

International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; SP-10(5): 411-416
www.biochemjournal.com
Received: 08-03-2026
Accepted: 13-04-2026

Vipasha D Dangariya
Department of Fruit Science,
ASPEE College of Horticulture,
Navsari Agricultural University,
Navsari, Gujarat, India

YN Tandel
Department of Fruit Science,
ASPEE College of Horticulture,
Navsari Agricultural University,
Navsari, Gujarat, India

VK Parmar
Department of Horticulture,
College of Agriculture, Navsari
Agricultural University,
Maktampur, Bharuch, Gujarat,
India

BM Tandel
Department of Fruit Science,
ASPEE College of Horticulture,
Navsari Agricultural University,
Navsari, Gujarat, India

Rajeshvaridevi R Jasani
Department of Fruit Science,
ASPEE College of Horticulture,
Navsari Agricultural University,
Navsari, Gujarat, India

DK Sharma
Department of Fruit Science,
ASPEE College of Horticulture,
Navsari Agricultural University,
Navsari, Gujarat, India

AI Patel
Department of Fruit Science,
ASPEE College of Horticulture,
Navsari Agricultural University,
Navsari, Gujarat, India

Brijal Chaudhri
Department of Fruit Science,
ASPEE College of Horticulture,
Navsari Agricultural University,
Navsari, Gujarat, India

Corresponding Author:
Vipasha D Dangariya
Department of Fruit Science,
ASPEE College of Horticulture,
Navsari Agricultural University,
Navsari, Gujarat, India

Taxonomical characterization of mango genotypes using leaf morphological traits

Vipasha D Dangariya, YN Tandel, VK Parmar, BM Tandel, Rajeshvaridevi R Jasani, DK Sharma, AI Patel and Brijal Chaudhri

DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i5Se.8398>

Abstract

The present investigation was conducted at Regional Horticultural Research Station, ASPEE College of Horticulture, NAU, Navsari, Gujarat, India to see the taxonomical characterization of mango genotypes using leaf morphological traits. During entire experiment, the data was collected of nine characters of leaf for fifty genotypes and three check varieties (Amrapali, Kesar and Sonpari) of mango to assess variability. The wide variation was observed in leaf colour, leaf length, leaf width, leaf blade shape, leaf margin, leaf apex shape, leaf base shape, petiole length and leaf attitude in relation to branch. Result revealed that majority of the 18 genotypes had light green with brownish tinge colour of young leaves, 34 genotypes had dark green colour of fully mature leaf, 28 genotypes had oblong leaf blade shape, 30 genotypes had entire leaf margin, 21 genotypes had acute leaf apex shape, 42 genotypes had acute leaf base shape and 42 genotypes had horizontal leaf attitude in relation to branch. Leaf length ranged from 10.05 to 33.20 cm, leaf width from 2.43 to 7.93 cm and petiole length from 1.00 to 7.65 cm. Based on the leaf characters, different superior genotypes can be identified easily during vegetative stage only prior to attaining reproductive stage and making use of these genotypes for breeding programme.

Keywords: Mango, genotypes, diversity and leaf morphological traits

Introduction

Mango (*Mangifera indica* L.) belongs to the family Anacardiaceae. It is also known as the "King of fruit", Choicest fruit of India, Pride of garden, National fruit of India. In India mango cultivated area is 24.07 lakh ha and production are 232.66 lakh MT (Anon., 2025) ^[1]. The major mango-growing states in India are Andhra Pradesh, Uttar Pradesh, Odisha, Gujarat, Bihar, Tamil Nadu, Karnataka and Telangana. The vast agroclimatic diversity across these regions has given rise to a wide variation of mango genotypes, each exhibiting distinct morphological traits.

Mango is a perennial tree with a long juvenile phase of 5 to 10 years. Taxonomical identification and selection of mango genotypes might be challenging during the vegetative stage (Joshi *et al.*, 2013) ^[2]. To make the identification process simple and accurate at an early stage, the vegetative characters of leaf can be used. Mango bears simple, clustered, alternate tristichous and petiolate leaves. Leaf structure generally does not change with age except its size and colour. Thus, leaves form a quite easy and reliable taxonomical trait that can be used to identify mango genotypes (Arora *et al.*, 2024) ^[3]. Kalyan *et al.* (2012) ^[4] observed variation in foliage density, shape of lamina, leaf nature, leaf apex, the colour of young and matured leaves and arrangement of major veins which can be helpful in differentiation across mango cultivars. However, limited studies have been carried out on leaf morphological traits of mango genotypes. Such studies are not only important for the identification of species, but also to determine their genetic divergence. Therefore, the present investigation was conducted to determine the taxonomical characterization of mango genotypes using leaf morphological traits.

