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STUDIES ON LEAF CHARACTERS OF DIFFERENT MANGO (*MANGIFERA INDICA* L.) VARIETIES UNDER AGRO-CLIMATIC CONDITIONS OF RAIPUR, CHHATTISGARH, INDIA

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ABSTRACT

The present study was conducted during 2023–24 and 2024–25 at the Horticulture Research Farm, Department of Fruit Science, IGKV, Raipur, to evaluate morphological diversity among fifteen mango (*Mangifera indica* L.) varieties based on leaf traits. The trial followed a Randomized Block Design (RBD) with three replications. Observations were recorded using IPGRI (2006) mango descriptors to assess both qualitative and quantitative leaf characteristics. Results revealed considerable variation among the genotypes. Qualitative traits showed that 53% of varieties had acuminate leaf apices, 60% had obtuse leaf bases and 67% had entire leaf margins. All varieties exhibited dark green mature leaves, while new leaf color ranged across five distinct categories, with deep coppery tan being the most frequent (34%). Quantitative traits varied significantly. Leaf length ranged from 14.68 cm (Kurukkan) to 24.94 cm (Mallika) and breadth from 2.65 cm (Kurukkan) to 5.10 cm (Chhattisgarh Swarnaprabha). The leaf length-to-breadth ratio was lowest in Chhattisgarh Swarnaprabha (3.28) and highest in Dashehari (6.10). Petiole length varied from 2.09 cm (Chhattisgarh Achar) to 3.96 cm (Amrapali). Improved varieties such as Mallika, Amrapali, and Dashehari exhibited superior leaf traits, while local genotypes showed comparatively lower values. The observed variability provides valuable input for varietal identification and mango improvement programs.
Keywords: Mango varieties, Leaf length, characteristics, breadth, petiole length etc.

Introduction

Mango (*Mangifera indica* L.), a prominent fruit crop in India, belongs to the Anacardiaceae family and is widely revered as the "King of Fruits" as well as the national fruit due to its exceptional flavor, fragrance, and cultural importance (Shah *et al*., 2010). It is a diploid fruit tree with 2n=40 chromosomes (Kuhn *et al.,* 2017). It is recognized as the ambassador fruit of India because of delicious taste, excellent flavor, attractive fragrance, religious and medicinal importance of the plant it is considered to be the "King of fruits" and "National Fruit of India". The Fruit Research Station in Sangareddy, Andhra Pradesh, conserves more than 470 mango varieties. Mangoes are highly nutritious, containing significant levels of vitamin A (389 mg/100g), vitamin C (32–200 mg/ 100g), carotenoids, and vital minerals (Pleguezuelo *et al*., 2012).

Mango has enormous diversity due to open pollination, allopolyploid, outbreeding and phenotypic variations occur from diverse Agro-climatic situation of different regions. Mango is heterogeneous in nature and has a great diversity in seedling genotypes which have shown wide genetic diversity in terms of shape, color, bearing habits, maturity stage and yield. The International Plant Genetic Resources Institute (IPGRI, 2006) descriptors allow for the use of visual assessment tools of morphological traits to characterize

mango germplasm. This makes it necessary to identify and utilize traits that are highly correlated with yield. Comprehensive, well-documented data on the existing mango genetic resources, along with a broad and well-maintained diversity of varieties, are crucial for successful breeding programs.

Materials and Methods

The research was carried out during 2023–24 and 2024–25 at the Horticulture Research Farm, Department of Fruit Science, College of Agriculture, IGKV, Raipur (Chhattisgarh), using mango trees aged between 10 to 20 years. The study site, situated in the Chhattisgarh plains (21.25°N latitude, 81.63°E longitude, 289.15 m above sea level), experiences a dry, moist sub-humid climate with annual rainfall ranging from 1200 to 1400 mm, mainly during the South-West monsoon. Temperature variations span from 6°C in winter to 46°C in summer. The experimental layout followed a Randomized Block Design (RBD), incorporating fifteen mango varieties with three replications. Observations on leaf characteristics were recorded using the mango descriptors outlined by IPGRI (2006), Rome, Italy.

