

Morphological Characterization of Mango (*Mangifera indica* L.) Cultivars

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ABSTRACT: Plant, leaf, inflorescence, fruit, stone and seed characteristics of 16 mango cultivars were studied from 2016 to 2018 at All India Coordinated Research Project on Fruits at Regional Research Station, Gayeshpur, West Bengal. Utilization of the conserved germplasm in the breeding program requires precise information on the genetic relationships among the cultivars.

Therefore, an attempt was made to study morphological characterization in mango. All the morphological observations were taken as per the IPGRI descriptors for mango. Observations were recorded on various morphological parameters like qualitative and quantitative characters. The wide variation was observed in crown shape, colour of young leaf, leaf blade length and width, regularity of flowering, inflorescence colour, length and width, pulp colour, and texture. Maximum inflorescence length (45.50 cm) and width (31.74 cm) were found in Kamala Bhog. The highest stone weight and seed weight were observed in Gopi Bhog (46.40 g) and Gopal Bhog (22.85 g) respectively. There were distinct variations in morphological characters indicating that the cultivars were wide variation among them. High variations allow breeders to select plants based on characters in improvement programs.

Keywords: Mango, Qualitative, Characterization, Variation, Improvement.

INTRODUCTION

Mango (*Mangifera indica* L.) is one of the choicest and most admired fruit crops of the tropical and subtropical areas of the world (Joshi *et al.*, 2013). Its significance can easily be recognized by the fact that it is known as 'King of Fruits'. The utilization of germplasm with distinctive characteristics in breeding programs desires precise information to develop new cultivars (Vasugi *et al.*, 2012). India is the centre of origin for cultivated mango and is distributed in tropical and subtropical regions. Mango has been cultivated in India for more than 4000 years. Mango is native to India and occurs abundantly in forests and cultivated areas. Hence, it is difficult to differentiate true wild forms from cultivated ones. The cross-pollination nature and a wide range of prevailing agro-climatic conditions have contributed to its wide genetic diversity in India (Mukherjee, 1972). Morphological data are imperative in preliminary germplasm evaluation as they consist of tree, leaf, inflorescence, fruit, and stone characteristics which can be recorded easily in the field (Knight *et al.*, 2009). Generally, morphological markers are those pivotal features that can be distinguished and scored visually by the naked eye. These characteristics include the tree height, bearing habit, flowering pattern, inflorescence

shape, colour and type of flowers, fruit shape, colour of the fruit, shoulder position, etc. (Bhat *et al.*, 2010). 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). Plant variety registration, genotype identification, and tree improvement programmes will all benefit from the generated and documented descriptors. The evaluation of germplasm also aids in the selection of parents for breeding programmes to increase production (Singh *et al.*, 2021).

Characterization and assessment of diversity are essential to utilize these unique cultivars in crop improvement programs and also for better conservation of genetic resources. Utilization of the conserved germplasm in the breeding program requires precise information on the genetic relationships among the cultivars while information on the genetic distance among the cultivars will also help in avoiding duplicates, thus clearing the ambiguity in nomenclature, widening the genetic base of the core collections and ultimately help in preserving the valuable diversity. Therefore, an attempt was made to study the plant, leaves, and inflorescence, fruit stone, and seed

morphology of 16 germplasm in the Regional Research Station, Gayeshpur, West Bengal.

MATERIALS AND METHODS

The present experiment was conducted in a pre-established orchard named of All India Coordinated Research Project on Fruits at Regional Research Station, Gayeshpur, West Bengal from 2016 to 2018. The experiment was conducted on 30-40 years old 16 mango cultivars. A random sampling strategy was followed for the collection of samples. Three plants in each cultivar were taken as a sample size. Distance between the plant to plant and row to row was 10 m. The experimental material consists of 16 indigenous mango cultivars. For leaf analysis, ten healthy and fully developed leaves were collected from the middle of the branches which were exposed to sunlight. Ten fruits were collected from each plant in each replication.

