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Clonal Evaluation of *Neolamarckia cadamba* at Different Growth Periods

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ABSTRACT

Neolamarckia cadamba is a fast growing multipurpose indigenous tree. It has the potential in the fodder contribution of agroforestry component. Owing to its importance, the performance of twenty-five genetic resources were analyzed for growth attributes and Leaf attributes. The growth attributes include basal diameter, height, number of Branches and the leaf traits includes leaf length, leaf width, leaf petiole length, total number of leaves, leaf area. While considering the growth and leaf attributes, three clones viz., AC 15, AC 17 and AC 16 proved its superiority at the periodic intervals of 3 MAP and 6 MAP. It can be further utilized for future improvement program in Neolamarckia cadamba genetic resources based on the growth and leaf characters.

Key words: *Neolamarckia cadamba, Clonal variation, Growth attributes, Leaf traits, Leaf area*

INTRODUCTION

Agroforestry has been playing critical role since time immemorial to meet the demands of wood and food production. However, with the economic development coupled with the associated urbanisation and industrialization the demand for wood and wood products has increased rapidly but there is no concomitant plantation development programme.

The forest in the country has been legally closed and there is a shift in forest management from production to conservation oriented approach. The enactment of forest conservation act and the subsequent enunciation of National Forest Policy, 1988 have recognised forest more towards conservation than timber production. This has resulted, decline in domestic wood production and necessitated massive imports. The reduced wood supply and the increased demand for wood products has ushered in a total mismatch between demand and supply.

Similarly, the demand for fodder production in the country is increasing at an alarming rate. The country has recorded the deficit of 61% green fodder, 21% Dry fodder and 64% concentrate feeds which creates threat to the animal husbandry[2]. Animal husbandry is not only a viable livelihood system but also a self-sustaining activity in different parts of the country. It also acts as a source of income and employment generation activity. However, animal husbandry is critically threatened due to shortage of green and dry fodder. Against the above backdrop there is a need to increase the productivity of wood and feed through organised agroforestry systems.

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Currently the agroforestry promotional activity in the country is depended primarily on few exotics like Casuarina, Eucalyptus and Populus. These species have their own limitations and they cannot meet the multifunctional demands of the society.

Under such circumstances there is a need to identify and promote fast growing indigenous and multipurpose tree species amenable for agroforestry system. The National Agroforestry Policy, 2014 also directed similar approach of promotion of multipurpose tree species to meet the multifarious demands of the society. Among various indigenous species, the significance of *Neolamarckia cadamba* is very important due to its fast growing nature with multiple utility coupled with organised tree architecture compatible for various agroforestry systems. However, such a multiple utility species gained little research attention towards its improvement through clonal plantations. Hence, the study was carried out to evaluate the growth performance of *Neolamarckia cadamba* genetic resources.

MATERIAL AND METHODS

Thirty open pollinated genetic resources of *Neolamarckia cadamaba* were collected from 11 natural ranges distributed in India includes Tamil Nadu, Assam, Bihar, Nagaland, Uttarkhand, Telangana, Uttar Pradesh, Maharastra, Karnataka, Kerala and Tripura. The seedlings were raised and systematic progeny test was carried out during 2013. Twenty five plus trees were selected based on comparison tree method[8]. These trees were felled, coppice shoots were induced and multiplied through mini clonal technology[7] and were designated as clones.

These clones were evaluated through clonal test in a Row Column design at an esplacement of 2m X 2m. The clones were evaluated for various growth attributes *viz.*, basal diameter, height, number of Branches, leaf length, leaf width, leaf petiole length, total number of leaves, leaf area at 3 Months After Planting and 6 Months after planting (MAP).

I. Growth attributes

Growth Attributes includes Basal Diameter, Plant Height and Number of branches.

1. Plant height

Plant Height is measures with the use of scale in the initial period and later on altimeter were used for the height measurement.

2. Basal diameter

Basal diameter is measured with the use of digital caliper in the basal portion of the tree

3. Number of branches

Number of branches was calculated by manual counting of branches in the tree

II. Leaf attributes

Leaf Attributes includes, Leaf length, Leaf Width, Leaf petiole length, Total number of Leaves and leaf area. For the measurement of leaf Length, leaf width, leaf petiole length and Leaf area, fifth leaf from tip of the tree is chosen.

