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RESEARCH ARTICLE

# Development and Documentation of DUS Traits for *Melia dubia* Cav. Genetic Resources

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*Melia dubia* Cav. is a fast-growing, multi-purpose tree suitable for various wood-based industries. Several tree improvement programmes have been undertaken within the country and Tamil Nadu Agricultural University has played a significant role in varietal development of this species. In order to protect the genetic resources through the existing legal mechanism, there is a need to develop DUS traits for each germplasm. Under such criteria, attempts were made to characterize and document DUS traits for *Melia dubia* genetic resources which involved 30 improved genotypes. As of now, there is no systematic documentation of DUS traits. The present study deployed 30 *Melia dubia* genotypes and identified DUS traits for bark, branch and leaf characters. The DUS characterization was carried out by studying the morphological characters such as bark colour and texture, branch angle, leaf apex and base shape, leaf margin and leaf rachis colour as qualitative parameters. The lenticel characters like size, diameter, density and leaf characters like length and breadth are assessed as quantitative parameters. The study exhibited significant variations among the melia genotypes for various DUS traits

**Key Words: *Melia dubia* –DUS Traits –Morphological characters–Bark, Branch, Leaf, Lenticel**

## Introduction

*Melia dubia* Cav. is an economically and industrially important fast-growing multipurpose tree distributed naturally in India, Sri Lanka, Malaysia, Bhutan, Burma, Australia and Africa. It is commonly known as Malabar neem and is a member of the family Meliaceae. It is a large, deciduous, perennial tree attaining height of 6 to 30 metres. Leaves are shed during (December-January) and new leaves appear in February-March followed by flowering. Fruit is a drupe, pulpy and yellowish on ripening with a sweet smell. Fruit ripens in winter season (October-February), with seeds enclosed in a stony endocarp.

*Melia dubia* with its multi-purpose uses like pulpwood, timber, fuel wood and plywood can be a suitable species for agro- and farm-forestry plantation programme. The wood is also used for making packing cases, ceiling planks, agricultural implements, pencils, match boxes, splints, furniture and also for building purposes. It is a good fuel wood and fodder yielding tree. It is also planted as an ornamental in avenues and also as shade tree in plantations. It grows rapidly and hence used as a fast-growing industrial agro-forestry species (Parthiban and Seenivasan, 2017).

In recent years, the species is becoming popular in plantation forestry in India due to its fast growth, coppicing ability and adaptability to variety of soil conditions. Large scale plantations of *Melia dubia* have been raised by the farmers, state forest departments and private entrepreneurs. Many tree improvement programmes are under way to develop varieties suitable for varied industrial utility. The species exhibits wide variability which needs to be documented in order to protect the Intellectual Property Rights (IPR) generated on this species. To distinguish the variety of this species, it is important to develop the descriptors so that these descriptors can be utilized as a reference and through this, protection of *Melia* variety can be achieved.

Protection of Plant Varieties and Farmers' Right Authority (PPV&FRA) insists on characterization and registration of extant, farmers and new varieties as a part of national and botanical asset. In order to implement the *sui generis* system for plant variety protection for granting Plant Breeder's Right (PBR) to a breeder or

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farmer or institution, DUS (Distinctiveness, Uniformity and Stability) testing is compulsory (PPV&FRA, 2001). A new variety shall be registered if it conforms to the criteria of novelty, distinctness, uniformity and stability and an extant variety, a variety about which there is a common knowledge shall also be registered within a specified period if it conforms such criteria as distinctness, uniformity and stability as shall be specified (Shobha *et al*., 2006). The grant of PBR under this Act entitles the breeder/his successor, agent, licensee to exclude others from producing, offering for sale, marketing, distributing, export or import of propagating material of the protected varieties for a period of 15 years for annuals and 18 years for vines and trees. The act provides all researchers the rights to use a protected variety as an initial source for creating another variety without prior approval of holder of PBR, provided that such use does not involve repeated use of the protected variety as a parental line or multiplication of its propagating material for commercial nature (Raghuvanshi *et al.,* 2014). Under such circumstances, it was planned to develop DUS traits for *Melia dubia* genetic resources in order to protect them through PPV&FRA.

## Materials and Methods

The present study was conducted at the six-year-old progeny of *M. dubia* evaluation trial established at Forest College and Research Institute, Mettupalayam (11º19' N; 76º56' E; 300 MSL) developed in an evaluation trial. The experimental site experienced an annual rainfall of 922 mm. The mean maximum and minimum temperature of the location was 32.2 ºC and 23.2 ºC respectively. The soil is red sandy loam with pH 7.5.

