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Morphology and histology of leaf of M*angifera indica* linn. variety, dasheheri and its taxonomic significance

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Abstract
The present study deals with the morphological and anatomical characters of the different part of leaf (Leaf lamina, Petiole and cuticle) of a variety, Dasheheri of *Mangifera indica* (Mango) collected from Balrampur area in the terai region of Uttar Pradesh. It aims to use their significant characters for species and genus identification. The leaves are simple, deep green, up to 25cm long and 6 cm wide, oblong - elliptic to lanceolate in shape with entire and sometimes undulate margin, acute base and apex and having eucamptodromous type of venation.The anatomical characters observed were the absence of trichomes, collateral closed vascular bundles, uniseriate, barrel shaped epidermal layers, presence of resin canal between parenchymatous cells, anticline wall patterns. Leaf is further characterized by the presence of both adaxial and abaxial epidermis and in between them palisade and spongy parenchymatous cells are arranged. The cuticular cells are slightly thick walled and polygonal in shape. The stomata are hypostomatic confined to lower epidermis and are anomocytic type. The leaf petiole shows large vascular bundles arranged around the medulla.

Keywords: Morphotaxonomy, histology, leaf lamina, petiole, cuticle, *Mangifera indica* Linn., var., dahseheri, anacardiaceae, Balrampur, U.P

Introduction

Mangifera indica Linn. (Mango) is a medium to large evergreen tree belonging to the family Anacardiaceae. It is famous for its important edible fruit as well as commercial timbers in the whole world. The genus *Mangifera* consists of 69 species of tree restricted in their native range to tropical Asia [1]. Wild members of this genus occur in India, Sri Lanka, Bangladesh, Myanmar, Sikkim, Thailand, Cambodia, Vietnam, Laos, southern China, Malaysia, Singapore, Indonesia, Brunei, the Philippines, Papua New Guinea, and the Solomon Islands.The greatest diversity, with approximately 28 species, occurs in western Malaysia, especially in peninsular Malaysia, Borneo, and Sumatra, a region considered to be the center of diversity of this genus [1, 2]. Fifteen species were described in the flora of Malaya [3]. and about 16 species occur in Thailand [4].

On the basis of the historical and general evidence available 'Dasheheri' mango serves its name from a village called *Dusher* (now Dusseheri) between Lucknow and Malihabad, Lucknow [5]. In the beginning some grafts of the cultivar are reported to have been presented by the Nawab to Alamgir Khan of Malihabad who planted these in his garden, which later on become the main source of it distribution in later years. It is also reported in the UP State Gazetteer that as per census 1951, the maximum areas in Malihabad Tehsil were under mango cultivation and the town of Malihabad is famous for the 'Dashehari' cultivar of mangoes.

Due to economic importance of fruits and timbers as well as their distribution range, it has much interest in its characteristic, origin and biogeography. Leaves of the mango plant have been studied so far for the health benefits of both human and animals which are attributed to mainly phytochemicals such as mangiferin, followed by phenolic acids, benzophenones, and other antioxidants namely, flavonoids, ascorbic acid, carotenoids, and tocopherols. The extracts from mango leaves have been studied for their biological activities, including anti-cancer and anti-diabetic etc. Leaf anatomical studies have been proven to be useful for species grouping and identification [6] and it has been of great taxonomic significance [7, 8]. Petiolar anatomy has also been used for interpretation of numerical taxonomic methods [8]. The micromorphological features of cuticles of these fossils are useful in interpreting palaeoecology/ palaeoenvironment of the region. Morphological variability of the epidermal characteristics mainly stomatal complex, number, form and arrangement of subsidiary cells have provided evidences of environmental changes [9]. The morphological and cuticular study of two fossil leaf compressions collected from Middle Siwalik sediments of Arjun Khola, Nepal have been carried out during the identification of fossil leaves with the modern taxa, *Srerculia coccinea* Jack. and *Diospyros toposia* Ham. of the family Sterculiaceae and Ebenaceae respectively [10]. Six fossil leaves possessing cuticle were identified on the basis of the morphological and cuticular features (epidermal cells, stomata structure, stomatal density, stomatal index etc). They have identified with the extant taxa, *Pterospermum acerifolium* Willd. (Sterculiaceae), *Dichapetalum gelonioides* Engl. (Dichapetalaceae), *Paranephelium macrophyllum* King, *P. xestophyllum* (Miq.) King (Sapindaceae), *Gluta renghas* Linn. (Anacardiaceae) and *Mimusops elengi* Linn. of the family Sapotaceae [11]. Recently, [12] enumerated about 68 timber yielding tree plants along with only their superficial features including canopy, height and width of the trees and general feature of trunk bark and leaves etc. Later on, a little attention has also been given by them on the wood anatomy of five variety of commercial wood yielding plant, *M. indica* Linn. of the family Anacardiaceae [13].There is no critical examination on the morphological and anatomical characters of the vegetative part, the leaves. Therefore, the current study will be focused on the detail morphology and histology of leaf