A. Morphological characterization

Tree type, crown shape, tree growth habit, foliage density was observed directly in the field, and tree height was measured from ground level to the top of the tree with help of measuring tape. Leaf attitude in relation to branch, leaf blade shape, leaf blade length, leaf blade width, petiole length, the thickness of pulvinus, leaf venation, leaf texture, leaf apex shape, leaf base shape, leaf margin, leaf pubescence, colour of young and mature leaves, leaf fragrance. Average of 10 inflorescences taken randomly each plant in each replication. The descriptors were secondary flowering, regularity of flowering, inflorescence position, inflorescence axis growth habit, inflorescence shape, length, width, pubescence of inflorescence rachis, presence of leafy bracts, type of flower, inflorescence colour. Ten mature fruits were collected randomly from the selected plants and taken in the laboratory and

cleansed with water for reading physical characters like the shape of fruit apex, fruit skin surface texture, depth of fruit stalk cavity, fruit neck prominence, the slope of fruit ventral side, fruit beak type, fruit sinus type. Stone length, width, thickness and weight, veins on stone, the pattern of stone venation, the quantity of fibre on stone, seed length, seed width, seed weight, seed shape. The overall description was largely performed as previously recommended (IPGRI, 2006). Ripen fruits were separated into peel, pulp, and seeds to evaluate the skin colour of ripe fruit, pulp colour of ripe fruit, pulp texture of ripe fruit, quantity of fibre in pulp, pulp juiciness, presence of turpentine flavour.

RESULTS AND DISCUSSION

A. Tree characteristics

As evident from the results (Table 1), a total of 16 cultivars were grafted. The majority of the cultivars showed broadly pyramidal crown and the rest of the cultivars were an oblong crown, semi-circular crown, and spherical in shape. The shape of the tree is determined by genetic makeup and environmental factors. Mango trees in this study showed two types of growth habits *viz.*, spreading and erect. Tree growth habit is a main role in deterring whether a cultivar is suited for high or low-density planting. Most of the trees showed dense foliage and the rest were intermediate in nature it could be related to differences in genetic makeup, which supports the findings of Dhillon *et al.* (2004). The size and shape of a plant are determined by the density of planting, training and pruning, and cultural practices (Neto, 2000). The noticed characteristics are also similar to those presented by Selvan *et al.* (2010); Vieccelli *et al.* (2016).

Table 1: Tree characteristics of 16 mango cultivars.

Sr. No.	Cultivar	Tree type	Crown shape	Tree growth habit	Foliage density	Tree height (m)
1.	Chatterjee	Grafted	Semi-circular	Spreading	Intermediate	08.50
2.	Gulab Khas	Grafted	Broadly pyramidal	Spreading	Intermediate	10.59
3.	Ranipasand	Grafted	Oblong	Spreading	Dense	10.86
4.	Sarikhas	Grafted	Broadly pyramidal	Spreading	Dense	10.48
5.	Himsagar	Grafted	Spherical	Spreading	Intermediate	10.15
6.	Banganpalli	Grafted	Broadly pyramidal	Spreading	Dense	11.55
7.	Langra	Grafted	Semi-circular	Spreading	Dense	8.55
8.	Fazli	Grafted	Oblong	Erect	Dense	12.56
9.	Gopal Bhog	Grafted	Broadly pyramidal	Erect	Dense	9.55
10.	Lakhan Bhog	Grafted	Spherical	Spreading	Intermediate	7.61
11.	Kancha Mitha	Grafted	Oblong	Erect	Dense	10.18
12.	Kanchan Kosa	Grafted	Broadly pyramidal	Spreading	Intermediate	13.02
13.	Kamala Bhog	Grafted	Oblong	Erect	Intermediate	6.60
14.	Gopi Bhog	Grafted	Oblong	Erect	Dense	12.52
15.	Madhu Chuski	Grafted	Broadly pyramidal	Spreading	Dense	10.90
16.	Khota Lagga	Grafted	Semi-circular	Spreading	Dense	10.46
	Mean	-	-	-	-	10.25
	S.E.	-	-	-	-	0.05
	C.D. (5%)	-	-	-	-	0.14

B. Leaf characteristics

The results showed significant variation in leaf characters of mango cultivars (Table 2). High variability was observed in leaf blade shape and leaf

apex shape. Similar findings were found by Fivaz (2008). The leaf position on the branch was observed semi-erect to horizontal. Pulvinus showed thick and tapering in all sixteen cultivars. The angle of secondary

veins towards the midrib was observed wide (ranging from 60 to 90°) and secondary veins showed a curvature when approaching leaf edges in all sixteen cultivars. Mature leaves showed coriaceous in nature, free of pubescence, and presented a mild fragrance in fifteen cultivars when crushed except Madhu Chuski cultivar, shown absent in fragrance and conformity with the earlier reports of Laroussilhe (1980). Leaf margin ranged from wavy to entire observations were close association with Rajwana *et al.* (2011); Viecelli *et al.*

