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Effect of soil types and age gradations on growth performance of *Melia dubia* under central dry zone of Karnataka

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Abstract

Melia dubia is a fast growing deciduous tree species has popularity among the farmers and wood based industries to fulfill their growing demands. Several workers have studied on growth performance of different tree species with respect to site factors. A field study was conducted to know the effect of soil types and age gradation on growth of *M. dubia* in central dry zone of Karnataka during 2018-19. Established plantation in two soil types (Black and red soil) with 2, 4, 6 and 8 year age gradations were selected. Results revealed that, trees grown in black soil recorded maximum height at initial (7.41 m) and at the end of 12 months (8.19 m) as compared to red soil at initial (6.89 m) and after 12 months (7.65 m). Diameter at breast height (DBH) and crown diameter did not differ significantly with respect to different soil types. Among the age gradation, the maximum height (10.75 m and 10.90 m), dbh (0.218 and 0.224 m) and crown diameter (3.44 m and 4.38 m), basal area (30.981 and 32.815 m² ha⁻¹) and wood volume production (200.279 and 241.529 m³ ha⁻¹) at initial and 12 months after start of experiment were recorded in 8 year plantation. Interaction of black soil and 8 year plantation recorded the maximum growth for all the growth parameters and may be recommended for harvest to get maximum returns.

Keywords: *Melia dubia*, wood volume, age gradation, Soil types

Introduction

Depletion of forest area in the country has badly hit the supply of fibrous raw materials to the industry and hence great importance has been given to raise fast growing species for use as raw material for paper and cellulose industries (Saikia *et al.*, 1997)^[3]. There is an urgent need to supply the raw materials sustainably for wood based industries through expansion of area under fast growing with short rotation species and enhanced productivity. Under such circumstances *Melia dubia* has been identified as one of the potential species as a raw material for different wood based industries (Saravanan *et al.*, 2013a)^[4]. It can grow at the rate of 41.54 m³ ha⁻¹ year⁻¹ which is higher as compared to Eucalyptus and poplar (Saravanan *et al.*, 2013)^[5]. Malabar neem (*Melia dubia* Cav.), commonly called as Hebbuvu or Dreak or Gora Neem, is a dry deciduous multipurpose tree belongs to the family Meliaceae. It is indigenous to Western Ghats and Himalayas, and grown extensively in Upper Assam, West Bengal, Khasi hills of Orissa, Western Ghats and moist deciduous forests of Kerala up to an altitude of 1500-1800 m above mean sea level (Ashok *et al.*, 2017)^[1]. Growth and productivity are one of the factors, which are to be considered while looking for the successful establishment of any plantation. The performance of plantation can be assessed only by calculating the growth and productivity in space and time. The choice of planting density is a primary silvicultural decision in plantation management which considers the tradeoff between individual tree size and total stand production, affecting the type of quality and quantity of products throughout the rotation. Currently there is an increased tendency to grow indigenous tree on a plantation scale, the species like *M. dubia* is being promoted which is fast growing and can fulfill the economic sustainability of farmers, raw material needs of industries and environment benefits.

Materials and Methods

Geographical location

The field experiments were carried out at College of Horticulture, Hiriyyur, University of Agricultural and Horticultural Sciences, Shivamogga.

The experimental sites are situated in Central dry zone (Zone-4) of Karnataka and lies between North latitude 13°56'57" and East longitude 76°37'13" at 606 meters above mean sea level (MSL).

Central dry zone

This Agro-climatic zone has an area of about 1.98 million ha spread over in 17 taluks of 5 districts of Karnataka state. The elevation ranges from 450 m – 900 m above mean sea level, with most parts lies at an elevation of 800 m – 900 m. The major area of the zone is covered with granite and gneissic landscapes and to a lesser extent with metamorphic landscape of the plateau region.

Climatic conditions

The study area (Hiriyur) gets benefits from both South- West and North- East monsoon. The mean monthly meteorological data on rainfall, temperature and relative humidity during the period of experimental year (2018-19 and 2019-20) and average annual values for the last 10 years (2008-17) recorded at Zonal Agricultural and Horticultural Research Station, Hiriyur are presented in Table 1 and depicted in Fig.1 and Fig2.

