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Distinctness, Uniformity and Stability (DUS) Characterization of Neolamarckia Cadamba Genetic Resources

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Abstract

Neolamarckia cadamba (Kadam) genetic resources were characterised Distinctness, Uniformity and Stability (DUS) traits based on International Union for the Protection of New Varieties of Plants [12] guidelines. Twenty-five clones of kadam were characterised based on the morphological characters of leaf and bark with 12 descriptors. Among these 12 descriptors, 9 were qualitative traits *viz.,* leaf shape, Leaf base shape, apex shape, leaf margin, leaf venation, base symmetry, Waxiness in upper side of leaf, bark colour and bark texture and 3 were quantitative characters *viz.,* leaf length, leaf breath, leaf petiole length. The study exhibited significant variations among the genetic resources investigated for various DUS traits, which could act as reference traits for developing variety to protect the genetic resources through Intellectual Property Rights.

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Introduction

Neolamarckia cadamba Miq., (Family-Rubiaceae) commonly called as Kadam is one of the best sources of raw material for plywood industry, besides pulp and paper production. Its leaves and barks have medical applications while dried barks can be used to relieve fever and as a tonic. The leaf extract can serve as a mouthwash. Other than medical applications, its leaves have also used as fodder to cattle.[1] The leaf area, pruning frequency, moisture content and nutritional characters of this species outreached it as an excellent fodder tree, which used to meet the green, dry and concentrate feed utility. Such a multiple utility tree reached only little research attention. Hence, Forest College and Research Institute, Mettupalayam has undertaken the improvement program through progeny and clonal tests.

DUS testing is useful for identification of varieties, registration of varieties and plant variety protection (PVP) Act, for varietal information system and classification of varieties into different groups, and for genetic resources.[2] The exhibited variation in the established genetic resources needs to preserve for protection of IPR (Intellectual Property Rights) genetics in the species.

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Materials and Methods

Clonal evaluation trial of *Neolamarckia cadamba* was established at Forest College and Research Institute, Mettupalayam from the best performing trees of *Neolamarckia cadamba*. The clonal evaluation trial comprises twenty-five clones and these clones were subjected to DUS characterization for the characters *viz.,* leaf shape, base shape, apex shape, leaf margin, leaf venation, base symmetry, leaf length in cm, leaf breath in cm, leaf petiole length in cm, Waxiness in upper side of Leaf, bark colour and bark texture and observations were recorded as per UPOV.[12]

Descriptors

Descriptors are developed based on the morphlogical assessment of Twenty-five *Neolamarckia cadamba* genetic resources for DUS characterization. The selection made on phenotypic assessment of character with distinctiveness for bark and leaf. Descriptors developed for qualitative (QL) and quantitative characteristics (QN) as per the procedure followed by Sivakumar *et al.,*[10].

Results and Discussion

Twenty-five *Neolamarckia cadamba* clones characterized for DUS traits in order to protect the genetic resources through possible IPR mechanism. Accordingly, the clones characterized for bark and leaf attributes, are presented in table 3 & 4. Considerable variation was recorded among the kadam genetic resources for the following characters *viz.,* leaf shape, leaf base shape, apex shape, leaf length, leaf petiole length, Waxiness in upper side of leaf, bark colour and bark texture.

Table 1: Leaf DUS characterization of *Neolamarckia cadamba*

Sl. No.	Characteristics	State	Distribution classes of descriptor	Source	Type of assessment
1	Leaf shape	Elliptic	18 (72%)	MTPAC 01, MTPAC 02, MTPAC 03, MTPAC 04, MTPAC 05, MTPAC 09, MTPAC 10, MTPAC 11, MTPAC 13, MTPAC 14, MTPAC 15, MTPAC 17, MTPAC 18, MTPAC 21, MTPAC 22, MTPAC 23 MTPAC 24, MTPAC 25	VG
		Ovate	2 (8%)	MTPAC 07, MTPAC 08	
		Broadly ovate	3 (12%)	MTPAC 06, MTPAC 12, MTPAC 19	
		Nearly round	2 (8%)	MTPAC 16, MTPAC 20	
2	Leaf base shape	Cordate	19 (76%)	MTPAC 01, MTPAC 02, MTPAC 03, MTPAC 04, MTPAC 05, MTPAC 10, MTPAC 11, MTPAC 13, MTPAC 14, MTPAC 15, MTPAC 16, MTPAC 17, MTPAC 18, MTPAC 20, MTPAC 21, MTPAC 22, MTPAC 23, MTPAC 24, MTPAC 25	VG
		Obtuse	5 (20%)	MTPAC 06, MTPAC 07, MTPAC 08, MTPAC 12, MTPAC 19	
		Acute	1 (4%)	MTPAC 09	
3	Leaf apex shape	Cuspidate	6 (24%)	MTPAC 09, MTPAC 10, MTPAC 16, MTPAC 18, MTPAC 21, MTPAC 24	VG
		Acuminate	9 (36%)	MTPAC 03, MTPAC 04, MTPAC 05, MTPAC 06, MTPAC 08, MTPAC 11, MTPAC 13, MTPAC 14, MTPAC 22	
		Apiculate	5 (20%)	MTPAC 02, MTPAC 17, MTPAC 19, MTPAC 22, MTPAC 25,	
		Acute	3 (12%)	MTPAC 01, MTPAC 07, MTPAC 12	
		Obtuse	2 (8%)	MTPAC 15, MTPAC 20	
4	Leaf length	Short (< 12 cm)	3 (12%)	MTPAC 08, MTPAC 09, MTPAC 12	MG