(2016). Leaf colour observed as light brick red, light green, reddish-brown, and deep copper tan when leaves were young, and acquires a green to dark green colour when it develops and become mature, these observations were in close conformity with the findings of Fivaz (2008); Litz (2009); Ribeiro *et al.* (2013). Leaf length, width, and petiole length varied from 17.88 to 29.52 cm, 4.68 to 8.35 cm, and 1.79 to 5.37 cm respectively. The results were in close association with Viecelli *et al.* (2016); Galal *et al.* (2017).

Table 2: Leaf characteristics of 16 mango cultivars.

Sr. No.	Cultivar	Leaf attitude relation to branch	Thickness of petiole	Angle of secondary veins to the midrib	Curvature of secondary veins	Leaf texture	Leaf apex shape	Leaf base shape
1.	Chatterjee	Horizontal	Thick and tapering	Wide	Present	Coriaceous	Acuminate	Acute
2.	Gulab Khas	Semi-erect	Thick and tapering	Wide	Present	Coriaceous	Acuminate	Acute
3.	Ranipasand	Semi-erect	Thick and tapering	Wide	Present	Coriaceous	Acuminate	Acute
4.	Sarikhas	Horizontal	Thick and tapering	Wide	Present	Coriaceous	Acuminate	Acute
5.	Himsagar	Semi-erect	Thick and tapering	Wide	Present	Coriaceous	Acuminate	Acute
6.	Banganpalli	Semi-erect	Thick and tapering	Wide	Present	Coriaceous	Acuminate	Acute
7.	Langra	Semi-erect	Thick and tapering	Wide	Present	Coriaceous	Acuminate	Acute
8.	Fazli	Horizontal	Thick and tapering	Wide	Present	Coriaceous	Acuminate	Acute
9.	Gopal Bhog	Horizontal	Thick and tapering	Wide	Present	Coriaceous	Acuminate	Acute
10.	Lakhan Bhog	Semi-erect	Thick and tapering	Wide	Present	Coriaceous	Acuminate	Acute
11.	Kancha Mitha	Horizontal	Thick and tapering	Wide	Present	Coriaceous	Acuminate	Acute
12.	Kanchan Kosa	Horizontal	Thick and tapering	Wide	Present	Coriaceous	Acute	Acute
13.	Kamala Bhog	Semi-erect	Thick and tapering	Wide	Present	Coriaceous	Acuminate	Acute
14.	Gopi Bhog	Semi-erect	Thick and tapering	Wide	Present	Coriaceous	Acuminate	Acute
15.	Madhu Chuski	Horizontal	Thick and tapering	Wide	Present	Coriaceous	Acute	Acute
16.	Khota Lagga	Horizontal	Thick and tapering	Wide	Present	Coriaceous	Acuminate	Acute

Contd.

Sr. No.	Cultivar	Leaf margin	Leaf pubescence	Leaf fragrance	Colour of young leaf	Colour of fully developed leaf	Leaf blade length (cm)	Leaf blade width (cm)	Petiole length (cm)
1.	Chatterjee	Wavy	Absent	Mild	Light brick red	Dark green	20.03	5.68	2.48
2.	Gulab Khas	Wavy	Absent	Mild	Light green	Green	19.25	4.68	2.01
3.	Ranipasand	Entire	Absent	Mild	Light brick red	Green	17.88	5.62	2.78
4.	Sarikhas	Wavy	Absent	Mild	Light brick red	Dark green	23.98	6.98	4.35
5.	Himsagar	Wavy	Absent	Mild	Reddish brown	Green	21.03	6.05	3.69
6.	Banganpalli	Entire	Absent	Mild	Light green	Green	22.45	7.38	1.79
7.	Langra	Entire	Absent	Mild	Deep copper tan	Dark green	20.45	5.53	3.09
8.	Fazli	Wavy	Absent	Mild	Light green	Green	27.23	8.35	4.80
9.	Gopal Bhog	Wavy	Absent	Mild	Reddish brown	Dark green	20.87	6.20	2.43
10.	Lakhan Bhog	Wavy	Absent	Mild	Light green	Dark green	25.30	5.65	5.37
11.	Kancha Mitha	Wavy	Absent	Mild	Light brick red	Dark green	29.52	6.83	4.11
12.	Kanchan Kosa	Entire	Absent	Mild	Light green	Dark green	19.22	5.08	2.14
13.	Kamala Bhog	Wavy	Absent	Mild	Light green	Dark green	22.13	5.53	3.82
14.	Gopi Bhog	Entire	Absent	Mild	Light green	Dark green	25.25	6.77	3.15
15.	Madhu Chuski	Wavy	Absent	Absent	Light brick red	Dark green	25.32	6.27	4.27
16.	Khota Lagga	Entire	Absent	Mild	Light brick red	Dark green	26.20	7.80	4.34
	Mean						22.88	6.28	3.41
	S.E.						0.69	0.23	0.32
	C.D. (5%)						1.93	0.65	0.90