The average annual rainfall for last 10 years (2008 to 2017) at the study area was 647 mm and the significant portion of the rainfall received in October (296.4 mm). During the experimental period, the rainfall received in 2018 (490.4 mm) and 2019 (788.4 mm) were lower and higher, respectively than the 10 years average annual rainfall. The mean maximum and minimum temperature in the study period was 2018 (32.3°C) and 2019 (32.5°C) as compared to 10 years mean (32.3 and 19.6 °C, respectively). The annual mean relative humidity was 2018 (73.9%) and 2019 (74.7%) recorded was higher than 10 year average humidity (72.8%).

Methodology

Melia dubia plantations established by farmers in different soil types (black soil and red soil) were identified and in each soil type, 4 plantations having age of 2, 4, 6 and 8 year age gradations with 4 × 3 m spacing were selected. In each selected plantations, centrally located 20 trees were marked for recording the growth attributes such as total height (m), diameter at breast height (cm) and canopy diameter (m). The basal area per tree (m² tree⁻¹) and per hectare (m² ha⁻¹), wood volume production (m³ tree⁻¹) and per hectare (m³ ha⁻¹) were

calculated for two season (at the time of start of experiment and 12 months after initiation of the experiment) in order to assess the productivity as influenced by the soil types.

Results and Discussion

Results pertaining to growth performance of *Melia dubia* as influenced by different soil types at different age gradation is presented in Table 1. Results revealed that, significant variation was observed in height growth due to effect of soil types. Trees grown in black soil recorded maximum height at initial (7.41 m) and at the end of 12 months (8.19 m) as compared to red soil at initial (6.89 m) and after 12 months (7.65 m). However, diameter at breast height (DBH) and crown diameter did not differ significantly with respect to different soil types. The effect of age gradation was significant on height. Among the age gradation, the higher height was recorded in 8 year plantation at initial (10.75 m) and 12 months (10.90 m) after start of experiment as compared to rest of age gradation and the lowest was recorded in 2 year plantation at initial (3.74 m) and 12 months (4.90 m) after start of experiment. Similar trend was observed for diameter at breast height and crown diameter also.

The crown diameter (m) also showed significant variation due to age gradation. Among the different age gradation, the maximum crown diameter was recorded in 8 year plantation at initial (3.44 m) and 12 months (4.38 m) after the start of experiment.

At an initiation of treatments, the diameter at breast height (DBH) showed significant difference due to the interaction of soil types and age gradation. The maximum DBH was recorded in interaction of black soil and 8 year of age gradation at initial (0.218 m) followed by red soil and 8 year of age at initial observation of experiment (0.220m). The lowest DBH was recorded in the interaction of red soil and 2 year age gradation at initiation (0.111 m) of experiment. Crown diameter did not differ significantly due to soil types and age gradation. The results are in conformity with the findings of Rao *et al.* (2000) [2] in *Leucaena leucocephala*, *Eucalyptus camaldulensis*, *Acacia albida* and *Acacia auriculiformis* at the age of 9 years *Albizia lebbek* (4 m x 4 m) *Azadirachta indica* (4 m x 4 m), *Acacia nilotica* (3 m x 3 m) and *Tamarindus indica* (4 mx 4 m) exhibited the height growth of 12.2 m, 11.4 m, 10.5 m and 11.2 m and the dbh of 18.2 cm, 13.7 cm, 15.2 cm and 12.7 cm respectively at the age of 12 years.