The evaluation parameters included leaf characteristics *viz*., leaf shape apex, base shape, leaf margin in this we do data observations with the help of mango descriptor (IPGRI, Rome, Italy, 2006) and moreover leaf length, leaf breadth, leaf length and breadth ratio, petiole length was measured through scale respectively.

Results and Discussion

Leaf apex shape

Data regarding Leaf apex shape of Mango trees has been presented in Table 1 and outlined in Fig. 1. In this study, the leaf apex of fifteen mango varieties was classified into acuminate, acute, and obtuse types. The acuminate apex was most common, found in eight varieties: Chhattisgarh Raj, Chhattisgarh Nandiraj, Dashehari, Langra, Mallika, Amrapali, Amin, and Local genotype-2. The acute apex appeared in six varieties: Chhattisgarh Swarnaprabha, Chhattisgarh Pawan, Chhattisgarh Achar, Chhattisgarh Gaurav, Kurukkan, and Kishanbhog. Only Local genotype-1 showed an obtuse apex. Overall, acuminate was the most frequent (53%), followed by acute (40%) and obtuse (7%).

Leaf base shape

The study presented in Table 1 and illustrated in Fig. 1 classified the leaf of fifteen mango varieties was classified into acute and obtuse types. Nine varieties such as Chhattisgarh Swarnaprabha, Chhattisgarh Achar, Chhattisgarh Gaurav, Chhattisgarh Nandiraj, Langra, Amin, Kurukkan, Kishanbhog and Local genotype-1 exhibited an obtuse leaf base. The remaining six varieties *viz*.,Chhattisgarh Pawan, Chhattisgarh Raj, Dashehari, Mallika, Amrapali and Local genotype-2 had an acute leaf base. Overall, 60% of the varieties showed an obtuse leaf base, while 40% had an acute base. Similar findings have been reported by several researchers, including Rymbai *et al*. (2014) and Rai *et al*. (2023).

Leaf margin

The data regarding leaf margin of different Mango varieties has been presented in the Table-1 and illustrated in Fig-2 classified into entire and wavy types. Ten varieties such as Chhattisgarh Swarnaprabha, Chhattisgarh Achar, Chhattisgarh Raj, Chhattisgarh Gaurav, Langra, Mallika, Amin, Kurukkan, Kishanbhog, and Local genotype-1 had an entire leaf margin. The remaining five varieties Chhattisgarh Pawan, Chhattisgarh Nandiraj, Dashehari, Amrapali, and Local genotype-2 exhibited a wavy leaf margin. The entire type was the most frequent, accounting for 67%, while the wavy type was observed in 33% of the varieties. These results are also parallel with the results reported by Bhamini *et al*. (2018), Ibukun and Yomi (2020), Rai *et al*. (2023) and Rana (2023) in Mango varieties.

New leaf color

The data showed in Table 1 and Fig. 2 revealed that the new leaf color of fifteen mango varieties was grouped into five categories: deep coppery tan, light green, light purple, light brick red, and reddish brown. Five varieties such as Chhattisgarh Achar, Chhattisgarh Gaurav, Mallika, Local Genotype-1, and Local Genotype-2 showed deep coppery tan leaves. Four varieties Dashehari, Langra, Amrapali and Amin had light green new leaves. Chhattisgarh Raj and Chhattisgarh Nandiraj exhibited light purple leaves, while Chhattisgarh Swarnaprabha and Chhattisgarh Pawan showed light brick red coloration. Lastly, Kurukkan and Kishanbhog had reddish brown new leaves. Deep coppery tan was the most frequent leaf color (34%), followed by light green (27%), with light purple, light brick red and reddish brown each representing 13% of the varieties. Similar results were also reported by Rymbai *et al.* (2014), Bhamini *et al*. (2018), Rai *et al.* (2023) and Rana (2023) in Mango varieties.

Color of fully developed leaf

The data showed in Table 1 and Fig. 3 revealed that the fully developed leaves of all fifteen mango varieties including Chhattisgarh Swarnaprabha,

Chhattisgarh Pawan, Chhattisgarh Achar, Chhattisgarh Raj, Chhattisgarh Gaurav, Chhattisgarh Nandiraj, Dashehari, Langra, Mallika, Amrapali, Amin, Kurukkan, Kishanbhog, Local Genotype-1 and Local Genotype-2 were uniformly classified as dark green. This trait was consistent across all varieties, with a 100% frequency of dark green leaf color. Similar results were also reported by Bhamini *et al.* (2018), Rai *et al.* (2023) and Rana (2023) in Mango varieties.