C. Inflorescence characteristics

All the cultivars were recorded absent in secondary flowering except Gopi Bhog which was recorded frequently secondary flowering. Regularity of flowering varied from regular to irregular. Cultivars Fazli, Lakhan Bhog, Kamala Bhog, and Khota Lagga were recorded horizontal axis growth habits and the rest of the cultivars were recorded semi-erect. All the sixteen cultivars' inflorescence positions were recorded terminal, pubescent, and presence of leafy bracts. The shape varied from conical, pyramidal, and broadly pyramidal, and colour of inflorescence was observed,

green with red patches, yellowish-green, pink, and light green. The density of flowering varied from medium to sparse density and type of flowers which was ranged from pentamerous to tetramerous or both. Inflorescence length and width recorded range from 23.56 to 45.50 cm and mean inflorescence length of 32.57 cm and 11.18 cm to 31.74 cm and mean inflorescence width of 21.22 cm respectively (Table 3). These results were found similar to the observation of Ali (2013); Rajwana *et al.* (2011) in mango cultivars.

Table 3: Inflorescence characteristics of 16 mango cultivars.

Sr. No.	Cultivar	Secondary flowering	Regularity of flowering	Inflorescence position	Inflorescence axis growth habit	Inflorescence shape	Pubescence of inflorescence rachis
1.	Chatterjee	Absent	Regular	Terminal	Semi erect	Conical	Pubescent
2.	Gulab Khas	Absent	Regular	Terminal	Semi erect	Conical	Pubescent
3.	Ranipasand	Absent	Regular	Terminal	Semi erect	Conical	Pubescent
4.	Sarikhas	Absent	Regular	Terminal	Semi erect	Conical	Pubescent
5.	Himsagar	Absent	Irregular	Terminal	Semi erect	Pyramidal	Pubescent
6.	Banganpalli	Absent	Regular	Terminal	Semi erect	Broadly pyramidal	Pubescent
7.	Langra	Absent	Irregular	Terminal	Semi erect	Conical	Pubescent
8.	Fazli	Absent	Regular	Terminal	Horizontal	Conical	Pubescent
9.	Gopal Bhog	Absent	Regular	Terminal	Semi erect	Conical	Pubescent
10.	Lakhan Bhog	Absent	Irregular	Terminal	Horizontal	Conical	Pubescent
11.	Kancha Mitha	Absent	Regular	Terminal	Semi erect	Pyramidal	Pubescent
12.	Kanchan Kosa	Absent	Irregular	Terminal	Semi erect	Conical	Pubescent
13.	Kamala Bhog	Absent	Irregular	Terminal	Horizontal	Conical	Pubescent
14.	Gopi Bhog	Frequent	Regular	Terminal	Semi erect	Conical	Pubescent
15.	Madhu Chuski	Absent	Regular	Terminal	Semi erect	Conical	Pubescent
16.	Khota Lagga	Absent	Irregular	Terminal	Horizontal	Conical	Pubescent

Contd.