Table 1: Growth performance of *Melia dubia* in different soil types at different age gradation

Parameters/ Intervals	Height (m)		Diameter at breast height (m)		Crown Diameter (m)	
	Initial	12 MASE	Initial	12 MASE	Initial	12 MASE
Soil Type						
Black	7.41	8.19	0.172	0.188	2.61	3.49
Red	6.89	7.65	0.169	0.190	2.51	3.39
SEm±	0.11	0.10	0.002	0.003	0.09	0.08
CD @ 5%	0.32	0.31	NS	NS	NS	NS
Age Gradation (Years)						
2	3.74	4.90	0.105	0.131	2.15	3.00
4	5.28	5.75	0.161	0.192	2.15	3.00
6	8.81	10.11	0.197	0.210	2.49	3.38
8	10.75	10.90	0.218	0.224	3.44	4.38
SEm±	0.16	0.15	0.003	0.004	0.13	0.11
CD @ 5%	0.46	0.43	0.010	0.013	0.36	0.31
Soil Type × Age Gradation						
Black × 2	3.93	5.00	0.111	0.134	2.18	3.04
Black × 4	6.08	6.43	0.149	0.182	2.18	3.04

Black × 6	8.80	10.16	0.206	0.217	2.34	3.23
Black × 8	10.83	11.15	0.218	0.220	3.74	4.65
Red × 2	3.56	4.81	0.100	0.128	2.12	2.96
Red × 4	4.48	5.08	0.156	0.201	2.12	2.96
Red × 6	8.83	10.05	0.188	0.204	2.65	3.54
Red × 8	10.55	10.70	0.216	0.228	3.14	4.10
SEm±	0.22	0.21	0.005	0.006	0.177	0.150
CD @ 5%	0.65	0.61	0.014	NS	NS	NS

Note: MASE = Months After Start of Experiment; NS = Non-significant

The data pertaining to basal area ($\text{m}^2 \text{ tree}^{-1}$ and $\text{m}^2 \text{ ha}^{-1}$) are presented in Table 2. Results revealed that, the non-significant difference with respect to effect of different soil types. The effect of age gradation on basal area ($\text{m}^2 \text{ tree}^{-1}$ and $\text{m}^2 \text{ ha}^{-1}$) was significantly differed. The maximum basal area per tree was recorded in 8 year plantation at initiation ($0.037 \text{ m}^2 \text{ tree}^{-1}$) and 12 months ($0.039 \text{ m}^2 \text{ tree}^{-1}$) while the minimum was recorded in 2 year age plantation at initial ($0.009 \text{ m}^2 \text{ tree}^{-1}$) and 12

months ($0.013 \text{ m}^2 \text{ tree}^{-1}$) after start of the experiment. The similar trend was also observed in basal area per hectare. The basal area ($\text{m}^2 \text{ ha}^{-1}$) among the age gradation in 8 year plantation recorded higher basal area per $\text{m}^2 \text{ ha}^{-1}$ at initial and 12 months (30.98 and $32.82 \text{ m}^2 \text{ ha}^{-1}$, respectively) after start of the experiment. The lowest was recorded in 2 year plantation (7.33 and $11.23 \text{ m}^2 \text{ ha}^{-1}$, respectively). Increase in basal area in black soil may be due to increase in soil fertility status.

Table 2: Basal area (m^2) of *Melia dubia* in different soil types at different age gradation

Parameters/ Intervals	Basal area ($\text{m}^2 \text{ tree}^{-1}$)		Basal area ($\text{m}^2 \text{ ha}^{-1}$)	
	Initial	12 MASE	Initial	12 MASE
Soil Type				
Black	0.025	0.029	20.570	24.091
Red	0.024	0.029	19.881	24.565
SEm±	0.001	0.001	0.561	0.847
CD @ 5%	NS	NS	NS	NS
Age Gradation (Years)				
2	0.009	0.013	7.326	11.229
4	0.020	0.029	15.844	24.127
6	0.031	0.035	25.567	29.141
8	0.037	0.039	30.981	32.815
SEm±	0.001	0.002	0.793	1.198
CD @ 5%	0.003	0.005	2.314	3.497
Soil Type × Age Gradation				
Black × 2	0.010	0.014	8.133	11.768
Black × 4	0.018	0.026	14.586	21.737
Black × 6	0.034	0.037	28.000	31.102
Black × 8	0.038	0.038	31.411	31.758
Red × 2	0.008	0.013	6.518	10.690
Red × 4	0.019	0.032	16.158	26.517
Red × 6	0.028	0.033	23.135	27.179
Red × 8	0.036	0.041	30.400	33.873
SEm±	0.002	0.003	1.121	1.694
CD @ 5%	NS	NS	3.272	NS