Table 1: Variability in leaf characteristics of different Mango varieties.

Varieties	Leaf shape Apex	Leaf shape Base	Leaf margin	New leaf color	Color of fully developed leaf
Chhattisgarh Swarnaprabha	Acute	Obtuse	Entire	Light brick red	Dark green
Chhattisgarh Pawan	Acute	Acute	Wavy	Light brick red	Dark green
Chhattisgarh Achar	Acute	Obtuse	Entire	Deep coppery tan	Dark green
Chhattisgarh Raj	Acuminate	Acute	Entire	Light purple	Dark green
Chhattisgarh Gaurav	Acute	Obtuse	Entire	Deep coppery tan	Dark green
Chhattisgarh Nandiraj	Acuminate	Obtuse	Wavy	Light purple	Dark green
Dashehari	Acuminate	Acute	Wavy	Light green	Dark green
Langra	Acuminate	Obtuse	Entire	Light green	Dark green
Mallika	Acuminate	Acute	Entire	Deep coppery tan	Dark green
Amrapali	Acuminate	Acute	Wavy	Light green	Dark green
Amin	Acuminate	Obtuse	Entire	Light green	Dark green
Kurukkan	Acute	Obtuse	Entire	Reddish brown	Dark green
Kishenbhog	Acute	Obtuse	Entire	Reddish brown	Dark green
Local Genotype-1	Obtuse	Obtuse	Entire	Deep coppery tan	Dark green
Local Genotype-2	Acuminate	Acute	Wavy	Deep coppery tan	Dark green