Materials and Methods

The present investigation was carried out during the year 2023-2024 and 2024-2025 on fifty mango genotypes of more than fifteen years age maintained by the Regional Horticultural

Research Station, ASPEE College Horticulture, Navsari Agricultural University, Navsari, Gujarat, India. During entire experiment, the data was collected of nine characters of leaf for fifty genotypes and three check varieties (Amrapali, Kesar and Sonpari) of mango to assess variability. Genotypes designated as MG-1 to MG-50 where MG represents Mango genotype. The qualitative

characteristics of leaf was recorded as per the mango descriptor (Anon., 2006) ^[5], while quantitative characteristics of leaf was analysed into descriptive statistics. Total ten leaf samples were taken randomly from all direction from each individual tree and used for characterization and evaluation for all parameters.

Table 1: Explanation of leaf morphological traits

Parameter	Methodology/Description
Leaf colour (young and fully developed)	Young leaf colour: light green, light green with brownish tinge, light brick red, reddish brown, deep coppery tan or other (recorded on 5-10 days old leaves) Fully developed leaf colour: pale green, green, dark green or other
Leaf length (cm)	Measured from the base to the tip of leaf using measuring scale
Leaf width (cm)	Measured at the widest point using measuring scale
Leaf blade shape	Elliptical, oblong, ovate, obovate, lanceolate, oblanceolate or other
Leaf margin	Entire or wavy
Leaf tip (apex) shape	Obtuse, acute or acuminate
Leaf base shape	Acute, obtuse or round
Petiole length (cm)	Measured from the stem to the base of leaf blade using measuring scale
Leaf attitude in relation to branch	Semi-erect, horizontal, semi-dropping or other

Results and Discussion

Leaf colour (young and fully develop)

Leaf colour (young and fully develop) of each genotype was observed using mango descriptor (Anon., 2006) ^[5] and mentioned in Table 2 and Photo 1. It was recorded that leaf colours of all genotypes ranged from various colour including light green, brick red, coppery tan, light pink *etc.* which shows great variability in different genotypes of mango. It was observed reddish brown colour in three

genotypes, light green with brownish tinge colour in 18 genotypes, light green colour in 17 genotypes, deep coppery tan colour in six genotypes, light brick red colour in two genotypes, light coppery tan colour in two genotypes, greenish brown colour and light pink colour in one genotype, respectively. In fully mature leaf, majority of genotypes (34) had dark green colour, 14 genotypes had green colour and two genotypes (MG-19 and MG-41) had pale green colour (Table 2).