(Leaf lamina, leaf, petiole, leaf veins and leaf cuticle of the *Mangifera indica* variety Dasheheri collected from a mango garden of Balrampur in the terai region of northern Uttar Pradesh. The study also deals with the leaf characters which are taxonomically important for its identification.

Geography of the study area

Balrampur District is one of the administrative districts of Uttar Pradesh with Balrampur city as its district headquarters. It occupies an area of about 3719sq km. lying in the terai region all along Indo- Nepal border. It is surrounded by district Siddharth Nagar and Gonda in the east-west and south sides respectively and Nepal in the northern side containing Siwalik hills of the Himalaya foot hills (Figure 1). Balrampur is known for the temple of Pateshwari Devi, a Shakti Pitha, and for the ruins of the nearby ancient city of Shravasti, now a pilgrimage site for Buddhists and Jains. The nearest airport is Shravasti airport which is about 24km on Balrampur- Bahraich Road.

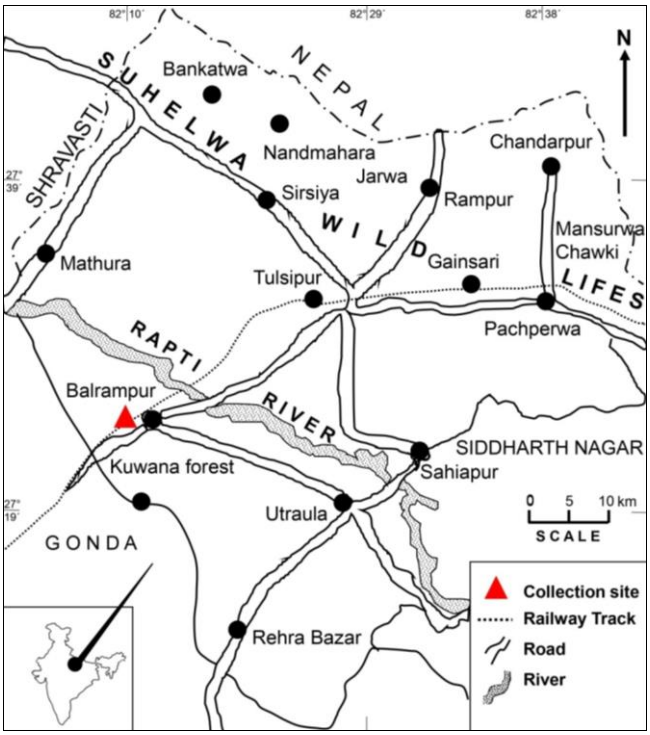

Fig 1: Map of District Balrampur showing the location of collection site of leaves from *Mangifera indica* variety Dasheheri for present study.

It has an average elevation of 106m. All the rivers of Balrampur District flow from north-west to south-east and belong to two main systems that of Rapti in the north and Ghaghara River. They flow from north-west to south-east and are joined by numerous tributaries. These Rivers only overflow their banks in rainy season. Many of these contain water for a part of the year only. But the only one which can be considered as a water stream is that know as the Burhi Rapti which emerges near Mathura in in the north -western part of the area and flow across the district in a direction roughly parallel to that of the Rapti. Kuwana River flows with slow speed. The Suhelwa Wild life forest is situated in the north of Balrampur district between the altitudes of 120m and 200m above the mean sea level and covering the adjoining districts of Balrampur, Shrawasti and Gonda. The most common and commercial tree plant in the forest area is *Shorea robusta* Roth. of the family Dipterocarpaceae. The other common trees found in the forest area of Balrampur are *Tectona grandis* Linn. f. (Lamiaceae), *Adina cordifolia* (Roxb.) Brandis (Rubiaceae), *Mangifera indica* Linn. (Anacardiaceae), *Ehretia laevis* Rottler ex G. Don. (Boraginaceae), *Gmelina arbroea* Roxb.ex Sm. (Lamiaceae), *Ficus* spp. (Moraceae), *Schleichera oleosa* (Laur.) Oken (Sapindaceae), *Dalbergia sissoo* Roxb. (Fabaceae) and *Lagerstroemia* and *Terminalia* spp..