The material for the present study consisted of 20 progenies of seed origin and within them 30 superior individual performers were selected based on growth and yield attributes amenable for varied industrial utility. These superior trees were felled and the bark, lenticels, branching and leaf characters were recorded and documented.

From the felled stumps, the coppice shoots were collected and rooted using apical shoot based clonal technology (Parthiban, 2017) and the trees multiplied through this technology are termed as clones. The clones were established in the clonal nursery in Randomized Block Design (RBD) at a spacing of 1.5m × 1.5m. Observations were taken for two years. The leaf characterization was done using lowermost leaves of the clones developed and the results are presented.

### Data Collection and Analysis

Data was collected on morphological (both quantitative and qualitative) characters using character descriptors. The type of assessment of characteristics is followed as per the standard method prescribed by UPOV (International Union for the Protection of New Varieties of Plants) (1989):

- MG: Measurement by a single observation of a group of plants or parts of plants.
- MS: Measurement of a number of individual plants or parts of plants.
- VG: Visual assessment by a single observation of a group of plants or parts of plants.
- VS: Visual assessment by observation of number of individual plants or parts of plants

### *Descriptors*

The requirement of distinctiveness, uniformity and stability were assessed on the basis of descriptors. The descriptors (a feature of whole plant or part of plant) were developed based on the phenotypic assessment of 30 *Melia dubia* genotypes. The observed and measured properties determined in the DUS testing procedure for a new variety shall be qualitative and quantitative.

The selection was made on phenotypic assessment of a character with distinctiveness *viz.,* bark, branch and leaf. A total 30 genotypes were focused for DUS characterization using morphological descriptors. The steps involved and the list of characters chosen for descriptor development are as follows:

i. Identification and screening of characters with distinctness based on the existing tree information followed by examination of screened characters for its uniformity and stability.

ii. Examination of specific time *i.e.* the time at which the most relevant characters can be assessed.

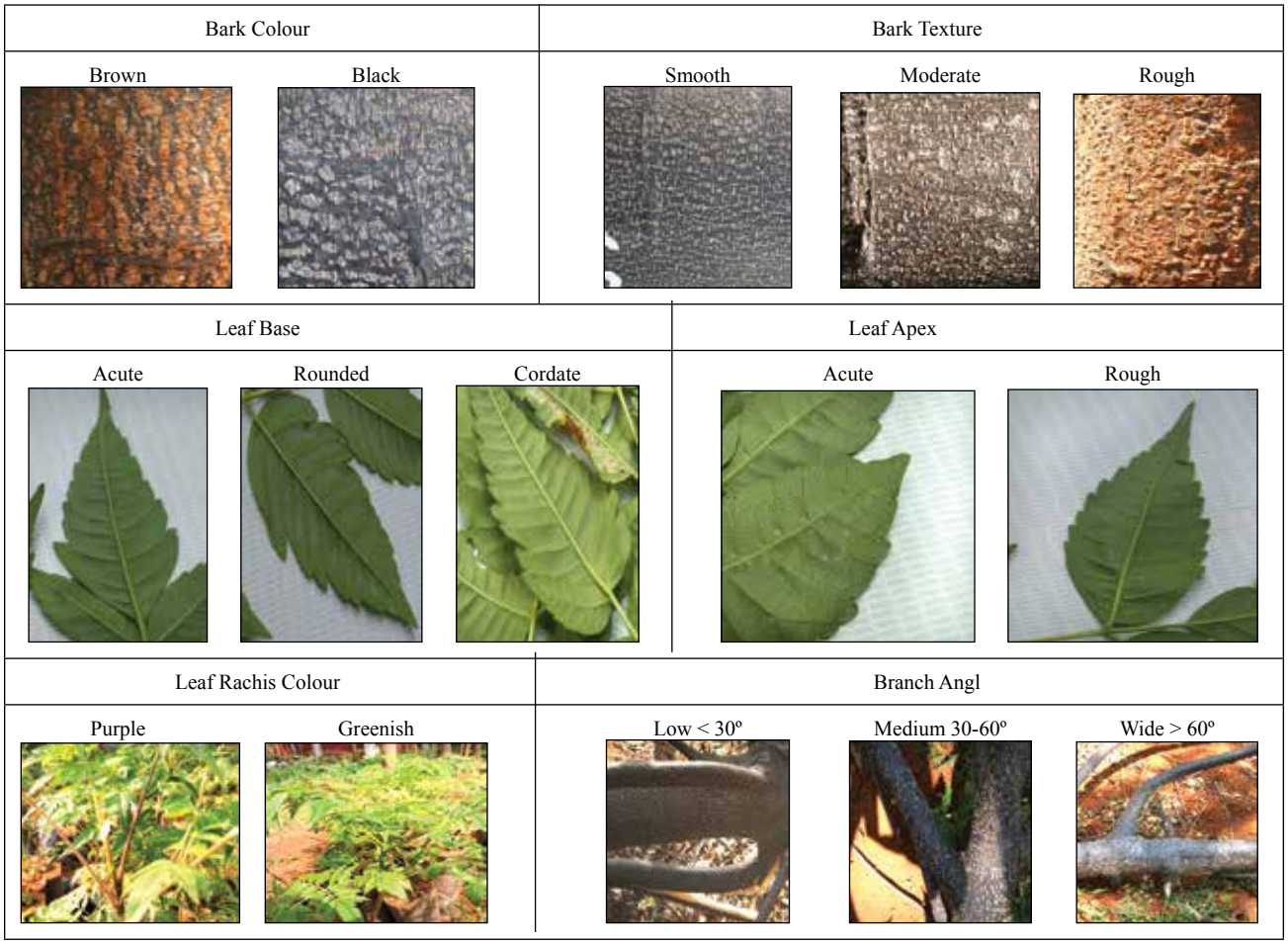
iii. Photographic documentation of visually assessed characters namely bark colour and texture, lenticel, branching pattern, leaf apex shape, leaf base shape, leaf serration and leaf rachis colour were done on site.