Sr. No.	Cultivar	Presence of leafy bracts	Density of flowers in inflorescence	Type of flower	Inflorescence colour	Inflorescence length (cm)	Inflorescence width (cm)
1.	Chatterjee	Present	Medium	Pentamerous	Green with red patches	32.04	21.64
2.	Gulab Khas	Present	Medium	Pentamerous	Light green	23.83	13.24
3.	Ranipasand	Present	Sparse	Both	Light green	41.55	30.58
4.	Sarikhas	Present	Medium	Pentamerous	Yellowish green	41.00	26.82
5.	Himsagar	Present	Dense	Both	Pink	29.74	23.75
6.	Banganpalli	Present	Dense	Both	Green with red patches	34.97	22.85
7.	Langra	Present	Medium	Both	Yellowish green	38.10	16.39
8.	Fazli	Present	Medium	Pentamerous	Green with red patches	32.32	21.90
9.	Gopal Bhog	Present	Sparse	Pentamerous	Green with red patches	28.36	16.21
10.	Lakhan Bhog	Present	Medium	Pentamerous	Green with red patches	23.56	11.18
11.	Kancha Mitha	Present	Dense	Pentamerous	Green with red patches	29.94	16.27
12.	Kanchan Kosa	Present	Medium	Pentamerous	Green with red patches	31.48	22.59
13.	Kamala Bhog	Present	Dense	Pentamerous	Green with red patches	45.50	31.74
14.	Gopi Bhog	Present	Medium	Pentamerous	Green with red patches	30.23	21.71
15.	Madhu Chuski	Present	Medium	Pentamerous	Light green	25.10	16.58
16.	Khota Lagga	Present	Medium	Pentamerous	Green with red patches	33.40	26.08
	Mean	-	-	-	-	32.57	21.22
	S.E.	-	-	-	-	0.57	0.53
	C.D. (5%)	-	-	-	-	1.61	1.50

D. Fruit characteristics

The fruit apex shape noticed as obtuse in all cultivars. Depth of fruit stalk cavity was classified as absent, shallow, and deep (Table 4). Fruit neck prominence was slightly prominent in five cultivars, while in eleven cultivars shown absent these results were in agreement with Kheshin *et al.* (2016) and Vieccelli *et al.* (2016). The slope of the fruit ventral shoulder ended in a long curve, raising and then curved and slopping abruptly. In the apical portion, a perceptible and pointed beak was noticed as well as sinus in ten cultivars noticed shallow and rest of the cultivar shown absent. Smooth fruit skin surface texture exhibited in all sixteen cultivars. The skin colour of ripe fruit was classified into four group's viz., green, greenish-yellow, yellow, green with red blush Mukharjee (1972); Barholia and Yadav (2014); Sennhenn *et al.* (2014) reported that fruit colour at maturity was dependent on genotype. All cultivars had non-waxy skin.

E. Pulp characteristics

Most of the cultivars had orange and yellow pulp among the 16 cultivars 12 cultivars showed soft pulp Sridhar *et al.*,

texture, 10 cultivars had juicy pulp (Table 5). Gulab Khas cultivars had high fibre content in pulp and Langra cultivar showed absence, the rest of the cultivars showed low to intermediate. Only Langra cultivar had turpentine flavour. The present results were partially associated with by Kheshin *et al.* (2016).

F. Stone and seed characteristics

The nature of veins on the stone was considered a varietal character. Three types of veins were observed in 16 mango cultivars studied in the present investigation (Table 6). Only Langra cultivar showed level with the surface veins, and rest were elevated and depressed partially similar results were also observed by Simi (2006) in mango cultivars at Kerala. Only Kancha Mitha showed a forked pattern of stone venation and the rest of the cultivars were parallel venation. Among the genotypes, 8 cultivars had highly fibrous stones and the rest of the cultivars showed low to intermediate fibre. The results of the present study are partially associated with Majumder *et al.* (2011). The stone length among the mango cultivars with a mean of 7.47 cm. Fazli recorded the longest stone (9.18

cm) and Kamala Bhog recorded the smallest stone (5.53 cm). An average number of stones width of different cultivar exhibited wide variations. The widest stone (4.47 cm) was noted in Fazli and the narrowest stone (3.00 cm) was found in Kancha Mitha. The results showed that Gopi Bhog produced the heaviest stone (46.40 g) and the lightest stone weight was noticed in Lakhan Bhog (21.12 g). The stone thickness of mango

cultivars ranged from 1.59 cm to 2.42 cm with a mean value of 2.10 cm. Out of sixteen cultivars, 7 cultivars recorded relatively greater stone thickness compared to overall mean stone thickness. Similar results are reported by Kumar and Brahmachari (2004) in mango. Khota Lagga had an oblong seed shape and the rest of the cultivars were reniform shape.

Table 4: Fruit characteristics of 16 mango cultivars.