The study area enjoyed as usual with four seasons; the cold season from about the middle of November to February is followed by the summer season from March to the middle of June. The south-west monsoon season is from the middle of June to September. October and first half of November constitutes the post-monsoon or transition season. The hottest month is generally May with the mean maximum temperature of 39°C and the mean minimum temperature of 24° C having comparatively greater humidity.

Material and method

The study material (extant leaves) for present study have been taken from the tree of the of *Mangifera indica* Linn. variety, Dasheheri growing in the Mango field of Dr. J. S. Chauhan, near Neel Kothi (27.432881° N:82.168622°E) in Balrampur district of Uttar Pradesh. The height of each tree is measured with the help of measuring tape from base as ground level to the apex of the tree and expressed in a meter which is up to 30 meters. The trunk girth was measured as average of 2.25m. The leaf samples for its morphological and anatomical study have been taken from the twig of the matured stem. The morphological feature of the leaf has been studied with the help of hand lens or low power microscope. For the description of leaf characterizations, the terminology given by Prof. Hickey and Prof. Dilcher has been used [14, 15]. Photographs were taken from the personal mobile camera. To study the anatomy of leaf, petiole, fruit and seed, their thin section has been cut as usual process and gone through the dehydration, staining and mounting process for the preparation of thin slides. These slides were studied under high power microscope and described them in detail. Their photography has been carried out with the help of microscopic camera attached to the high power microscope. The cuticle study of the leaf has been carried out with the help of maceration technique by using HNO_3 and H_2o_2 using for dissolving the mesophyll part of the leaf. Their slides were prepared also through usual process of dehydration, staining and mounting. Epidermal cell frequency, epidermal cell size, stomatal architecture and their size, stomatal frequency, stomatal indices were observed under high power microscope. The stomatal index of different fossil leaves was calculated by the following expression [9]. Stomatal Index (S I) = S/ (E+S) x 100; S= Number of stomata in a unit area; E= Number of epidermal cells in the same unit area. All the prepared slides were kept at Department of Botany, M. L. K. College, Balrampur, U. P.

Observations

A critical study on the morphology of leaf and its prepared slides of leaf lamina, leaf petiole and leaf cuticle of *Mangifera indica* Linn. variety Dasheheri has been carried out. Both the external and internal characters exhibited by them are observed and described separately in details. The

Dasheheri mango tree is an evergreen tree of varying size and shape. It has a deep taproot and profuse surface roots with a stout trunk having an round umbrella-shaped crown. Leaves are alternately arranged, usually lanceolate, and leathery in texture. The immature leaves are pinkish amber or pale green in colour and becoming dark green at mature stages.

Leaf morphology of *M. Indica* Linn. Variety Dasheheri

Leaves simple, symmetrical, oblong - elliptic to lanceolate, average size varies from 15-20cm in length and 4.5-5.5 cm in width; apex acute; base acute; margin entire to undulate; texture thick coriaceous; petiole small to long, 1.5-3cm long, lowest part of petiole is thick; venation pinnate, eucamptodromous; primary vein (1°) single, stout, straight, thicker toward basal region; secondary veins (2°) moderate, 20-22 pairs, 0.5-1.5cm apart, alternate to rarely opposite, sometimes branched, angle of divergence 45°- 65°, narrow to moderate acute, uniformly curved up and running a little of upwards and join to super adjacent secondary at obtuse angle; inter-secondary veins present, composite, frequent, sometimes join to secondary veins; Intra-secondary veins absent; tertiary veins (3°) moderate, with angle of divergence usually RR, percurrent, straight to sinuous, branched, sometimes curved near the midrib, oblique in relation of midvein, predominantly alternate and close; areoles well developed, consist of 3°, 4° and 5° order veins, containing free ending vein lets (Fig.2A-C; Fig. 3A,B).