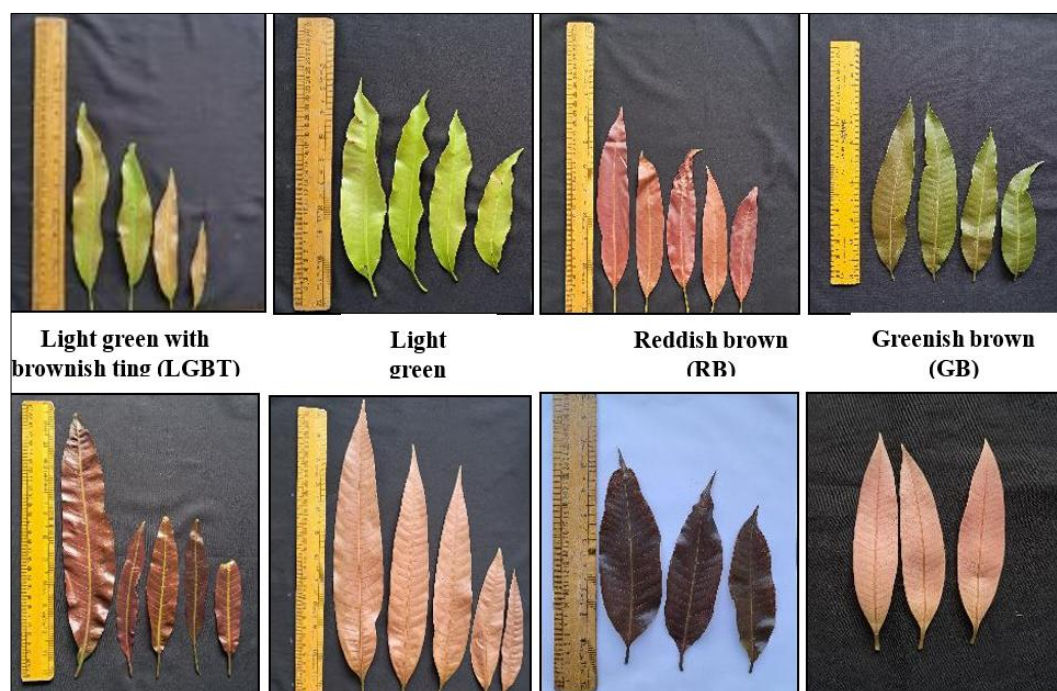


Photo 1: Variation in young leaf colour of 5-10 days old in mango genotypes

Leaf length (cm)

The data recorded on leaf length is presented in Table 2. The maximum leaf length was recorded in MG-5 (33.20 cm), while minimum in MG-17 (10.05 cm). The average leaf length was 22.74 cm in overall 50 mango genotypes. The variation in leaf length among the genotype was attributed to genotype of the plant which might have been further modified by environmental influence and management

factors. Similar results were reported Veena and Dinesh (2018) ^[6], Igbari *et al.* (2019) ^[7], Indian *et al.* (2020) ^[8], Odunayo *et al.* (2022) ^[9], Ruchika *et al.* (2023) ^[10] and Patel *et al.* (2024a) ^[11] in mango genotypes.

Leaf width (cm)

The data regarding leaf width was observed for different genotypes and shown in Table 2. The data revealed that

significantly maximum leaf width was recorded in genotype MG-10 (7.93 cm) whereas, the minimum leaf width in genotype MG-19 (2.43 cm). The average leaf width was recorded 5.29 cm. Variation in leaf width among the genotypes were also reported by Ruchika *et al.* (2023) ^[10], Arora *et al.* (2024) ^[3] and Patel *et al.* (2024a) ^[11] in mango genotypes.

Leaf blade shape

The shape of leaf blade for the mango genotypes falls into various groups *viz.*, elliptic, oblong, ovate, obovate, lanceolate and oblanceolate. The types of leaf blade shape

for the genotypes observed during the course of investigation were noted and presented in the Table 2 and Photo 2. Out of 50 genotypes and three check varieties, 38 were having oblong leaf blade shape, ten were having lanceolate shape, one having oblanceolate shape (MG-25), one having elliptic shape (MG-40) and three having ovate leaf blade shape (MG-4, MG-18 and MG-29). The present finding is in agreement with Raza *et al.* (2017) ^[12], Igbari *et al.* (2019) ^[7], Indian *et al.* (2020) ^[8], Latheef *et al.* (2022) ^[13], Arora *et al.* (2024) ^[3], Patel (2024) ^[14] and Ansari *et al.* (2026) ^[15] in mango genotypes.