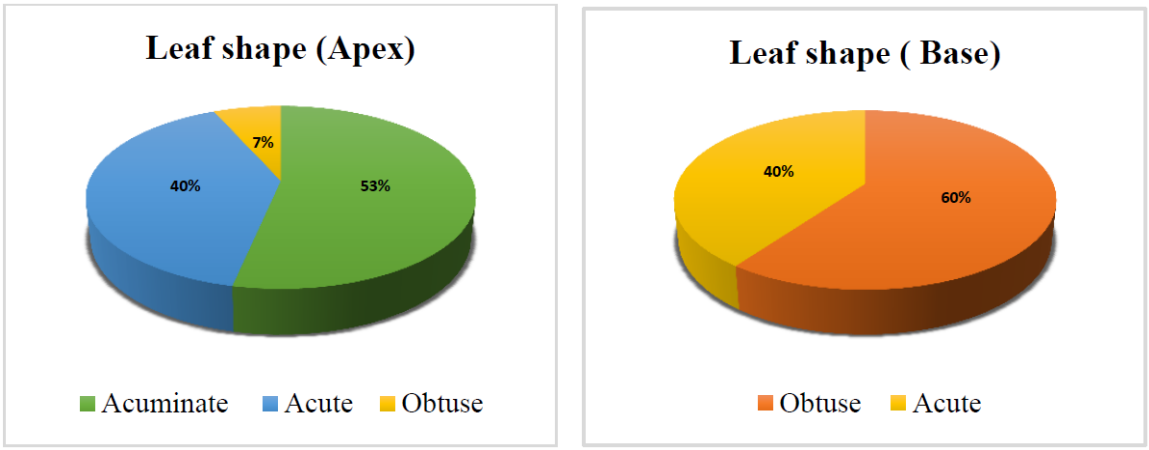

Fig.1: Leaf apex and base shape percentage of different Mango varieties

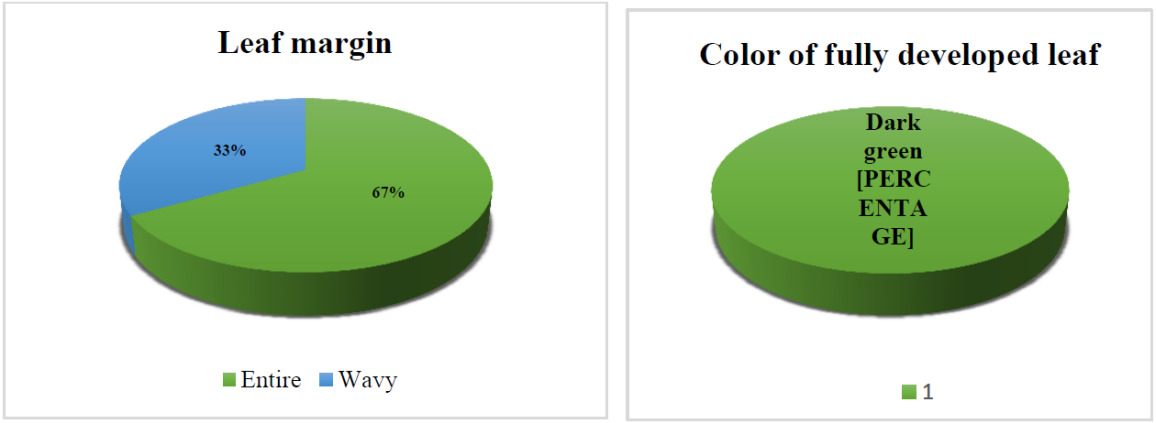

Fig.2: Leaf margin and color of fully developed leaf percentage of different Mango varieties

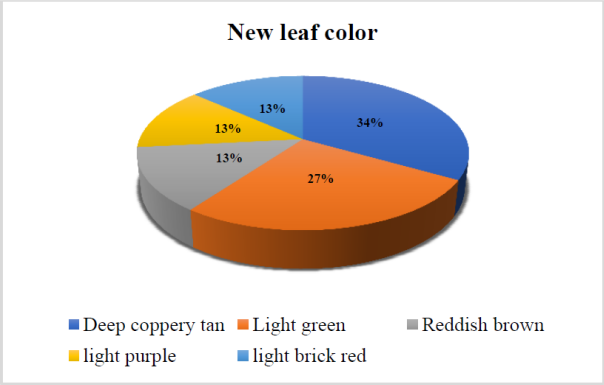

Fig. 3: New leaf color percentage of different Mango varieties

Leaf length (cm)

Significant variation in leaf length among the evaluated mango varieties was observed, as shown in Table 2. Over two years of study, significant variation in leaf length was observed among mango varieties. In the first year, leaf length ranged from 14.03 cm (Kurukkan) to 25.38 cm (Mallika), with Mallika also showing the longest panicle, statistically similar to Dashehari and Langra. In the second year, Mallika again had the longest leaves (24.51 cm), while Kurukkan had the shortest (15.33 cm), statistically comparable to Chhattisgarh Raj and Chhattisgarh Pawan. Pooled analysis showed leaf lengths ranging from 14.68 cm (Kurukkan) to 24.94 cm (Mallika), with Mallika, Dashehari, Langra, Amin and Kishanbhog recording the highest values. Significant differences were noted among varieties, although some varieties like Kurukkan, Chhattisgarh Swarnaprabha, Chhattisgarh Achar and Mallika) were statistically non-significant to each other. The results from the present study are similar with the findings of Toili *et al*. (2014), Bhamini *et al*. (2018), Hussain *et al*. (2023) and Rana (2023) in Mango varieties.

Leaf breadth (cm)

The present study recorded notable differences in leaf breadth across the mango varieties, as detailed in Table 2. Across both years of the study, significant variation was observed in the leaf breadth of mango varieties. In the first year, values ranged from 2.67 cm (Kurukkan) to 5.16 cm (Local Genotype-1), with the widest leaves recorded in Local Genotype-1, Chhattisgarh Swarnaprabha, Mallika, Langra, and Amrapali. Kurukkan consistently showed the narrowest leaf breadth, followed by Amin, Chhattisgarh Achar, and Chhattisgarh Raj. In the second year, leaf breadth ranged from 2.62 cm (Kurukkan) to 5.10 cm (Mallika), which was statistically at par with Chhattisgarh Swarnaprabha and Local Genotype-1. Similar trends were observed with broader leaves in improved varieties and narrower ones in local types like Kurukkan. The Pooled analysis confirmed significant differences among varieties. Chhattisgarh Swarnaprabha recorded the highest leaf breadth (5.10 cm), followed closely by Local Genotype-1 and Mallika, while Kurukkan had the lowest (2.65 cm). Several varieties, including Kurukkan, Chhattisgarh Pawan, and Chhattisgarh Gaurav, showed statistically significant different. The results from the present study are consistent with the findings of Bhamini *et al*. (2018), Sinha *et al*. (2018) and Hussain *et al*. (2023) in Mango varieties.