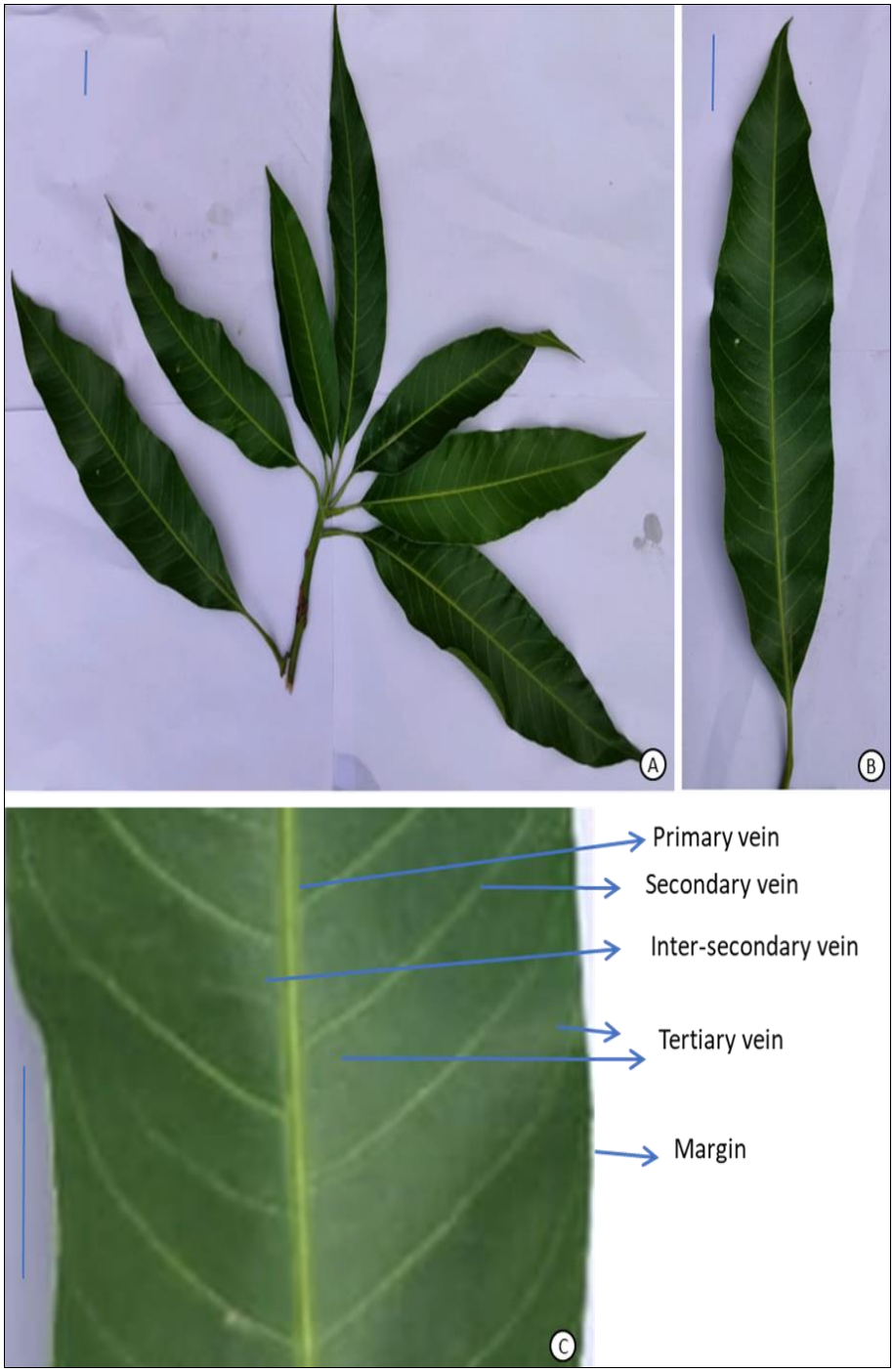

Fig 2: A. Twig having the leaves of *M. indica* Linn. variety Dasheheri showing its arrangement and variation in shape and size **B**. Single leaf showing shape, size nature of base, apex and margin and the venation pattern. **C**. a part of leaf magnified to show the details of venation pattern.