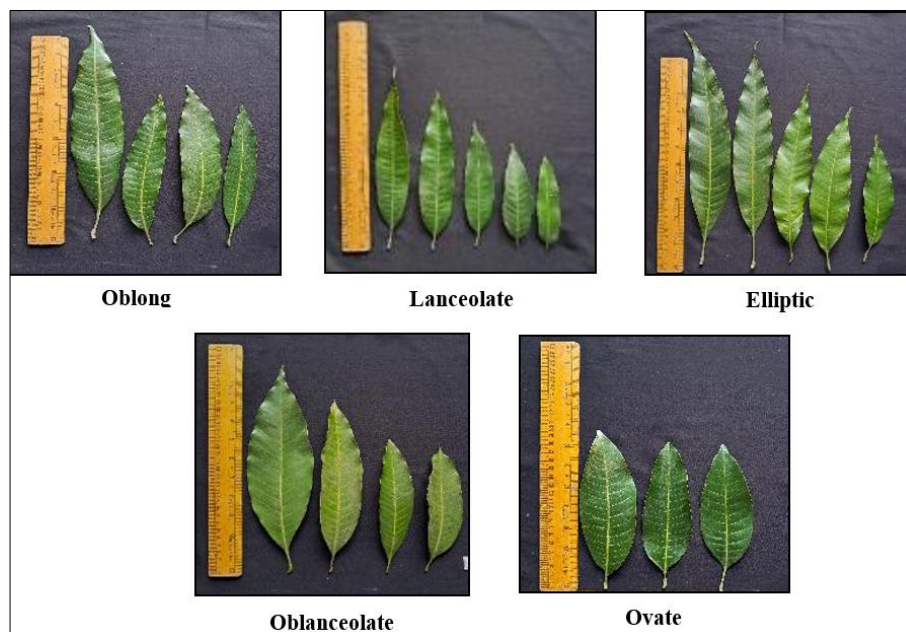


Photo 2: Variation in leaf blade shape of mango genotypes

Leaf margin

Predominately entire leaf margin was recorded in 30 genotypes whereas, wavy leaf margin was recorded in 20 genotypes (Table 2 and Photo 3). Similar work also reported by Raza *et al.* (2017) ^[12], Patel (2024) ^[14] and Ansari *et al.* (2026) ^[15] in mango genotypes.

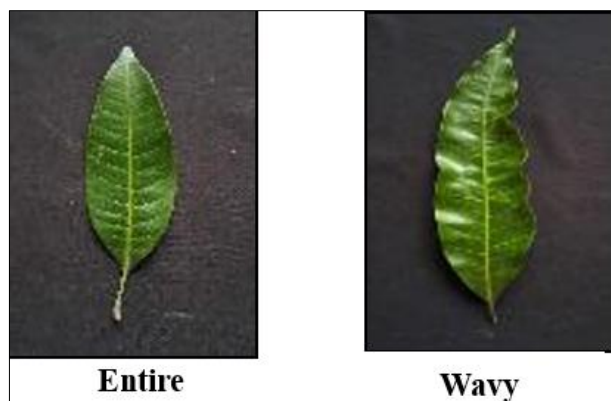


Photo 3: Variation in leaf margin of mango genotypes

Leaf apex (tip) shape

Leaf apex shape was categorized as obtuse, acute and acuminate. It was observed that the 21 genotypes had acute apex shape, 31 had acuminate shape and one genotype had

round leaf apex shape (Table 2 and Photo 4). Raza *et al.* (2017) ^[12], Latheef *et al.* (2022) ^[13], Ahmed and Mohamed (2023) ^[16], Ruchika *et al.* (2023) ^[10], Patel *et al.* (2024a) ^[11] and Ansari *et al.* (2026) ^[15] reported variation in leaf apex in mango germplasm.

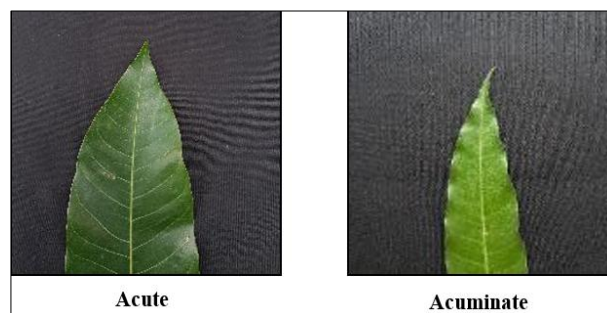


Photo 4: Variation in leaf apex of mango genotypes

Leaf base shape

Out of 50 genotypes, 42 genotypes had acute leaf base shape, five had obtuse base shape and three genotype (MG-4, MG-18 and MG-29) were in round leaf base shape (Table 2 and Photo 5). A significant variation in leaf base shape was also recorded earlier by Raza *et al.* (2017) ^[12], Latheef *et al.* (2022) ^[13], Ahmed and Mohamed (2023) ^[16], Ruchika *et al.* (2023) ^[10], Patel (2024) ^[14] and Ansari *et al.* (2026) ^[15].