		Medium (12 – 21 cm)	4 (16%)	MTPAC 05, MTPAC 10, MTPAC 16, MTPAC 19	
		Long (> 21 cm)	18 (72%)	MTPAC 01, MTPAC 02, MTPAC 03, MTPAC 04, MTPAC 06, MTPAC 07, MTPAC 11, MTPAC 13, MTPAC 14, MTPAC 15, MTPAC 17, MTPAC 18, MTPAC 20, MTPAC 21, MTPAC 22, MTPAC 23, MTPAC 24, MTPAC 25,	
5	Leaf petiole length	Short (< 2cm)	2 (8%)	MTPAC 05, MTPAC 20	MG
		Intermediate (2-3 cm)	5 (20%)	MTPAC 04, MTPAC 09, MTPAC 10, MTPAC 19, MTPAC 24	
		Wide (> 3 cm)	18 (72%)	MTPAC 01, MTPAC 02, MTPAC 03, MTPAC 06, MTPAC 07, MTPAC 08, MTPAC 11, MTPAC 12, MTPAC 13, 18, MTPAC 21, MTPAC 22, MTPAC 23, MTPAC 25,	
6	Leaf waxiness in upper side	Absent or weak	10 (40%)	MTPAC 03, MTPAC 04, MTPAC 05, MTPAC 11, MTPAC 12, MTPAC 13, MTPAC 18, MTPAC 21, MTPAC 23, MTPAC 24	VG
		Medium	3 (12%)	MTPAC 06, MTPAC 07, MTPAC 08	
		Strong	12 (48%)	MTPAC 01, MTPAC 02, MTPAC 09, MTPAC 10, MTPAC 14, MTPAC 15, MTPAC 16, MTPAC 17, MTPAC 19, MTPAC 20, MTPAC 22, MTPAC 25	

Table 2: Bark DUS characterization of *Neolamarckia cadamba*

Sl. No.	Characteristics	State	Distribution of classes of descriptor	Example source	Type of assessment
1	Bark colour	Brown	4 (16%)	MTPAC 16, MTPAC 19, MTPAC 22, MTPAC 23,	VG
		Light Brown	11 (40%)	MTPAC 01, MTPAC 02, MTPAC 03, MTPAC 04, MTPAC 05, MTPAC 06, MTPAC 07, MTPAC 11, MTPAC 14, MTPAC 17, MTPAC 24	
		Black	10 (44%)	MTPAC 08, MTPAC 09, MTPAC 10, MTPAC 12, MTPAC 13, MTPAC 15, MTPAC 18, MTPAC 20, MTPAC 21, MTPAC 25	
2	Bark texture	Smooth	14 (56%)	MTPAC 01, MTPAC 02, MTPAC 03, MTPAC 06, MTPAC 07, MTPAC 11, MTPAC 12, MTPAC 13, MTPAC 14, MTPAC 15, MTPAC 16, MTPAC 17, MTPAC 19, MTPAC 24	VG
		Moderate	8 (32%)	MTPAC 04, MTPAC 05, MTPAC 08, MTPAC 09, MTPAC 10, MTPAC 20, MTPAC 21, MTPAC 22,	
		Rough	3 (12%)	MTPAC 18, MTPAC 23, MTPAC 25	

Leaf Characterization

Leaf Shape

The leaves of kadam exhibited four different shapes *viz.,* elliptic, ovate, broadly ovate and nearly round (Fig. 1). Elliptic shape was predominantly reported and showed predominance of 72% occurrence in the *Neolamarckia cadamba* genetic resources. Broadly ovate shape of leaves was found in three clones *viz.* MTPAC 06, MTPAC 12, MTPAC 19, which contributed to 12% of occurrence. Nearly round shape of leaves found in MTPAC 16, MTPAC 20. The elliptic character showed predominance with 72% occurrence in the *Neolamarckia cadamba* genetic resources followed by broadly ovate (12%), ovate (8%) and nearly ovate (8%). Similar variation observed by Hare Krishna *et al.,*[5]in *Ziziphus mauritian*a. It showed three types of leaf shape *viz.,* ovate, cordate and oval in Ber. The study showed similar variation in leaf shape as recorded in Eucalyptus[10] and Neem.[9]