Sr. No.	Cultivar	Shape of fruit apex	Fruit skin surface texture	Depth of fruit stalk cavity	Fruit neck prominence	Fruit beak type	Slope of fruit ventral shoulder	Fruit sinus type
1.	Chatterjee	Obtuse	Smooth	Shallow	Absent	Perceptible	Slopping abruptly	Absent
2.	Gulab Khas	Obtuse	Smooth	Absent	Slightly prominent	Pointed	Ending in a long curve	Shallow
3.	Ranipasand	Obtuse	Smooth	Shallow	Absent	Perceptible	Rising and then rounded	Shallow
4.	Sarikhas	Obtuse	Smooth	Absent	Absent	Pointed	Ending in a long curve	Shallow
5.	Himsagar	Obtuse	Smooth	Shallow	Absent	Perceptible	Rising and then rounded	Absent
6.	Banganpalli	Obtuse	Smooth	Deep	Absent	Perceptible	Rising and then rounded	Shallow
7.	Langra	Obtuse	Smooth	Absent	Slightly prominent	Perceptible	Ending in a long curve	Absent
8.	Fazli	Obtuse	smooth	Shallow	Absent	Perceptible	Rising and then rounded	Shallow
9.	Gopal Bhog	Obtuse	Smooth	Shallow	Absent	Perceptible	Rising and then rounded	Shallow
10.	Lakhan Bhog	Obtuse	Smooth	Shallow	Absent	Perceptible	Rising and then rounded	Shallow
11.	Kancha Mitha	Obtuse	Smooth	Shallow	Absent	Perceptible	Rising and then rounded	Shallow
12.	Kanchan Kosa	Obtuse	Smooth	Shallow	Slightly prominent	Perceptible	Rising and then rounded	Shallow
13.	Kamala Bhog	Obtuse	Smooth	Shallow	Absent	Perceptible	Rising and then rounded	Absent
14.	Gopi Bhog	Obtuse	Smooth	Shallow	Absent	Perceptible	Ending in a long curve	Absent
15.	Madhu Chuski	Obtuse	Smooth	Absent	Slightly prominent	Perceptible	Rising and then rounded	Shallow
16.	Khota Lagga	Obtuse	Smooth	Absent	Slightly prominent	Perceptible	Rising and then rounded	Shallow

Table 5: Pulp characteristics of 16 mango cultivars.

Sr. No.	Cultivar	Pulp colour of ripe fruit	pulp texture of ripe fruit	Quantity of fibre in pulp	Pulp juiciness	Presence of turpentine flavour
1.	Chatterjee	Orange	Soft	Low	Slightly juicy	Absent
2.	Gulab Khas	Yellow	Intermediate	High	Juicy	Absent
3.	Ranipasand	Golden yellow	Soft	Low	Slightly juicy	Absent
4.	Sarikhas	Yellow	Intermediate	Low	Juicy	Absent
5.	Himsagar	Golden yellow	Soft	Low	Juicy	Absent
6.	Banganpalli	Yellow	Soft	Low	Slightly juicy	Absent
7.	Langra	Dark orange	Soft	Absent	Slightly juicy	Intermediate
8.	Fazli	Yellow	Soft	Low	Slightly juicy	Absent
9.	Gopal Bhog	Orange	Soft	Low	Juicy	Absent
10.	Lakhan Bhog	Orange	Soft	Low	Juicy	Absent
11.	Kancha Mitha	yellow	Intermediate	Intermediate	Juicy	Absent
12.	Kanchan Kosa	Orange	Soft	Intermediate	Juicy	Absent
13.	Kamala Bhog	Orange	Soft	Low	Juicy	Absent
14.	Gopi Bhog	Yellow orange	Soft	Low	Slightly juicy	Absent
15.	Madhu Chuski	Orange	Intermediate	High	Juicy	Absent
16.	Khota Lagga	Orange	Soft	Intermediate	Juicy	Absent

Table 6: Stone and seed characteristics of 16 mango cultivars.