Photo 5: Variation in leaf base of mango genotypes

Petiole length (cm)

The significant difference in petiole length was recorded in different mango genotypes is depicted in Table 2. The longest petiole length (7.65 cm) was obtained in genotype MG-43, while the smallest petiole length (1.00 cm) was recorded in genotypes MG-19 and MG-31. Patel *et al.* (2024a) ^[11] reported petiole length from 3.34 to 6.33 cm in mango genotypes from South Gujarat.

Leaf attitude in relation to branch: Leaf attitude in

relation to branch having three categories in 42 genotypes were having horizontal type leaf attitude in relation to branch, six genotypes were having semi-erect leaf attitude in relation to branch, while two genotypes (MG-27 and MG-33) were having semi-drooping type leaf attitude in relation to branch (Table 2).

The significant variation among the genotypes for leaf characteristics could be due to the genetic constitution of particular variety, interaction with environmental factors, cultivation practices and the developmental stage of the plant. The results revealed that mango leaves showed high variability in shape, size and even colour, as a fact also reported by Singh *et al.* (2025) ^[17] in mango. The present finding is in agreement with (Rymbai *et al.*, 2015) ^[18], Raza *et al.* (2017) ^[12], Veena and Dinesh (2018) ^[6], Igbari *et al.* (2019) ^[7], Indian *et al.* (2020) ^[8], Latheef *et al.* (2022) ^[13], Odunayo *et al.* (2022) ^[9], Ahmed and Mohamed (2023) ^[16], Ruchika *et al.* (2023) ^[10], Arora *et al.* (2024) ^[3], Patel (2024) ^[14], Patel *et al.* (2024a) ^[11] and Ansari *et al.* (2026) ^[15] in mango genotype.

Table 2: Variability in leaf morphological traits of mango genotypes

Sr. No.	Genotypes	Leaf colour		Leaf length (cm)	Leaf width (cm)	Leaf blade shape	Leaf margin	Leaf tip (apex shape)	Leaf base shape	Petiole length (cm)	Leaf attitude in relation to branch
		Young	Fully Developed								
1	MG-1	RB	DG	23.50	4.70	Oblong	Entire	Acute	Acute	3.10	Horizontal
2	MG-2	LGBT	DG	20.00	4.50	Oblong	Entire	Acute	Acute	3.00	Horizontal
3	MG-3	LG	DG	24.00	4.70	Oblong	Entire	Acute	Acute	3.30	Horizontal
4	MG-4	DCT	DG	22.67	6.60	Ovate	Entire	Acute	Round	2.02	Horizontal
5	MG-5	LGBT	Green	33.20	6.80	Oblong	Entire	Acuminate	Obtuse	3.80	Horizontal
6	MG-6	LGBT	Green	24.10	5.20	Oblong	Wavy	Acuminate	Acute	2.00	Horizontal
7	MG-7	DCT	DG	15.60	4.10	Oblong	Entire	Acuminate	Acute	2.70	Horizontal
8	MG-8	DCT	Green	22.00	5.20	Lanceolate	Entire	Acuminate	Obtuse	3.50	Horizontal
9	MG-9	LG	Green	20.00	4.90	Oblong	Wavy	Acuminate	Obtuse	2.90	Horizontal
10	MG-10	LG	DG	24.60	7.93	Lanceolate	Entire	Acute	Acute	2.33	Horizontal
11	MG-11	LGBT	DG	15.80	4.00	Oblong	Entire	Obtuse	Acute	1.50	Horizontal
12	MG-12	LGBT	DG	22.70	4.70	Oblong	Entire	Acute	Acute	2.80	Horizontal

* RB- Reddish brown, LGBT- Light green with brownish tinge, LG- Light green, PG- Pale green, DG- Dark green, LBR- Light brick red, DCT- Deep coppery tan, LCT- Light coppery tan, GB- Greenish brown, LP- Light pink

Table 2: Conti...

