membranous
Annur-25	Light green	Dark Green	Oblanceolate	Acuminate	Obtuse	Entire	Membranous

Inflorescence characters. One of the most crucial phenological stages in mango crop production is flowering. Paniculate inflorescence was the form of inflorescence seen in mango variations. Mango genotypes have different densities of inflorescence. In the genotypes, flower density was found to be medium, dense, and sparse. Flowering intensity is a significant feature that is closely linked to mango growers' economic condition (Kulkarni, 2004). Mango genotypes had diverse inflorescence colours, such as yellowish green and light green. The genotypes differed in terms of inflorescence position. Inflorescences with axillary and terminal positions were found in the genotypes. Similarly, the mango genotypes inflorescence axes grew horizontally and semi-erectly. Pyramidal, conical, and widely pyramidal inflorescence morphologies were seen (Table 3).

Fruit characters. All the mango genotypes showed green colored fruits even after ripening (Table 4). This is because the colour of the mature fruit is determined by genotypes reported by Barholia and Yadav (2014); Sennhenn *et al.*, (2014). Fruit shape was observed as round and ovoid in the mango genotypes. All the genotypes were observed as medium sized fruits. Fruit beak types were observed as prominent and perceptible. Fruit sinus types were observed as shallow and absent (Table 4). This result is also in consistent with the findings of Hossain and Talukder (1974); Bhuyan and Islam (1989); Hossain *et al.*, (2002).

Table 3: Morphological characterization in Inflorescence parameters.

Genotypes	Inflorescence density	Inflorescence colour	Inflorescence position	Inflorescence axis growth habit	Inflorescence shape
Annur-1	Medium	Yellowish green	Terminal	Semi-erect	Pyramidal
Annur-2	Medium	Yellowish green	Terminal	Semi-erect	Pyramidal
Annur-3	Dense	Yellowish green	Terminal	Semi-erect	Conical
Annur-4	Medium	Yellowish green	Terminal	Semi-erect	Broadly pyramidal
Annur-5	Dense	Yellowish green	Terminal	Semi-erect	Conical
Annur-6	Medium	Yellowish green	Terminal	Semi-erect	Pyramidal
Annur-7	Medium	Yellowish green	Terminal & Axillary	Semi-erect	Pyramidal
Annur-8	Dense	Yellowish green	Terminal & Axillary	Semi-erect	Conical
Annur-9	Dense	Yellowish green	Terminal & Axillary	Semi-erect	Conical
Annur-10	Dense	Yellowish green	Terminal & Axillary	Semi-erect	Broadly pyramidal
Annur-11	Sparse	Light green	Terminal	Horizontal	Pyramidal
Annur-12	Sparse	Light green	Terminal	Horizontal	Broadly pyramidal
Annur-13	Sparse	Light green	Terminal	Horizontal	Conical
Annur-14	Sparse	Light green	Terminal	Horizontal	Broadly pyramidal
Annur-15	Sparse	Light green	Terminal	Horizontal	Broadly pyramidal
Annur-16	Sparse	Yellowish green	Terminal	Horizontal	Pyramidal
Annur-17	Medium	Yellowish green	Terminal	Horizontal	Pyramidal
Annur-18	Medium	Yellowish green	Terminal	Horizontal	Pyramidal
Annur-19	Medium	Yellowish green	Terminal	Horizontal	Broadly pyramidal
Annur-20	Sparse	Yellowish green	Terminal	Horizontal	Conical
Annur-21	Medium	Light green	Terminal & Axillary	Semi-erect	Conical
Annur-22	Medium	Light green	Terminal & Axillary	Semi-erect	Pyramidal
Annur-23	Medium	Light green	Terminal & Axillary	Semi-erect	Broadly pyramidal
Annur-24	Medium	Light green	Terminal & Axillary	Semi-erect	Conical
Annur-25	Medium	Light green	Terminal & Axillary	Semi-erect	Broadly pyramidal

Table 4: Morphological characterization in Fruit parameters.

Genotypes	Fruit colour	Fruit shape	Fruit size	Fruit beak type	Fruit sinus type
Annur-1	Green	Roundish	Medium	Perceptible	Absent
Annur-2	Green	Roundish	Medium	Perceptible	Absent
Annur-3	Green	Roundish	Medium	Perceptible	Absent
Annur-4	Green	Roundish	Medium	Perceptible	Absent
Annur-5	Green	Roundish	Medium	Perceptible	Absent
Annur-6	Green	Roundish	Medium	Perceptible	Absent
Annur-7	Green	Roundish	Medium	Perceptible	Absent
Annur-8	Green	Roundish	Medium	Perceptible	Absent
Annur-9	Green	Roundish	Medium	Perceptible	Absent
Annur-10	Green	Roundish	Medium	Prominent	Shallow
Annur-11	Green	Ovoid	Medium	Perceptible	Absent
Annur-12	Green	Ovoid	Medium	Perceptible	Absent
Annur-13	Green	Ovoid	Medium	Perceptible	Absent
Annur-14	Green	Ovoid	Medium	Perceptible	Absent
Annur-15	Green	Ovoid	Medium	Perceptible	Absent
Annur-16	Green	Ovoid	Medium	Perceptible	Absent
Annur-17	Green	Roundish	Medium	Prominent	Shallow
Annur-18	Green	Roundish	Medium	Perceptible	Absent
Annur-19	Green	Roundish	Medium	Perceptible	Absent
Annur-20	Green	Roundish	Medium	Perceptible	Absent
Annur-21	Green	Roundish	Medium	Perceptible	Absent
Annur-22	Green	Roundish	Medium	Perceptible	Absent
Annur-23	Green	Roundish	Medium	Perceptible	Absent
Annur-24	Green	Roundish	Medium	Perceptible	Absent
Annur-25	Green	Roundish	Medium	Perceptible	Absent

CONCLUSION

The easiest, shortest, and most easily adaptable approach for identifying clones at the field level is through morphological features, which is required for tree improvement programmes. Mango genotypes identified in this study were seedling population which flowers throughout the year and produce fruits in three seasons, could be exploited for commercial purpose and multiplied through vegetative means. The evaluation of morphological variations obtained in the study might help the breeders for various genetic breeding programs in mango cultivars and also serve as a baseline for further study on mango in the area. However, to confirm whether the variations are genetic in nature there is need for characterization using molecular markers.

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Conflict of Interest. None.

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