iv. Measurable characters *viz.,* leaf length, leaf breadth, lenticel size and lenticels density were assessed.

## Qualitative Descriptors

Qualitative descriptors are those that are expressed in discontinuous state. These states are self-explanatory and independently meaningful. All states are necessary to describe the full range of the characteristics and every form of expression can be described by a single state. The qualitative descriptors studied and the classifications followed are furnished in Table 1.

**Table 1. Qualitative Descriptors**




## Quantitative Descriptors

Quantitative descriptors are those where the expression covers the full range of variation from one extreme to other. The expression can be recorded on a one-dimensional, continuous or discrete and linear scale. The range of expression is divided into a number of states for the purpose of description. The division seeks to provide, as far as possible, an even distribution across the scale and the same is furnished in Table 2.

**Table 2. Quantitative Descriptors**

| S. No. | Character | State | Scale |
|---|---|---|---|
| 1. | Lenticel size | Small | 1-3mm |
| | | Medium | 3-6mm |
| | | Large | >6mm |
| 2. | Lenticel no./density | Low | <30 / 10cm$^2$ |
| | | Medium | 31-45 / 10cm$^2$ |
| | | High | >45 / 10cm$^2$ |
| 3. | Lenticel diameter | Small | < 5 mm |
| | | Medium | 5 – 7 mm |
| | | Large | > 7mm |
| 4. | Leaf length | Short | < 30 cm |
| | | Medium | 30 – 50 cm |
| | | Long | > 50 cm |
| 5. | Leaf breadth | Short | < 20 cm |
| | | Intermediate | 20 – 30 cm |
| | | Wide | > 30 cm |

### *Pseudo-Qualitative Characteristics*

In case, the range of expression is at least partly continuous, but varies in more than one dimension and cannot be adequately described by just defining two

ends of a linear range, such characters are expressed in range. In a similar way the qualitative characteristics needs to be identified and to be adequately described the range of the characteristics (Table 1).

## Results

### *DUS Traits for Bark Characteristics*

The *Melia dubia* genetic resources exhibited two distinct bark colour *viz*., brown and black. The texture of bark exhibited three different types viz., smooth, moderate and rough. Based on bark colour and texture, the data characterized and tabulated are given in Table 3.