Sr. No.	Genotypes	Leaf colour		Leaf length (cm)	Leaf width (cm)	Leaf blade shape	Leaf margin	Leaf tip (apex shape)	Leaf base shape	Petiole length (cm)	Leaf attitude in relation to branch
		Young	Fully Developed								
13	MG-13	LGBT	DG	24.70	5.60	Oblong	Entire	Acute	Acute	3.30	Horizontal
14	MG-14	LG	DG	22.00	5.10	Lanceolate	Entire	Acuminate	Acute	3.30	Horizontal
15	MG-15	LG	DG	20.40	4.50	Lanceolate	Entire	Acuminate	Acute	2.10	Horizontal
16	MG-16	LG	DG	28.72	5.65	Oblong	Entire	Acuminate	Acute	4.67	Horizontal
17	MG-17	LGBT	DG	10.05	5.56	Oblong	Wavy	Acuminate	Acute	2.95	Horizontal
18	MG-18	LG	DG	16.90	5.50	Ovate	Entire	Acuminate	Round	2.50	Horizontal
19	MG-19	LGBT	PG	11.03	2.43	Oblong	Entire	Acuminate	Acute	1.00	Horizontal
20	MG-20	LG	Green	26.06	6.03	Oblong	Wavy	Acuminate	Acute	3.86	Horizontal
21	MG-21	LG	DG	19.75	4.45	Oblong	Wavy	Acute	Acute	2.65	Horizontal
22	MG-22	DCT	DG	23.00	6.40	Lanceolate	Wavy	Acuminate	Acute	2.10	Horizontal
23	MG-23	RB	DG	24.40	4.50	Oblong	Entire	Acuminate	Acute	2.45	Horizontal
24	MG-24	LGBT	DG	21.35	6.10	Lanceolate	Wavy	Acute	Acute	3.90	Horizontal

* RB- Reddish brown, LGBT- Light green with brownish tinge, LG- Light green, PG- Pale green, DG- Dark green, LBR- Light brick red, DCT- Deep coppery tan, LCT- Light coppery tan, GB- Greenish brown, LP- Light pink

Table 2: Conti...

Sr. No.	Genotypes	Leaf colour		Leaf length (cm)	Leaf width (cm)	Leaf blade shape	Leaf margin	Leaf tip (apex shape)	Leaf base shape	Petiole length (cm)	Leaf attitude in relation to branch
		Young	Fully Developed								
25	MG-25	LG	DG	22.6	6.40	Oblanceolate	Entire	Acute	Acute	2.85	Horizontal
26	MG-26	LG	DG	20.00	5.35	Oblong	Wavy	Acute	Acute	2.90	Horizontal
27	MG-27	RB	DG	16.16	4.80	Lanceolate	Wavy	Acuminate	Obtuse	2.12	Semi-drooping
28	MG-28	LGBT	Green	22.30	5.30	Oblong	Wavy	Acute	Acute	2.80	Horizontal
29	MG-29	LG	DG	23.40	5.75	Ovate	Entire	Acute	Round	2.75	Horizontal
30	MG-30	LG	DG	23.65	4.30	Oblong	Wavy	Acute	Acute	3.00	Semi-erect
31	MG-31	LGBT	Green	20.70	4.15	Oblong	Wavy	Acute	Acute	1.00	Horizontal
32	MG-32	LCT	Green	22.85	5.55	Oblong	Entire	Acuminate	Acute	4.15	Horizontal
33	MG-33	LG	DG	24.10	5.30	Oblong	Entire	Acute	Acute	2.50	Semi-drooping
34	MG-34	LCT	Green	27.30	5.70	Oblong	Entire	Acuminate	Acute	2.40	Horizontal
35	MG-35	LGBT	DG	19.10	4.50	Oblong	Entire	Acuminate	Acute	2.00	Semi-erect
36	MG-36	LG	DG	28.10	4.80	Oblong	Wavy	Acuminate	Acute	2.40	Semi-erect

* RB- Reddish brown, LGBT- Light green with brownish tinge, LG- Light green, PG- Pale green, DG- Dark green, LBR- Light brick red, DCT- Deep coppery tan, LCT- Light coppery tan, GB- Greenish brown, LP- Light pink

Table 2: Conti...