1. Leaf length

Leaf length was measured from lamina tip to the point of intersection of the lamina and the petiole, along the midrib of the lamina[13]

Leaf length was measured from lamina tip to the point of

intersection of the lamina and the petiole, along the

midrib of the lamina

2. Leaf width

Leaf width was measured from end-to-end between the widest lobes of the lamina perpendicular to the lamina mid-rib[13]

3. Leaf petiole length

The petiole connects the leaf blade to the stem. Measure the petiole in centimeters from the base of the leaf blade (or lowest leaflet in compound leaf) to the point of attachment to the stem. This value can be zero if there is no petiole.

4. Total number of leaves

Total number of leaves includes the leaves in the main stem as well as branches

5. Leaf area

Leaf area is calculated by the graphical method[13]

RESULTS AND DISCUSSION

I. Growth attributes

1. Plant height

Height growth attributes significantly differs among the 25 clones of *Neolamarckia cadamba*. It ranged from 0.20 m to 1.01m at 3 MAP. Maximum height was recorded by AC 15 (1.01 m) followed by AC 16 (0.84 m). At 6 MAP, height growth ranged between 2.66 m and 0.43 m. Higher plant height was recorded by AC 17 (2.66 m) followed by AC 15 (2.62 m). Lowest was registered by AC 20 (0.43 m).

2. Basal diameter

Basal Diameter has significantly differed among the twenty-five clones. The maximum basal diameter was recorded by AC 15 (21.68 mm) followed by AC 16 (20.93 mm) and AC 18 (19.58 mm) at 3 MAP. The least was registered by AC 24 (6.43 mm). At 6 MAP, Higher basal diameter was recorded by AC 17 (43.76 mm) and Least was recorded by AC 20 (7.52 mm).

3. No. of branches

At 3 MAP, Number of branches was ranged from 6.00 to 0.00. The maximum number of branches was observed by AC 18 (6.00) followed by AC 15 (4.67). At 6 MAP, number of branches varied between 4.00 and 0.67.

In the purview of growth attributes, three clones *viz.*, AC 17, AC 15 and AC 16 have registered higher values. The variation among the genetic resources at 3 MAP and 6 MAP was irrational due to its early stage of growth. Similar kind of variations were observed by Tharakan *et al.*[14] who found statistically significant differences between clones of *Populus* and *Salix* for height, diameter, growth, leaf area and biomass production. Highly significant differences in mean tree height, basal diameter and volume observed between parental species of poplar and hybrids by Ceulemans *et al.* [1] which lends support to the current study.

Similar genetic variation for height and diameter under field conditions in poplar clones have been reported by singh *et al.*[12] and Sindhu and Dhillon[11]. Significant differences were observed in Plant height, Diameter at breast height, volume index and bole straightness in the clones of Salix. Highly significant differences among *Populus nigra* clones for diameter and height[5] and volume index in *Populus deltoids* hybrids[4,6] and old plants have been reported. Similarly, Tunctanar [15] evaluated 53 willow clones in Turkey and found that clones of *Salix excelsa* were better in growth performance that even poplar check clone which supports the current study.

II. Leaf attributes

Among the leaf attributes, leaf Width, leaf length, leaf Petiole length and Total number of leaves were recorded and presented in Table 3.

1. Leaf length

Leaf length significantly differs among the 25 clones. At 3 MAP, Highest was recorded in AC 15 (47.17 cm) followed by AC 18 (43.20 cm). Lowest leaf length was registered by AC 24 (4.83 cm). At 6 MAP, Higher leaf length was recorded by AC 14 (45.03 cm) followed by AC 15 (44.50 cm) and AC 16 (42.90 cm). Least was recorded by AC 20 (19.50 cm)**.**

2. Leaf width

Leaf width was ranged between 32.57 cm (AC 15) and 2.83 cm (AC 24). Higher leaf width was recorded b AC 15 (32.57 cm) followed by AC 25 (27.53 cm) at 3 MAP. At 6 MAP, it was ranged between 29.90 cm and 12.60 cm.

3. Leaf petiole length

Leaf petiole length also significantly differed among the twenty-five clones of *Neolamarckia cadamba* at 5% significance level. It ranged between 9.38 cm (AC 8) and 3.31 cm (AC 20). The higher leaf petiole length was recorded in AC 8 (9.38 cm) followed by AC 7 (9.27 cm) and AC 16 (9.10 cm) at 3 MAP. At 6 MAP, Higher leaf petiole length was recorded by AC 7 (9.17 cm) followed by AC 8 (8.87 cm). least was recorded by AC 20 (3.67 cm).