Histology of Leaf of *M. indica* Linn. variety Dasheheri

The prepared slides of the Cross section of the leaf lamina has been studied under high power microscope which revealed that it is consists of three parts, epidermis, mesophyll and vascular region**.** The cuticle is also one of its parts attached to the uppermost part of lamina**.** The epidermis is present on the both upper and lower surface of lamina as one celled thick layers made up of barrel shaped, compactly placed cells. The lower epidermis contains stomata. The mesophyll is differentiated into palisade and spongy parenchyma cells. Palisade parenchyma situated just inner to the upper epidermis, and composed of two layers of elongated cells containing generally chloroplasts. Sometimes the palisade parenchyma cells are arranged distantly making small to big intercellular spaces. Parenchymatous cells are found both above and below the v ascular bundles and looking as the extensions of the bundle sheath. Spongy parenchyma region is comes just below the palisade and extends towards the lower epidermis. Spongy parenchyma cells are loosely arranged like palisade parenchyma and also filled with chloroplasts. The intercellular spaces are present among them. The remaining part of lamina where vascular bundles are scattered is known as vascular region. The vascular bundles are conjoint, collateral and closed type composed of both metaxylem and protoxylem. They are surrounded by a layer of parenchymatous cells called bundle sheath. The xylem is present towards the upper epidermis. Protoxylem is present towards upper epidermis while the metaxylem towards the lower epidermis. The phloem is situated towards the lower epidermis Fig. 3 D, E).