Leaf Length and breadth ratio

The present study recorded notable differences in leaf length and breadth ratio across the mango varieties, as detailed in Table 2. The leaf length-to-width ratio of mango varieties showed significant variation across both years of the study and in the pooled analysis. In the first year, the ratio ranged from 3.23 in Chhattisgarh Swarnaprabha to 5.90 in Amin. Chhattisgarh Swarnaprabha recorded the lowest ratio, followed by Local Genotype-1 (3.72) and Chhattisgarh Pawan (3.80), while the highest ratio was found in Chhattisgarh Gaurav (5.90), which was statistically at par with Dashehari (5.84). In the second year, the ratio varied from 3.33 (Chhattisgarh Swarnaprabha) to 6.35 (Dashehari), with similarly low ratios in Local Genotype-1 (3.76), Chhattisgarh Raj (4.10), and Chhattisgarh Pawan (4.14). High ratios were observed in Kurukkan (5.85) and Amin (5.80), just below Dashehari. The pooled analysis further confirmed significant differences among varieties, with values ranging from 3.28 (Chhattisgarh Swarnaprabha) to 6.10 (Dashehari). Other high-ranking varieties included Amin (5.85), Kurukkan (5.55), and Kishanbhog (5.30), while lower values were noted in Local Genotype-1 (3.74), Chhattisgarh Pawan (3.97), and Chhattisgarh Raj (4.12). Overall, several varieties exhibited statistically significant differences at the 5% level

throughout the trial. The results from the present study are similar with the findings of Halder *et al*. (2020), Indian *et al*. (2020) and Hussain *et al*. (2023) in Mango varieties.

Petiole Length (cm)

Significant variation in petiole length among the evaluated mango varieties was observed, as shown in Table-2. The petiole length of mango varieties varied significantly across both years of the study. In the first year, petiole length ranged from 2.16 cm (Chhattisgarh Achar) to 3.91 cm (Amrapali). Amrapali had the longest petiole, statistically at par with Kishanbhog and Amin, while the shortest values were recorded in Chhattisgarh Achar, Kurukkan, and Mallika, showing no significant differences among them. In the second year, the trend was similar, with Amrapali (4.01 cm) again showing the longest petiole, followed by Amin, and Chhattisgarh Achar (2.02 cm) having the shortest, along with low values in Chhattisgarh Swarnaprabha, Kurukkan, and Chhattisgarh Gaurav. The pooled data confirmed significant differences among varieties, with Amrapali (3.96 cm) and Amin (3.90 cm) showing the highest values, and Chhattisgarh Achar (2.09 cm) the lowest. Several varieties, including Chhattisgarh Gaurav, Mallika, Langra, and Kishanbhog, showed statistically significant differences in petiole length. The results from the present study are similar with the findings of Toili *et al*. (2014), Bhamini *et al*. (2018), Halder *et al*. (2020) and Hussain *et al*. (2023) in Mango varieties.

Table 2: Variability in leaf length (cm), leaf breadth (cm), leaf length and breadth ratio and petiole length (cm) of different mango varieties during the year 2023-24 and 2024-25.