4. Total number of leaves

Total number of leaves was ranged between 34.67 and 7.33. This trait has significantly differed among the 25 clones at 5% significance level. Maximum Total number of leaves is recorded in AC 18 (34.67) followed by AC 15 (29.33), AC 23 (24.67), AC 25 (22.67), AC (21.00) and AC 17 (20.00) were recorded higher total number of leaves at 3 MAP and The least was recorded in AC 5

(7.33). At 6 MAP, Higher total number of leaves was recorded by AC 23 (29.00) and Least was registered by AC 5 (8.67).

5. Leaf area

While considering Leaf area, AC 15 (0.1257 m^2) has recorded higher leaf area followed by AC 25 (0.0936 m^2), AC 18 (0.0860 m^2) a 3 MAP. The lowest Leaf area was recorded in the clone AC 5 (0.0010 m^2). At 6 MAP, higher leaf area was registered in AC 14 (0.1101 m^2) followed by AC 15 (0.1079 m^2) and Least was recorded by AC 20 (0.0215 m^2).

Overall performance considering the leaf attributes, only one *viz.*, AC 15 proved its superiority over the other genetic resources. Similar kind of variation was observed in different accessions of *Ficus carica* in the attributes of leaf length (cm), leaf width (cm), leaf edge shape, leaf top shape, number of leaf lobes, leaf color, leaf texture and leaf neck length (cm)[16] which lend support to the current study.

Genetically different fig cultivars with similar morphological characteristics were distinguished from 11 out of 26 plant traits. The number and shape of lobes[10], tree growth habit, size of the tree, degree of branching, number of lobes per leaf [3], leaf length, leaf width, leaf area, density of hairs/spicules on the leaf's upper surface, and petiole thickness[9] were the traits used for the discrimination of fig accessions which supports the present study.

Table 1 growth parameters at two growth periods

Clone	Basal diameter (mm)		Height (m)		Number of branches	
	3 MAP	6 MAP	3 MAP	6 MAP	3 MAP	6 MAP
AC 1	12.33	34.30	0.28	2.03	0.00	3.33
AC 2	11.04	36.77	0.34	1.99	0.67	3.33
AC 3	11.61	35.35	0.29	1.91	0.00	3.33
AC 4	7.57	28.46	0.22	1.65	0.67	2.00
AC 5	7.53	23.89	0.20	1.63	0.33	0.67
AC 6	13.08	29.63	0.40	1.18	1.67	0.67
AC 7	17.83	31.73	0.53	1.89	3.67	1.33
AC 8	15.92	26.69	0.38	1.08	1.67	1.33
AC 9	11.32	17.80	0.46	1.06	0.67	2.00
AC 10	9.86	18.53	0.25	0.94	0.00	1.33
AC 11	15.62	38.37	0.36	2.05	0.67	2.67
AC 12	10.23	22.49	0.25	1.04	0.67	2.00
AC 13	15.42	41.49	0.50	2.36	1.67	3.33
AC 14	14.53	39.77	0.42	2.13	1.67	2.67
AC 15	21.68*	40.94	1.01*	2.62*	4.67*	2.67
AC 16	20.93*	40.84	0.84*	1.98	1.67	2.00
AC 17	18.04	43.76*	0.65	2.66*	3.33	4.00
AC 18	19.58*	34.23	0.58	1.89	6.00*	2.67
AC 19	18.47	26.70	0.64	1.40	3.00	1.33
AC 20	7.52	9.58	0.26	0.43	0.67	1.00
AC 21	14.62	28.30	0.37	1.41	0.67	2.67
AC 22	11.33	32.77	0.27	1.89	0.33	4.00
AC 23	17.70	39.83	0.62	2.33	3.33	4.00
AC 24	6.43	19.46	0.23	0.81	2.67	1.33
AC 25	16.40	44.24*	0.51	2.36	4.00	2.00
Mean	**13.86**	**31.44**	**0.43**	**1.71**	**1.77**	**2.31**
SEd	2.69	4.84	0.12	0.38	1.09	1.03
CD (0.05)	5.41	9.74	0.23	0.77	2.18	2.06