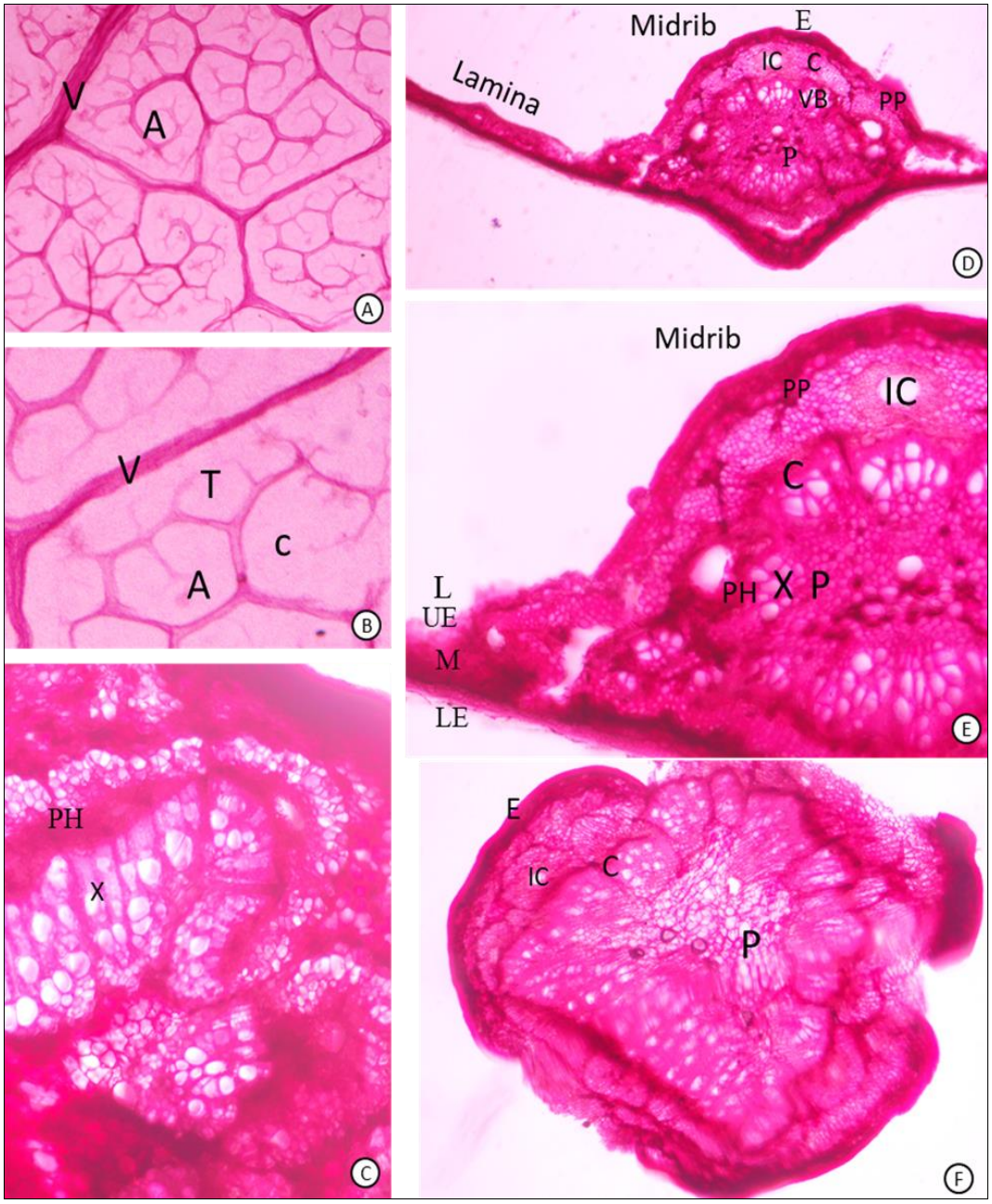

Fig 3: Histology of *Mangifera indica* Linn variety Dusheheri. **A,B.** Leaf lamina showing nature of veins and areoles with free vein lets. A- areole, t –vein lets, C- cellular structures, V -vein, **D, E.** T.S. of leaf lamina through the midvein. L- lamina, UE -upper epidermis, LE- lower epidermis, M,- mesophyll, PP – palisade parenchyma, C- Cortex, PH-phloem, X- Xylem, E – Epidermis, IC- intercellular canals, P- pith. **C, F.** T. S. of petiole of leaf showing its internal structures. E. –Epidermis, C- Cortex, IC- intercellular canals, PH- Phloem, X- Xylem, P- Pith.

Histology of Petiole of *M. indica* Linn. variety Dasheheri

The petiole is the stalk that connects the leaf blade (lamina) to the stem or branch of a plant. In the case of the Dasheheri mango (*Mangifera indica* Linn.), the anatomy of the leaf petiole is similar to that of most dicotyledonous plants also including other mango varieties. Here is an overview of the anatomy of leaf petiole of Dasheheri mango. The cross section of present petiole showed that it is divisible into epidermis, cortex and vascular and pith regions. The outer surface is not circular but oval in shape having 2-3 notches. on the surface. The epidermis is the outermost layer of cells covering the petiole. It provides protection and helps to regulate the water loss. The epidermis may have small pores called stomata, especially on the lower surface, for gas exchange and transpiration control. Beneath the epidermis lies the cortex, which consists of several layers of parenchymatous and collenchymatous cells. Parenchymatous cells are found throughout the cortex and are useful in various functions like storage and support. The Collenchymatous cells are elongated and provide support to the petiole. They are mostly lying just below the epidermis and provide the petiole flexibility and support. In the vascular region the vascular bundles are distributed as clusters of specialized tissues that transport water, nutrients, and sugars between the leaf and the rest of the plant. In the petiole, these vascular bundles form a circular outline and consist of both xylem and phloem. Surrounding the vascular bundles, there is a layer of specialized cells called bundle sheath cells that provide protection to the vascular tissue (Fig. 3C, F).