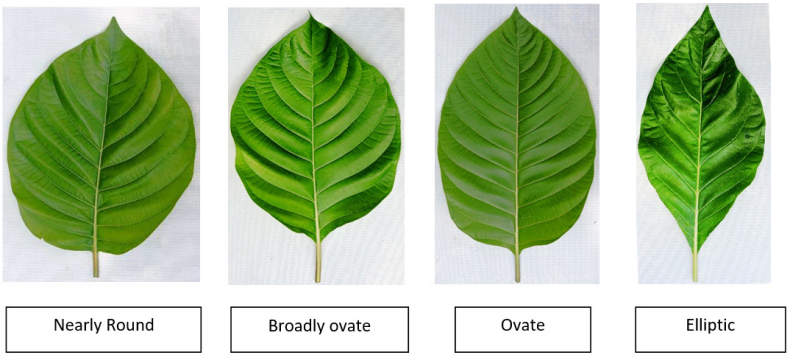

Fig. 1: Leaf shape

Leaf Base Shape

The Base shape of Kadam leaf sample recorded three categories *viz.,* cordate, obtuse and acute (Fig. 2). MTPAC 09 registered acute leaf base. Five clones *viz.,* MTPAC 06, MTPAC 07, MTPAC 08, MTPAC 12 and MTPAC 19 recorded obtuse leaf base and the remaining clones recorded cordate leaf base. In Base shape, cordate was predominantly found (76%) in kadam genetic resources followed by obtuse (20%) and acute (4%). These variations authenticated by the study on *Ziziphus mauritiana*[5] and Eucalyptus.[10]

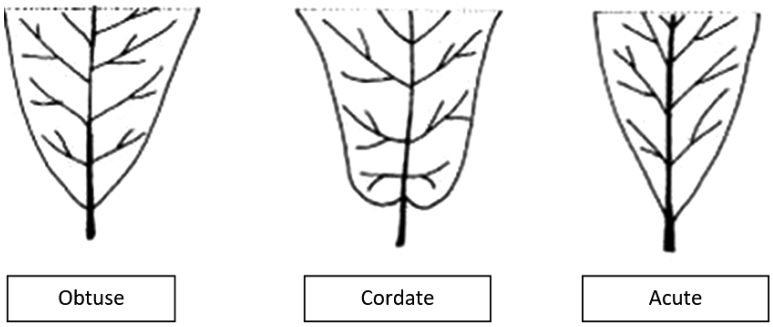

Fig. 2. Base shape

Leaf Apex

Apex shape of leaf in *Neolamarckia cadamba* clones represent five different shapes *viz.,* Acute, Acuminate, Apiculate, cuspidate and Obtuse (Fig. 3). Among the five different shapes, occurrence of acuminate (36%) and cuspidate (24%) was given major contribution while considering kadam genetic resources. Similar results recorded in *Ziziphus*

mauritiana[5] and Eucalyptus.[10] Leaf margin, leaf venation and base symmetry are same across the clones having undulate, pinnate and bilateral symmetry, respectively (Fig. 4,5,6).

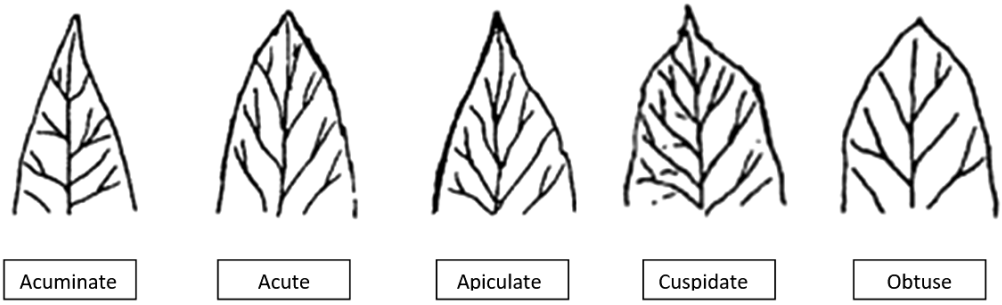

Fig. 3: Apex shape

Fig. 4: Leaf margin

Fig. 5: Leaf venation

Fig. 6: Base symmetry

Leaf Length and Width

Leaf length was categorized into three *viz.,* Short (< 12 cm), Medium (12-21cm) and Long (> 21 cm). Three clones *viz.,* MTPAC 08, MTPAC 09 and MTPAC 12 recorded short leaf length, four clones *viz.*, MTPAC 05, MTPAC 10, MTPAC 16 and MTPAC 19 recorded medium leaf length, and the remaining clones registered long leaf length. Among the three distinctive characters of leaf length, maximum kadam genetic resources recorded long leaf length (72%) followed by medium (16%) and short (12%). Similar variation reported in Neem[9] Leaf breadth was same across the clones, which comes under the category of wide (> 4 cm).