Sr. No.	Genotypes	Leaf colour		Leaf length (cm)	Leaf width (cm)	Leaf blade shape	Leaf margin	Leaf tip (apex shape)	Leaf base shape	Petiole length (cm)	Leaf attitude in relation to branch
		Young	Fully Developed								
37	MG-37	GB	DG	30.00	6.50	Oblong	Entire	Acuminate	Acute	3.90	Semi-erect
38	MG-38	LG	DG	23.95	6.25	Oblong	Entire	Acuminate	Acute	2.45	Horizontal
39	MG-39	DCT	DG	30.95	5.75	Oblong	Entire	Acuminate	Acute	5.00	Semi-erect
40	MG-40	LGBT	Green	20.60	5.40	Elliptic	Wavy	Acuminate	Acute	1.90	Horizontal
41	MG-41	LGBT	PG	23.65	4.90	Oblong	Wavy	Acuminate	Acute	3.60	Horizontal
42	MG-42	LP	Green	21.20	5.05	Oblong	Wavy	Acuminate	Acute	2.25	Semi-erect
43	MG-43	LGBT	Green	32.55	6.80	Oblong	Entire	Acuminate	Acute	7.65	Horizontal
44	MG-44	LG	DG	20.80	5.05	Oblong	Entire	Acute	Acute	1.40	Horizontal
45	MG-45	DCT	DG	24.40	5.00	Oblong	Wavy	Acute	Acute	2.60	Horizontal
46	MG-46	LBR	DG	25.45	5.40	Lanceolate	Entire	Acute	Acute	4.25	Horizontal
47	MG-47	LGBT	Green	20.54	5.36	Oblong	Wavy	Acuminate	Acute	3.20	Horizontal
48	MG-48	LBR	DG	30.00	5.90	Oblong	Wavy	Acuminate	Acute	3.80	Horizontal

* RB- Reddish brown, LGBT- Light green with brownish tinge, LG- Light green, PG- Pale green, DG- Dark green, LBR- Light brick red, DCT- Deep coppery tan, LCT- Light coppery tan, GB- Greenish brown, LP- Light pink

Table 2: Conti...

Sr. No.	Genotypes	Leaf colour		Leaf length (cm)	Leaf width (cm)	Leaf blade shape	Leaf margin	Leaf tip (apex shape)	Leaf base shape	Petiole length (cm)	Leaf attitude in relation to branch
		Young	Fully Developed								
49	MG-49	LGBT	DG	24.70	5.30	Oblong	Entire	Acute	Acute	3.20	Horizontal
50	MG-50	LGBT	Green	26.60	5.10	Oblong	Wavy	Acuminate	Obtuse	3.10	Horizontal
51	Amrapali	LGBT	DG	20.30	4.30	Lanceolate	Wavy	Acuminate	Acute	3.84	Semi-erect
52	Kesar	LGBT	Green	21.10	5.56	Oblong	Entire	Acuminate	Acute	3.50	Horizontal
53	Sonpari	LGBT	DG	22.90	5.46	Lanceolate	Entire	Acute	Obtuse	2.60	Semi-drooping
Mean	-	-	-	22.74	5.29	-	-	-	-	2.96	-
Range	-	-	-	10.05 - 33.20	2.43 - 7.93	-	-	-	-	1.00 - 7.65	-
S.Em. ±	-	-	-	0.63	0.12	-	-	-	-	0.15	-
S.D.	-	-	-	4.60	0.89	-	-	-	-	1.07	-
Variance	-	-	-	21.15	0.79	-	-	-	-	1.14	-
CV%	-	-	-	20.21	16.78	-	-	-	-	36.21	-

* RB- Reddish brown, LGBT- Light green with brownish tinge, LG- Light green, PG- Pale green, DG- Dark green, LBR- Light brick red, DCT- Deep coppery tan, LCT- Light coppery tan, GB- Greenish brown, LP- Light pink

Conclusion

The current study indicated that the fifty mango genotypes have showed significant differences in leaf morphological traits. The wide variation was observed in leaf colour, leaf length, leaf width, leaf blade shape, leaf margin, leaf apex shape, leaf base shape, petiole length and leaf attitude in relation to branch. It will help the farmers and breeders for an early and easy selection and identification of suitable genotypes for promoting their cultivation and making use for further breeding programme.