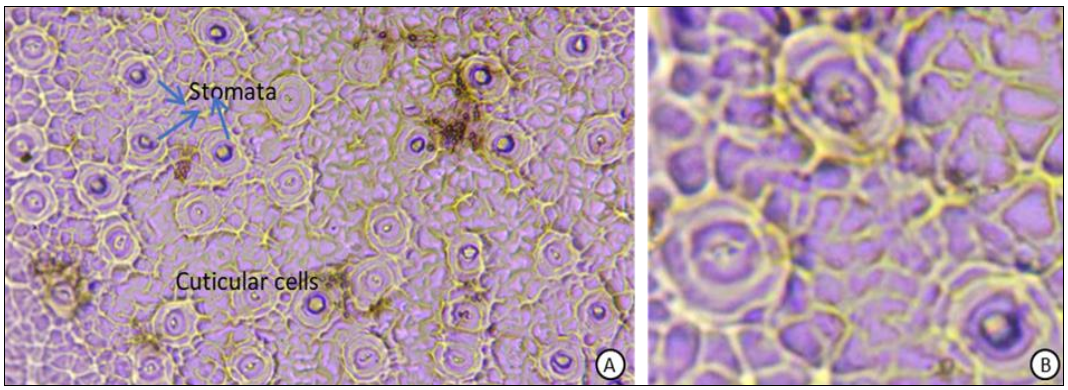

Fig 4: Histology of cuticle of *M. indica* Linn. variety Dasheheri. **A.** Part of cuticle showing the shape, size and distribution of cuticular cells and stomata. **B**. A part of cuticle magnified to show the characteristics of the stomata, cuticular cells and cell walls.

Histology of culicle of *M. indica* Linn. variety Dasheheri

Cuticle thin, the cells are usually rectangular to polygonal with straight to sometimes sinuous walls, thick walled, almost evenly distributed, sometimes the thickness on the cell wall is more prominent, average cell size 22 x12 µm, epidermal cell frequency 1050 per sq mm, stomata were observed in the lower foliar surface, distributed randomly, anomocytic, 18x16µm, subsidiary cells were irregular in shape, 40 µm in length and 15 µm in width, stomatal frequency about 30 per sq mm and stomatal index is 2.77 (Fig. 4A, B).

Result and discussion

Mangifera indica Linn. (Mango) is an evergreen tree belonging to dicot family, Anacardiaceae. It is native to tropical Asia and has been cultivated in the whole Indian subcontinent for over 4000 years and is also found naturalized in most tropical countries. In order to extend the existing information, the morphological and histological study on the vegetative structures of *Mangifera indica* was developed, using high power microscope for the characterization at the tissue level. The leaves are variable in shape and size but usually are oblong with tips varying from rounded to acuminate. Leaf form differs among varieties but is more consistent within a variety. Leaves are usually lanceolate type having acute base and apex, entire, slightly undulated margins totally devoid of division or striking ripples. The angle of divergence of the secondary veins towards the midrib proved to be acute ranging from 45 º to 60º. However in some cases the secondary veins arises from midrib towards the basal region at nearly right angle. The secondary veins showed a sharp curvature when reaching to margin and joined to its upper secondary veins and making eucamptdromous type of venation pattern.

Leaf lamina of *Mangifera indica*, Linn. variety Dasheheri exhibits mesophyll clearly divisible into palisade and spongy parenchyma. The palisade parenchyma cells are located in two layers, elongated aspect, and some segments with appreciable small intercellular spaces, whereas, the spongy parenchyma cells are located up to the abaxial epidermis, and are having rounded to irregular morphology, with small to big intercellular species. The number of intercellular spaces in the leaves of Safeda and Bombay mango is greater than in Dasheheri mango. In relation to the xylem and phloem morphological attributes, the observations made to the leaf petioles of *Mangifera indica* Linn. variety, Dasheheri showed larger vascular bundles as compared to varieties, Safeda, Langra and Chaunsa and arranged similarly around the medulla in a collateral way and significantly closed. The outline of cross section of petiole varies from species to species. It may be circular or semi-circular and sometimes it is boat shaped. Generally, *Mangifera* Linn. are possessing circular outline with a little variation in the nature of outer surface [16]. According to him the ring-shaped bundle sheaths is one of the diagnostic characters for this genus. Similarly the size of vascular bundle in this genus varies from small (0.8-1.25 mm) to large (2.5-3 mm). Thus, the petiole continues to be one of the most important sources of taxonomic evidence in the field of systematic botany at both generic and specific level. It has been observed that the stomata are located exclusively on the lower face or the opposite side of the leaf lamina of studied variety of *Mangifera indica* Linn. and the type of stomata found is of anomocytic type. The result showed that

the taxonomic implication of above mentioned anatomical characters when used in combination are quite useful in the identification of different varieties/ species of the genus *Mangifera* Linn..