The study conducted by George *et al.,*[4] showed that leaf length varies from 12.5 cm (HC 27) to 7.6 cm (HC 19) among the 27 back cross clones of *Jatropha curcas*. These results are at par with the current study.

Leaf Petiole Length

Leaf petiole length of kadam is categorized into three *viz.* short (< 2 cm), intermediate (2-3 cm) and wide (> 3 cm). MTPAC 05 and MTPAC 20 recorded the short leaf petiole length. Five clones *viz.,* MTPAC 04, MTPAC 09, MTPAC 10, MTPAC 19 and MTPAC 24 recorded intermediate leaf petiole length and the remaining clones showed wide leaf petiole length. Wide petiole length (72%) was recorded in maximum number of *Neolamarckia cadamba* genetic resources showed followed by intermediate petiole length (20%) and Short petiole length (2%). George *et.al.,*s[4] showed variation in leaf petiole length ranged from 12.1cm (HC 12) to 4.5cm (HC 16) among the 27 back cross clones of *Jatropha curcas*, which is

Fig. 7. Bark colour

Fig. 8: Bark texture

at par with current results. Similar variations were reported in Neem.[9]

Waxiness in Upper Side of Leaf

Waxiness in upper side of the leaves was categorized into weak (or) absent, medium and strong. Three clones *viz.,* MTPAC 06, MTPAC 07 and MTPAC 08 recorded Medium waxiness in the upper side of the leaf. Among the *Neolamarckia cadamba* genetic resources, 48% genetic resources showed strong leaf waxiness in upper side of the leaves followed by 40 % (Weak or absent) and 12 % (Medium).

Study conducted by Gnanasekar and Bala subramanian[9] shows significant variations in leaf length and width, rachis length, petiole length within the type in Neem. Similar findings were reported in Teak,[6] Eucalyptus,[3] Sandal[1] and Jamun.[8]

Bark Characterization

Bark Color

Bark colour of the Neolamarckia cadamba categorized into brown, Light brown and black (Fig. 7). Four clones *viz.,* MTPAC 16, MTPAC 19, MTPAC 22 and MTPAC 23 exhibited brown bark colour and Ten clones *viz.,* MTPAC 8, MTPAC 9, MTPAC 10, MTPAC 12, MTPAC 13, MTPAC 15, MTPAC 18, MTPAC 20, MTPAC 21 and MTPAC 25 recorded black bark colour. The remaining clones showed light brown bark colour. Among the kadam genetic resources, 44% of genetic resources with black bark colour followed by light brown (40%) and brown (16%).

Bark Texture

Bark texture grouped in to smooth, moderate and rough (Fig. 8). Three clones *viz.,* MTPAC 18, MTPAC

23 and MTPAC 25 recorded rough bark texture and eight clones *viz.,* MTPAC 4, MTPAC 5, MTPAC 8, MTPAC 9, MTPAC 10, MTPAC 20, MTPAC 21 and MTPAC 22 exhibited moderate bark texture. The remaining clones recorded smooth bark texture. Among the kadam genetic resources, 56% of clones registered smooth bark followed by 32% (medium) and 12% (rough).

Similar descriptor study showing significant genotypic variations in bark texture, annual peeling type, colour of fresh bark, colour of dried bark and colour of rhytidome bark characters were studied in casuarina[7] and Eucalyptus.[10]

Conclusion

Neolamarckia cadamba genetic resources were characterised for DUS traits based on UPOV[11] guidelines. Twenty-five clones of kadam were characterised based on the morphological characters of leaf and bark. In leaf, four distinct leaf shapes were recorded *viz.,* elliptic, ovate, broadly ovate and nearly round. Two clones *viz.,* MTPAC 16 and MTPAC 20 showed nearly round shape of leaf. In leaf base shape, three base shapes were recorded and higher variation was recorded for the leaf apex shape. Obtuse leaf apex shape registered lower frequency (8%) among the kadam genetic resources. Leaf margin, leaf venation and base symmetry are same across the clones. Leaf length has showed considerable variation among the clone, which grouped into three categories *viz.,* short, medium and long. Leaf width has not revealed any variation among clones. Leaf petiole length is categorized into three *viz.,* short, Intermediate and wide. MTPAC 05 and MTPAC 20 were showed short petiole length. Higher variation was registered due to waxiness on the upper side of the leaf. Bark colour is categorised into brown, light brown and black. In bark texture, three characters were recorded *viz.,* smooth, moderate and rough. Three clones (MTPAC 18, MTPAC 23 and MTPAC 25) are showed rough bark texture. The clones depicted wide variability for various morphological traits, which is used for conservation of germplasm through IPR mechanism.

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