References

- Anonymous. Horticulture Crops for 2024-25 (3rd Advance Estimates). Horticulture Statistics Division, Department of Agriculture, Cooperation and Farmers Welfare, Agriculture and Farmers Welfare, Government of India. 2025.
<http://www.agricoop.nic.in/statistics/horticulture>
- Joshi R, Kundu M, Singh CP. Morphological characters: efficient tool for identification on different

- mango cultivars. *Journal Ecology and Environment*. 2013;31(1):385-388.
3. Arora V, Rawat DS, Singh AK, Chaturvedi P. Taxonomical identification of mango (*Mangifera indica* L.) varieties using leaf morphological characteristics. *Plant Archives*. 2024;24(1):983-990.
 4. Kalyan C, Tuhinsri S, Arvind KC, Samir KS. Leaf characters and measurements of mango cultivars in gangetic plains of West Bengal In: International seminar on multidisciplinary approaches in angiosperm systematics. Kalyani, WB. 2012;762-768.
 5. Anonymous. Descriptors for Mango (*Mangifera indica* L.). International Plant Genetic Resources Institute, Rome, Italy. 2006;1-60.
 6. Veena GL, Dinesh MR. Genetic diversity in Appemidi (unique aromatic pickle mango) genotypes from Western Ghats Regions of Chikmagalur (Karnataka), India. *International Journal of Current Microbiology and Applied Sciences*. 2018;7(7):1010-1018.
 7. Igbari AD, Nodza GI, Adeusi AD, Ogundipe OT. Morphological characterization of mango (*Mangifera indica* L.) cultivars from South-West Nigeria. *Ife Journal Science*. 2019;21(1):155-163.
 8. Indian G, Naik E, Deenavarman M, Jagathesan K, Janani T. Studies on the growth and flowering behaviour of different mango (*Mangifera indica* L.) genotypes. *International Journal of Current Microbiology and Applied Sciences*. 2020;9(6):1981-1989.
 9. Odunayo OJ, Emmanuel AA, Chiwendu EP, Iseoluwa AI. Genetic assessment of mango (*Mangifera indica* L.) from selected locations in Oyo State, Nigeria. *Journal of Biological Research and Biotechnology*. 2022;20(2):1446-1460.
 10. Ruchika, Bhat RP, Ravishankar KV. Qualitative and quantitative assessment of wild genotypes of mango. *Journal of Horticulture Science*. 2023;18(2):1-5.
 11. Patel N, Tandel YN, Dangariya V. Evaluation of sucking purpose seedling origin mango genotypes from South Gujarat. *Environment and Ecology*. 2024;42(4B):1951-1957.
 12. Raza SA, Khan AS, Khan IA, Rajwana IA, Ali S, Khan AA, *et al.* Morphological and physico-chemical diversity in some indigenous mango (*Mangifera indica* L.) germplasm of Pakistan. *Pakistan Journal Agriculture Science*. 2017;54(2):287-297.
 13. Latheef AA, Pugalendhi L, Rani AMS, Jeyakumar P, Kumar M. Morphological characterization of mango (*Mangifera indica* L.) seedling progenies for flowering and yield contributing traits. *Biological Forum International Journal*. 2022;14(1):32-37.
 14. Patel NC. Assessment of genetic diversity among seedling origin mango genotypes from south Gujarat [Thesis]. Navsari Agricultural University, Navsari, Gujarat, India. 2024;124-143.
 15. Ansari WZ, Mukhtar H, Ali A, Arif M, Iqbal J, Henry R. Evaluation of mango (*Mangifera indica* L.) germplasm for phenotypic diversity and breeding potential in Pakistan. *Scientific Reports*. 2026. <https://doi.org/10.1038/s41598-025-33793-y>
 16. Ahmed THM, Mohamed ZMA. Diversity of mango (*Mangifera indica* L.) cultivars in Shendi area: morphological fruit characterization. *International Journal Research Agricultural Science*. 2023;2(4):141-148.
 17. Singh AK, Shivran JS, Singh NK, Bains G, Dimri DC, Kumar R, *et al.* Morphological and biochemical diversity of promising mango (*Mangifera indica* L.) indigenous cultivars in India. *Genetic Resource Crop Evolution*. 2025;72:7821-7846.
 18. Rymbai H, Patel CR, Ahlawat TR, Patel NL. Studies on fruit and yield traits in indigenous coloured varieties of mango (*Mangifera indica* L.) in South Gujarat. India. *Journal Horticultural Sciences*. 2015;10(1):94-98.