The stem of the *Melia dubia* genotype has been characterized based on the size and frequency of lenticels which provide a direct exchange of gases between internal plant tissue and atmosphere. Accordingly, the genetic resources have been grouped under three types based on lenticels type as small (1–3 mm), medium (3–6 mm) and large (above 6 mm). Through this characterization, the genetic resources MD 42 has been characterized under small, four genetic resources *viz*., MD 39, MD 40, MD 43 and MD 44 under medium type and the remaining resources under large category. Lenticels diameter exhibit variations among the genetic resources, they are grouped into Small (<5mm), Medium (5-7mm), Large (>7mm). Through this characterization the genetic resources MD 42 and MD 43 are grouped in to small, seven genetic resources *viz*. MD 2, MD 12, MD 14, MD 15, MD 25, MD 32 and MD 46 under large and remaining resources are in medium category (Table 3).

Lenticels help in transpiration and lenticular transpiration occurs when stomata closes. Thus, it helps to prevent the plant parts from heating up. The frequency of lenticels differed significantly among the genotypes. In 10cm$^2$ area, the number of lenticels varied among the genetic resources and are grouped in to Low (30 and less), Medium (31-45) and High (>45). With this characterization four genetic resources MD 12, MD 19, MD 26 and MD 29 are grouped in to low, five genetic resource *viz*. MD 2, MD 13, MD 15, MD 39 and MD 42 grouped in to high and the remaining are grouped in to Medium category. The lenticels diameter, frequency and the size expressed significant scope for confirming the DUS traits towards protection for IPR (Table 3).

**Table 3. Characterization of DUS traits through bark characters**

| S.No. | Characteristics | State | Example source | Type of assessment |
|---|---|---|---|---|
| 1 | Bark colour | Brown | MD 1, MD 3, MD 4, MD 7, MD 12, MD 14, MD 15, MD 17, MD 23, MD 24, MD 26, MD 29, MD 32, MD 34, MD 39, MD 46 | VS |
| | | Black | MD 2, MD 5, MD 6, MD 11, MD 13, MD 19, MD 21, MD 22, MD 25, MD 30, MD 40, MD 42, MD 43, MD 44) | |
| 2 | Bark smoothness | Smooth | MD 3, MD 6, MD 7, MD 12, MD 19 | VS |
| | | Moderate | MD 1, MD 5, MD 11, MD 13, MD 14, MD 15, MD 17, MD 21, MD 22, MD 23, MD 24, MD 25, MD 29, MD 30, MD 39, MD 42, MD 43, MD 44, MD 46 | |
| | | Rough | MD 2, MD 4, MD 26, MD 32, MD 34, MD 40 | |
| 3 | Lenticel size | Small (1-3 mm) | MD 42 | MS |
| | | Medium (3-6 mm) | MD 39, MD 40, MD 43, MD 44 | |
| | | Large (above 6 mm) | MD 1, MD 2, MD 3, MD 4, MD 5, MD 6, MD 7, MD 11, MD 12, MD 13, MD 14, MD 15, MD 17, MD 19, MD 21, MD 22, MD 23, MD 24, MD 25, MD 26, MD 29, MD 30, MD 32, MD 34, MD 46 | |
| 4 | Lenticel diameter | Small (<5mm) | MD 42, MD 43 | MS |
| | | Medium (5-7mm) | MD 1, MD 3, MD 4, MD 5, MD 6, MD 7, MD 11, MD 13, MD 17, MD 19, MD 21, MD 22, MD 23, MD 24, MD 26, MD 29, MD 30, MD 34, MD 39, MD 40, MD 44) | |
| | | Large (>7mm) | MD 2, MD 12, MD 14, MD 15, MD 25, MD 32, MD 46 | |
| 5 | Lenticel no. (density) | Low (30 and less) | MD 12, MD 19, MD 26, MD 29 | MS |
| | | Medium (31-45) | MD 1, MD 3, MD 4, MD 5, MD 6, MD 7, MD 11, MD 14, MD 17, MD 21, MD 22, MD 23, MD 24, MD 25, MD 30, MD 32, MD 34, MD 40, MD 43, MD 44, MD 46 | |
| | | High (>45) | MD 2, MD 13, MD 15, MD 39, MD 42 | |

### *DUS Traits for Branch Characteristics*

*Melia dubia* genetic resources expressed different branching patterns. They are characterized into three types based on the angle of branch *viz*., narrow (< 30°), intermediate (30-60°) and wide (>60°). Predominantly 16 genetic resources registered intermediate angle of branching whereas six genetic resources *viz.,* MD 6, MD 11, MD 13, MD 15, MD 29 and MD 31 registered wide angle of branching (Table 4).