*5 % significance

Table 2 leaf parameters at two growth periods

	Leaf Length (cm)		Leaf Width (cm)		Petiole Length (cm)	
Clone	**3 MAP**	**6 MAP**	**3 MAP**	**6 MAP**	**3 MAP**	**6 MAP**
AC 1	31.83	39.83	23.50	29.00	8.25	7.07
AC 2	26.00	34.50	19.17	23.83	6.63	6.27
AC 3	32.07	35.67	25.23	24.70	6.07	6.10
AC 4	17.70	37.40	12.93	25.20	7.23	7.50
AC 5	16.92	21.30	13.92	20.50	6.23	5.87
AC 6	32.50	40.67	21.83	28.20	7.90	8.03
AC 7	39.67	43.90	24.33	29.10	9.27*	9.17*
AC 8	32.50	40.23	19.17	27.23	9.38*	8.87*
AC 9	31.00	31.87	21.67	19.73	5.32	5.53
AC 10	26.67	34.20	18.50	22.67	4.70	5.47
AC 11	34.13	38.33	24.23	27.07	7.02	6.77
AC 12	26.67	38.87	17.55	24.37	5.60	5.77
AC 13	35.60	36.67	24.17	25.80	5.85	5.53
AC 14	38.53	45.03*	25.23	28.77	8.20	7.50
AC 15	47.17*	44.50	32.57*	29.90	7.78	7.87
AC 16	35.69	42.90	25.43	26.90	9.10*	8.30
AC 17	39.13	38.33	23.47	25.30	8.67	7.80
AC 18	43.20	39.07	27.73	24.30	6.45	6.10
AC 19	30.77	35.77	21.62	21.93	6.43	6.20
AC 20	19.40	19.50	14.29	12.60	3.31	3.67
AC 21	27.33	33.07	19.83	20.03	6.73	6.23
AC 22	25.17	39.83	19.00	26.07	6.90	6.60
AC 23	34.50	37.43	25.17	24.63	7.07	6.60
AC 24	4.83	31.23	2.83	18.43	5.92	4.93
AC 25	41.23	33.87	27.53	24.70	5.42	5.13
Mean	**30.81**	**36.56**	**21.24**	**24.44**	**6.86**	**6.59**
SEd	6.63	4.17	3.88	2.93	1.11	1.05
CD (0.05)	13.32	8.39	7.81	5.90	2.23	2.11

*5 % significance

Table 3 Total number of leaves and Leaf area at two growth periods

Clone	Total Number of Leaves		Leaf area (m^2)	
	3 MAP	6 MAP	3 MAP	6 MAP
AC 1	11.00	24.33	0.0616	0.0976
AC 2	11.33	25.00	0.0383	0.0626
AC 3	11.67	24.33	0.0607	0.0658
AC 4	11.33	19.33	0.0203	0.0756
AC 5	7.33	8.67	0.0193	0.0347
AC 6	13.67	13.67	0.0700	0.0964
AC 7	21.00*	16.67	0.0813	0.1004
AC 8	11.33	14.33	0.0488	0.0824
AC 9	14.67	18.67	0.0533	0.0487
AC 10	9.00	15.67	0.0407	0.0617
AC 11	14.00	24.67	0.0661	0.0828
AC 12	8.67	19.67	0.0390	0.0781
AC 13	17.33	26.00	0.0667	0.0712
AC 14	16.67	22.67	0.0826	0.1101*
AC 15	29.33*	21.33	0.1257*	0.1079
AC 16	14.00	19.33	0.0756	0.0865
AC 17	20.00*	28.00	0.0739	0.0727
AC 18	34.67*	20.67	0.0860	0.0682
AC 19	17.33	14.33	0.0531	0.0629
AC 20	9.67	11.33	0.0213	0.0215
AC 21	14.67	20.33	0.0382	0.0468
AC 22	12.00	28.00	0.0340	0.0780
AC 23	24.67*	29.00	0.0659	0.0701
AC 24	12.00	11.00	0.0010	0.0427
AC 25	22.67*	19.67	0.0936	0.0697
Mean	15.60	19.87	0.0567	0.0718
SEd	2.06	4.60	0.0219	0.0186
CD (0.05)	4.14	9.25	0.0440	0.0375

*5 % significant

CONCLUSION

In the present study, clonal variation among the twenty-five genetic resources of *Neolamarckia cadamba* were analyzed. Clones were investigated based on the Growth attributes *viz.*, plant height, basal diameter and Number of branches as well as Leaf attributes *viz.*, leaf Width, leaf length, leaf Petiole length and Total number of leaves. Among the growth attributes, three clones viz., AC 17, AC 15 and AC16 were performed well at 3 MAP and 6 MAP period. Considering the leaf attributes, one clone *viz.*, AC 15 showed superiority over the other *Neolamarckia cadamba* genetic resources.

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