Conclusion

The morphological and anatomical study of the different part of leaf (Leaf lamina, Petiole and cuticle) of a variety, Dasheheri of *Mangifera indica* have been carried out in details.

The leaves are simple, deep green, up to 25cm long and 6 cm wide, oblong - elliptic to lanceolate in shape with entire and sometimes undulate margin, acute base and apex and having eucamptodromous type of venation, angle of divergence of secondary veins varies from acute to right angle

Several significant characters such as outline of petiole in cross section and its vascular bundles, shape size and nature of intercellular spaces, thickness of cuticle, shape and size of cuticular cells, and its number/ square mm, number of stomata and stomatal index of the dasheheri variety of *Mangifera indica* Linn. were investigated and compares with its other variety like, safeda, Langra, Chaunsa, and Bombay mango.

Most of the anatomical characters are evaluated and found to be significant in differentiating the other varieties of *Mangifera indic*a Linn.

The shape of the petiole in Cross section of almost all the varieties is circular. In Dasheheri variety the outline is circular but there is small extension at few places on the surface.

The intercellular spaces in leaf lamina and petiole of Dasheheri variety are fewer and smaller than Safeda and Bombay mango varieties.

The vascular bundles are larger in the variety of Bombay mango and Safeda as compared to Dasheheri.

Acknowledgments

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References

1. Bompard JM, Schnell RJ. Taxonomy and systematics. In: Litz RE, editor. The mango: botany, production and uses. Wallingford: CAB International, 1997, 21-47.
2. Lemmens RHMJ, Soerianegara I, Wong WC. Plant resources of South-East Asia No. 5, part 2. Timber trees: minor commercial timbers. Leiden: Backhuys Publishers, 1995.
3. Kochummen KM. Anacardiaceae. In: Forest Research Institute of Malaysia, editor. Tree flora of Malaya,1989:4:9-57.
4. Chayamarit K. Preliminary checklist of the family Anacardiaceae in Thailand. Thai Forest Bulletin (Botany),1994:22:1-25.
5. Gangolly SR, Ranjit Singh, Katyal SL, Daljit Singh. The mango. New Delhi: Indian Council of Agricultural Research, 1957, 530.
6. Metcalfe CR, Chalk L. Anatomy of the dicotyledons. Oxford: Clarendon Press,1950:1(2):1500.
7. Dehgan B. Comparative anatomy of the petiole and infra-generic relationships in *Jatropha* (Euphorbiaceae). Am J Bot,1982:69:1283-95.
8. Ogundipe OT. Leaf anatomical studies on eleven species of *Zanthoxylum* Linn (Rutaceae). Phytomorphology,2002:52:103-12.
9. Salisbury EJ. On the cause of ecological significance of stomatal frequency with special reference to woodland flora. Philos Trans Roy Soc Lond,1928:216:1-65.
10. Prasad M, Khare EG. Cuticular studies on the fossil leaves from Churia (Siwalik) sediments of Arjun Khola sequence, western Nepal. Palaeobotanist,2004:53:105-12.
11. Prasad M, Khare EG, Kannaujia AK, Alok. Cuticle bearing fossil leaves from Mio-Pliocene sediments in the Sub-Himalayan zone and its phytogeographical and palaeoenvironmental implications. J Environ Biol,2013:34:863-75.
12. Ranjan R, Srivastava D, Prasad M. Commercial timber yielding plants from Balrampur District, Uttar Pradesh, India. Geophytology,2013:54(1):107-18.
13. Ranjan R, Pandey R, Khatoon A, Prasad M. Anatomy of wood (timber) of *Mangifera indica* Linn. from Balrampur district in the Terai region of Uttar Pradesh and its origin and diversification. Plant Archives, 2024.
14. Hickey LJ. Classification of the architecture of dicotyledonous leaves. Am J Bot,1973:60:17-33.
15. Dilcher DL. Approaches to the identification of angiospermous leaf remains. Bot Rev,1974:40:1-157.
16. Mohd Norfaizal G, Latiff A. Leaf anatomical characteristics of *Bouea*, *Mangifera* and *Spondias* (Anacardiaceae) in Malaysia. AIP Conf Proc,2013:1571:394-403. doi:10.1063/1.4858690.