### Leaf Characteristics

*Melia dubia* leaves exhibited three different leaf base shapes *viz.,* acute, round and cordate. Among all, acute and round shapes are commonly occurring in the genetic resources. Cordate shape was observed in MD 5, MD 29 and MD 30. Leaf margin found to be serrate in all the 30 genetic resources. Apex shapes of the leaves were either acuminate or acute. The predominant apex shape was acuminate. Two genetic resource *viz.,* MD 22 and MD 29 showed acute shape at the apex (Table 5).

Leaf length was characterized into three categories *viz*., Short (<30 cm), Medium (30-50cm) and Long (> 50 cm). Two genetic resources *viz.,* MD 2 and MD 19 registered short type. Other resources registered medium (14 resources) as well as long type (14 resources). Leaf breadth was characterized to three types *viz*., Short (<20 cm), Intermediate (20-30 cm) and Wide (>30 cm). Three genetic resource *viz*., MD 2, MD 4 and MD 19 registered short leaf breadth whereas remaining falls under Intermediate (16 resources) and wide type (11 resources) (Table 5).

The *Melia dubia* genetic resources have also been characterized for leaf rachis colour which exhibited two major colours *viz.,* purple and green. 11 genetic resources *viz.,* MD 01, MD 02, MD 03, MD 06, MD 17, MD 29, MD 30, MD 32, MD 34, MD 39 and MD 46 recorded purple colour rachis and the remaining genetic resources expressed green colour leaf rachis which indicated the presence of significant variability in the genetic resources and extend greater scope for DUS trait registration towards IPR protection (Table 5).

## Discussion

The principal objective of PVP & FRA 2001, is to stimulate both private and public investment in the plant breeding research and enhance the interest of plant breeders as well farmers or farmer's community in the development of outstanding varieties, by granting protections rights to plant variety. Considering this, the morphological traits were evaluated as per DUS guidelines, expressed variability within the *Melia dubia* genetic resources.

Bark has numerous functions during the lifespan of the plant, while it also changes with age. The outer bark is very diverse and can take characteristic shape in some species. Bark of *Melia dubia* showed variations in colour as well as in texture. Colour of the bark characterized into brown and black whereas bark texture is characterized into smooth, moderately smooth and rough. A similar type of description for stem colour *viz.,* light green, green, light grey, and grey have been reported in jatropha by George *et al.* (2016) and skin texture of *Solanum tuberosum* in to very rough, rough, intermediate, smooth and very smooth (Arslanoglu *et al*., 2011). Jaskani *et al*. (2006) reported a similar study where the branch angle of three citrus rootstocks was found to have wide angle. Similarly, George *et al.* (2016) reported branch angle variations in the jatropha which extend support for the current DUS trait characterization in *Melia dubia.*

Leaf apex and leaf base shows predominant variations in *Melia dubia*. Leaf margin found to be serrate in all genetic resource. It is parallel with the study by Jaskani *et al.* (2006) where leaf lamina shape was lanceolate and ovate in sweet orange and yuma citrange, respectively.

**Table 4. DUS traits for branch characterization**

| S. No. | Characteristics | State | Example source | Type of Assessment |
|---|---|---|---|---|
| 1 | Branching angle | <30º Narrow | MD 2, MD 3, MD 4, MD 22, MD 24, MD 39, MD 42, MD 43 | VS |
| | | 30º-60º intermediate | MD 1, MD 5, MD 7, MD 12, MD 14, MD 17, MD 19, MD 21, MD 23, MD 25, MD 26, MD 29, MD 32, MD 40, MD 44, MD 46 | |
| | | >60º Wide | MD 6, MD 11, MD 13, MD 15, MD 30, MD 34 | |