Varieties	Leaf length (cm)			Leaf breadth (cm)			Leaf length and breadth ratio			Petiole length (cm)		
	2023 -24	2024 -25	Pooled Mean	2023 -24	2024 -25	Pooled Mean	2023 -24	2024 -25	Pooled Mean	2023 -24	2024 -25	Pooled Mean
Chhattisgarh Swarnaprabha	16.65^{c}	16.83^{c}	16.74^{c}	5.15^{hi}	5.05^{i}	5.10^{h}	3.23^{a}	3.33^{a}	3.28^{a}	2.35^{cd}	2.16^{b}	2.26^{b}
Chhattisgarh Pawan	15.6^{b}	16.08^{b}	15.84^{b}	4.1d^{e}	3.88^{cd}	3.99^{d}	3.80^{b}	4.14^{c}	3.97^{c}	3.32^{g}	3.22^{i}	3.27^{i}
Chhattisgarh Achar	17.02^{d}	17.5^{d}	17.26^{d}	3.83^{b}	3.75^{bc}	3.79^{bc}	4.44^{cd}	4.66^{ef}	4.55^{e}	2.16^{a}	2.02^{a}	2.09^{a}
Chhattisgarh Raj	16.3^{c}	15.59^{ab}	15.95^{b}	3.92^{bc}	3.8^{bc}	3.86^{c}	4.15^{c}	4.10^{c}	4.13^{c}	2.45^{d}	2.4^{de}	2.43^{d}
Chhattisgarh Gaurav	19.22^{e}	19.50^{efg}	19.36^{cd}	4.5^{f}	4.41^{f}	4.46^{f}	4.27^{c}	4.42^{d}	4.35^{d}	2.33^{cd}	2.36^{cd}	2.35^{c}
Chhattisgarh Nandiraj	19.31^{e}	19.42^{ef}	19.37^{cd}	4.18^{e}	4.04^{de}	4.11^{e}	4.61^{de}	4.80^{f}	4.71^{f}	2.70^{e}	2.66^{f}	2.68^{f}
Dashehari	23.16^{h}	23.51^{i}	23.34^{g}	3.96^{bcd}	3.70^{b}	3.83^{bc}	5.84^{i}	6.35^{i}	6.10^{k}	3.52^{h}	3.44^{j}	3.48^{j}
Langra	23.06^{h}	23.2^{i}	23.13^{g}	4.98^{gh}	4.88^{gh}	4.93^{g}	4.63f	4.75^{ef}	4.69^{f}	3.11^{f}	3.09^{h}	3.10^{h}
Mallika	25.38^{h}	24.51^{j}	24.95^{h}	5.03^{ghi}	5.1^{i}	5.07^{h}	5.04^{fg}	4.8^{f}	4.92^{g}	2.3^{bc}	2.76^{g}	2.53^{e}
Amrapali	21.66^{f}	21.06^{gh}	21.36^{e}	4.88^{g}	4.8^{g}	4.84^{g}	4.43^{cd}	4.38^{d}	4.41^{d}	3.91^{i}	4.01^{l}	3.96^{l}
Amin	22.42^{g}	21.52^{h}	21.97^{f}	3.8^{b}	3.71^{b}	3.76^{b}	5.90^{i}	5.8^{h}	5.85^{j}	3.83^{i}	3.97^{l}	3.90^{l}
Kurukkan	14.03^{a}	15.33^{a}	14.68^{a}	2.67^{a}	2.62^{a}	2.65^{a}	5.25^{gh}	5.85^{h}	5.55^{i}	2.21^{ab}	2.28^{c}	2.25^{b}
Kishenbhog	22.03^{f}	21.36^{h}	21.70^{ef}	4.12^{de}	4.06^{e}	4.09^{e}	5.34^{h}	5.26^{g}	5.30^{h}	3.88^{i}	3.7^{k}	3.79^{k}
Local Genotype-1	19.2^{e}	18.96^{e}	19.08^{c}	5.16^{i}	5.03^{hi}	5.10^{h}	3.72^{b}	3.76^{b}	3.74^{b}	2.40^{cd}	2.46^{e}	2.43^{d}
Local Genotype-2	19.56^{e}	19.87^{fg}	19.72^{d}	4.08^{cde}	4.29^{f}	4.19^{e}	4.79^{ef}	4.63^{e}	4.71^{f}	2.76^{e}	2.81^{g}	2.79^{g}
	0.06	**0.05**	**0.03**	**0.19**	**0.21**	**0.15**	**0.10**	**0.06**	**0.06**	**0.04**	**0.03**	**0.03**
	0.17	**0.16**	**0.09**	**0.55**	**0.60**	**0.42**	**0.29**	**0.16**	**0.18**	**0.10**	**0.08**	**0.07**