Sr. No.	Cultivar	Veins on stone	Pattern of stone venation	Quantity of fibre on stone	Seed shape
1.	Chatterjee	Depressed	Parallel	Intermediate	Reniform
2.	Gulab Khas	Elevated	Parallel	High	Reniform
3.	Ranipasand	Elevated	Parallel	Intermediate	Reniform
4.	Sarikhas	Elevated	Parallel	High	Reniform
5.	Himsagar	Depressed	Parallel	Low	Reniform
6.	Banganpalli	Elevated	Parallel	Low	Reniform
7.	Langra	Level with surface	Parallel	Low	Reniform
8.	Fazli	Elevated	Parallel	Low	Reniform
9.	Gopal Bhog	Elevated	Parallel	High	Reniform
10.	Lakhan Bhog	Elevated	Parallel	High	Reniform
11.	Kancha Mitha	Elevated	Forked	Intermediate	Reniform
12.	Kanchan Kosa	Elevated	Parallel	High	Reniform
13.	Kamala Bhog	Depressed	Forked	High	Reniform
14.	Gopi Bhog	Depressed	Parallel	High	Reniform
15.	Madhu Chuski	Elevated	Parallel	High	Reniform
16.	Khota Lagga	Elevated	Parallel	Intermediate	Oblong

Contd.

Sr. No.	Cultivars	Stone length (cm)	Stone width (cm)	Stone thickness (cm)	Stone weight (gm)	Seed length (cm)	Seed width (cm)	Seed weight (g)
1.	Chatterjee	8.59	3.59	2.00	37.08	6.10	3.15	17.75
2.	Gulab Khas	6.86	3.44	2.19	26.61	5.57	2.65	18.18
3.	Ranipasand	6.62	3.59	2.10	25.43	5.26	2.62	18.28
4.	Sarikhas	6.86	3.61	2.31	32.09	5.11	2.74	20.93
5.	Himsagar	7.54	4.21	2.24	32.75	6.20	3.29	21.72
6.	Banganpalli	8.39	4.43	1.60	25.68	5.88	3.21	12.40
7.	Langra	6.89	3.53	2.14	26.49	5.30	2.63	17.92
8.	Fazli	9.18	4.47	2.28	33.60	6.04	3.07	21.24
9.	Gopal Bhog	7.81	3.86	2.42	34.63	6.16	2.90	22.85
10.	Lakhan Bhog	6.46	3.41	1.59	21.12	4.05	1.89	6.05
11.	Kancha Mitha	6.13	3.00	1.80	29.28	5.18	5.10	11.28
12.	Kanchan Kosa	8.63	3.46	2.08	42.87	7.30	2.33	19.56
13.	Kamala Bhog	5.53	3.46	2.36	33.78	4.97	2.42	15.75
14.	Gopi Bhog	7.54	3.64	2.38	46.40	6.24	3.08	2.78
15.	Madhu Chuski	8.19	3.14	2.09	40.21	6.48	2.50	17.83
16.	Khota Lagga	8.34	3.45	2.03	26.64	6.20	2.33	18.86
Mean		7.47	3.64	2.10	32.17	5.75	2.87	16.46
S.E.		0.07	0.06	0.05	0.52	0.18	0.06	0.37
C.D. (5%)		0.20	0.16	0.14	1.47	0.50	0.18	1.03

These results conformed with the reports given by Kheshin *et al.* (2016); Vieccelli *et al.* (2016). Significant differences were observed in seed length, width, and weight among the mango cultivars. Kanchan Kosa found the longest seed 7.30 cm and Lakhan Bhog the smallest seed 4.05 cm. The widest seed found in Himsagar (3.29 cm) and tapered seed found in Lakhan Bhog (1.89 cm). The Heaviest seed found in Gopal Bhog (22.85 g) and the lightest seed in Lakhan Bhog (6.05 g).

CONCLUSION

The study on morphological characterization of mango cultivars showed that there have variations among the cultivars. It helps to select cultivars based on desirable characters. Many efforts were made to understand the variability of mango germplasm and cultivars identification. Earlier, morphological characteristics were used to establish and identify cultivars and the simplest and easiest way and are considered the first step for evaluating the genetic diversity. The actual identity of some cultivars is still unclear because some of these characteristics differed from year to year as affected by environmental conditions and agricultural practices. Therefore, there is a great need to identify mango cultivars at the molecular level. Unlike the agronomic and morphologic characteristics, the molecular markers are not subject to the environmental effect.

FUTURE SCOPE

The cultivars with high desirable characters from this study can be used for hybridization process which would result in heterotic hybrids. For protection of valuable germplasm, molecular markers can be employed for characterization and conservation of elite genotypes.

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