**Table 5. DUS Trait through Leaf Characters**

| S.No. | Characteristics | State | Example source | Type of Assessment |
|---|---|---|---|---|
| 1 | Leaf base shape | Acute | MD 1, MD 2, MD 3, MD 5, MD 11, MD 12, MD 15, MD 17, MD 19, MD 21, MD 22, MD 24, MD 42, MD 46 | VG |
| | | Rounded | MD 4, MD 7, MD 13, MD 14, MD 23, MD 25, MD 26, MD 32, MD 34, MD 39, MD 40, MD 43, MD 44 | |
| | | Cordate | MD 6, MD 29, MD 30 | |
| 2 | Leaf margin | Serrate | MD 1, MD 2, MD 3, MD 4, MD 5, MD 6, MD 7, MD 11, MD 12, MD 13, MD 14, MD 15, MD 17, MD 19, MD 21, MD 22, MD 23, MD 24, MD 25, MD 26, MD 29, MD 30, MD 32, MD 34, MD 39, MD 40, MD 42, MD 43, MD 44, MD 46 | VG |
| 3 | Leaf apex shape | Acuminate | MD 1, MD 2, MD 3, MD 4, MD 5, MD 6, MD 7, MD 11, MD 12, MD 13, MD 14, MD 15, MD 17, MD 19, MD 21, MD 23, MD 24, MD 25, MD 26, MD 30, MD 32, MD 34, MD 39, MD 40, MD 42, MD 43, MD 44, MD 46 | VG |
| | | Acute | MD 22, MD 29 | |
| 4 | Leaf length | Short (<30 cm) | MD 2, MD 19 | MG |
| | | Medium (30-50cm) | MD 1, MD 4, MD 5, MD 7, MD 12, MD 17, MD 22, MD 23, MD 24, MD 29, MD 30, MD 32, MD 39, MD 43 | |
| | | Long (>50 cm) | MD 3, MD 6, MD 11, MD 13, MD 14, MD 15, MD 21, MD 25, MD 26, MD 34, MD 40, MD 42, MD 44, MD 46 | |
| 5 | Leaf breadth | Short (<20 cm) | MD 2, MD 4, MD 19 | MG |
| | | Intermediate (20-30cm) | MD 1, MD 5, MD 7, MD 11, MD 12, MD 13, MD 17, MD 22, MD 23, MD 24, MD 26, MD 30, MD 32, MD 39, MD 43, MD 46 | |
| | | Wide (>30 cm) | MD 3, MD 6, MD 14, MD 15, MD 21, MD 25, MD 29, MD 34, MD 40, MD 42, MD 44 | |
| 6 | Leaf rachis colour | Purple | MD 1, MD 2, MD 3, MD 6, MD 17, MD 29, MD 30, MD 32, MD 34, MD 39, MD 46 | VG |
| | | Green | MD 4, MD 5, MD 7, MD 11, MD 12, MD 13, MD 14, MD 15, MD 19, MD 21, MD 22, MD 23, MD 24, MD 25, MD 26, MD 40, MD 42, MD 43, MD 44 | |

The sour orange and yuma citrange showed sinuate leaf lamina margin. Leaflet size and bristle number have frequently been used as descriptors of *Arachis pintoi* cultivars. The variability in bristle number in the different plant structures as well as in leaflet size permits the use of these traits in cultivar development (Argel and Villarreal, 1998). Leaves of sweet cherry, duke cherry and sour cherry were characterized into obovate elliptic, acuminate to elliptic acuminate. Leaf margin of sweet cherry was crenate serrated and with glandular teeth (Perez *et al.*, 2010). Leaf length and breadth also showed considerable variation in *Melia* genetic resource. Similar kind of variations were reported in neem (Gnanasekar *et al.,* 2014) and jatropha (George *et al.,* 2016). Leaf rachis colour variation might be due to the hereditary or geographical variations.

All the genetic resources have shown morphological differences which could be attributed to several factors including hereditary, differences in geographical and ecological adaptation to sites. A similar report has been observed in cashew, where variability was observed in nut, kernel characteristics and other traits (Felix *et al.,* 2009).

## Conclusion

An attempt was made to identify and document DUS traits in *Melia dubia* based on morphological characters by developing DUS descriptors. Descriptors were developed based on the guidelines that are envisaged in PPV and FRA Act 2001. Accordingly, in the present study major focus was given to develop descriptors for bark, branch and leaf characters. Twelve DUS descriptors were developed for *Melia dubia* after selecting the 30 superior genetic resources. Among the 12 descriptors, five were quantitative (Lenticel size, Lenticel diameter, Lenticel no., Leaf length, Leaf breadth) and seven

were qualitative characters (Bark colour, Bark texture, Branch angle, Leaf apex shape, Leaf base shape, Leaf margin and Leaf rachis colour). Among the quantitative characters three were developed for bark character and two were developed for leaf characters. Whereas among the qualitative character two were developed for bark character, one was developed for branch and four for leaf characters. The DUS traits identified and documented in this manuscript will help the breeders and farmers to protect their variety developed in *Melia dubia* by deploying suitable traits.

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