Conclusion

The study revealed notable morphological diversity among fifteen mango (*Mangifera indica* L.) varieties, assessed over two years (2023–24 and 2024–25). Significant variations were observed in leaf traits, including apex shape, base, margin, new and mature leaf color, leaf length, breadth, length-to-width ratio, and petiole length. Most varieties exhibited acuminate apices, obtuse bases, and entire margins, with deep coppery tan as the most common new leaf color and uniformly dark green mature leaves. Quantitative traits highlighted superior vegetative characteristics in varieties such as Mallika, Dashehari, Amrapali, Amin, and Kishanbhog. Conversely, local types like Kurukkan, Chhattisgarh Achar, and Chhattisgarh Pawan displayed smaller leaf and petiole dimensions. These findings underscore the genetic variability present in mango germplasm, offering valuable traits for varietal identification, selection, and breeding. Morphological characterization remains a vital tool for evaluating and conserving genetic diversity, which is essential for future mango improvement and regional adaptability.

References

Anonymous (2006). IPGRI, Descriptors for mango (*Mangifera indica* L.). Inter. Plant Genet. Resources, Rome, Italy; c2006. p. 60.

Bhamini, K., Kumar, A., Jaiswal, U.S., Ahmad, M.F. and Rani, R. (2018). Morphological characterization of mango (*Mangifera indica* L.) germplasm using DUS testing. *Int. J. Curr. Microbiol*., **7**(5): 2944-2959.

Halder, S., Saha, A.K., Ghosh, S. and Hasan, M.A. (2020). Qualitative and quantitative characterization of off-season mango cultivars in some districts of West Bengal. *J Crop Weed.,* **16**(2): 147-154.

Hussain, T., Ishttiaq, M., Zafar, B., Parveen, A., Maqbool, M., & Khan, F. A. (2023). Morphometric characterization of different mango varieties cultivated in tehsil Bernala district Bhimber Azad Kashmir, Pakistan. *Pak. J. Bot*, **55**(5), 1805-1812.

Ibukun, E.O. and Yomi, O.D. (2020). Studies on variation in morphological traits of mango trees (*Mangifera indica* L) growing on Kogi State University Campus, Anyigba, Kogi State, Nigeria. *GSC Biol. Pharm. Sci.,* **11**(01): 113–120.

Indian, G., Naik, E., Deenavarman, M., Jagathesan, K., & Janani, T. (2020). Studies on the growth and flowering behavior of different mango (*Mangifera indica* L.) genotypes. *Int J Curr Microbiol Appl Sci*, **9**(06), 1981-1989.

Kuhn, D.N., Bally, I.S.E., Dillon, N.L., Innes, D., Groh, A.M., Rahaman, J., Ophir, R., Cohen, Y., Sherman, A. (2017). Genetic map of mango. A tool for mango breeding. *Front Pl Sci*., **8**: 577.

Pleguezuelo, C.R.R., Zuazo, V.H.D., Fernández, J.L.M., Tarifa, D.F. (2012). Physico-chemical quality parameters of mango (*Mangifera indica* L.) fruits grown in a mediterranean subtropical climate (SE Spain). *J Agric. Sci.* **14**(8):365-374.

Rai, A. K., Sengupta, S., Kumar, R., Rani, R., Pandey, A. K., Kumari, S., & Singh, G.P. (2023). Morphological characterization of different primary genotypes of mango (*Mangifera indica* L.) in Bihar. *Emergent Life Sciences Research*, **9**, 77-82.

Rana, G., Sharma, G. L., & Sahu, R. L. (2023). Tree Morphological Characterization of Mango Varieties (*Mangifera indica* L.) under Chhattisgarh Plain Condition. *Environment and Ecology*, **41**(2A): 949-952.

Shah, K.A., Patel, M.B., Patel, R.J., & Parmar, P.K. (2010). *Mangifera indica* (mango). *Pharmacognosy reviews*, **4**(7):42.

Sinha, A., Mir, H., Rani, R., & Prasad, B. D. (2018). Studies on floral biology and leaf characteristics of mango hybrids and their parents. *Current Journal of Applied Science and Technology*, **31**(4), 1-6.

Toili, M. E. M., Rimberia, F. K., Nyende, A. B., & Sila, D. (2016). Morphological diversity of mango germplasm from the Upper Athi River region of eastern Kenya: An analysis based on non-fruit descriptors. *African Journal of Food, Agriculture, Nutrition and Development*, **16**(2), 10913-10935.