Note: MASE = Months after Start of Experiment; NS = Non-significant

The effect of soil type and age gradation on wood volume production per tree and per hectare is presented in Table 3. Perusal of results revealed that, there was significant difference in wood volume production per tree at initiation of experiment due to effect of different soil type. Higher volume per tree was recorded in black soil ($0.128 \text{ m}^3 \text{ tree}^{-1}$) as compared to red soil ($0.115 \text{ m}^3 \text{ ha}^{-1}$) at initiation of start of the experiment.

The effect of soil types showed significant difference in volume per tree and per hectare due to age gradation. Significantly higher volume per tree was recorded in 8 year plantation at initial ($0.240 \text{ m}^3 \text{ tree}^{-1}$) and 12 months ($0.258 \text{ m}^3 \text{ tree}^{-1}$) after start of the experiment. Whereas, lowest volume was recorded in 2 year age plantation at initial ($0.020 \text{ m}^3 \text{ tree}^{-1}$) and 12 months ($0.040 \text{ m}^3 \text{ tree}^{-1}$) after start of the experiment.

Similarly, significantly higher wood volume production per hectare ($\text{m}^3 \text{ ha}^{-1}$) was recorded in 8 year plantation at initial ($200.279 \text{ m}^3 \text{ ha}^{-1}$) and 12 months ($214.529 \text{ m}^3 \text{ ha}^{-1}$) as compare to 2 year plantation at initial ($16.630 \text{ m}^3 \text{ ha}^{-1}$) and 12 months ($33.080 \text{ m}^3 \text{ ha}^{-1}$) after start of the experiment. Increase in basal area in black soil may be due to increase in soil fertility status. The findings are in conformity with the findings of Rao *et al.* (2000) [2] in *Leucaena leucocephala*, *Eucalyptus camaldulensis*, *Acacia albida* and *Acacia auriculiformis* at the age of 9 years *Albizia lebbek* (4 m x 4 m) *Azadirachta indica* (4 m x 4 m), *Acacia nilotica* (3 m x 3 m) and *Tamarindus indica* (4 m x 4 m) exhibited the height growth and the dbh at the age of 12 years.

1) and 12 months ($0.040 \text{ m}^3 \text{ tree}^{-1}$) after start of the experiment.

Table 3: Wood volume ($\text{m}^3 \text{ tree}^{-1}$ and $\text{m}^3 \text{ ha}^{-1}$) production in *Melia dubia* in different soil types at different age gradation

Parameters /Intervals	Volume ($\text{m}^3 \text{ tree}^{-1}$)		Volume ($\text{m}^3 \text{ ha}^{-1}$)	
	Initial	12 MASE	Initial	12 MASE
Soil Type				
Black	0.128	0.156	106.516	130.142
Red	0.115	0.148	96.073	122.885
SEm \pm	0.005	0.006	3.878	4.953
CD @ 5%	0.014	NS	NS	NS
Age Gradation (Years)				
2	0.020	0.040	16.630	33.080
4	0.062	0.099	51.816	82.302
6	0.163	0.211	135.523	176.144
8	0.240	0.258	200.279	214.529
SEm \pm	0.007	0.008	5.484	7.004
CD @ 5%	0.019	0.025	16.006	20.445
Soil Type \times Age Gradation				
Black \times 2	0.023	0.042	19.134	35.310
Black \times 4	0.064	0.101	53.154	83.819
Black \times 6	0.179	0.227	148.697	188.762
Black \times 8	0.246	0.255	205.080	212.676
Red \times 2	0.017	0.037	14.127	30.849
Red \times 4	0.054	0.097	52.330	80.785
Red \times 6	0.147	0.196	122.349	163.525
Red \times 8	0.235	0.260	195.478	216.381
SEm \pm	0.009	0.012	7.755	9.906
CD @ 5%	NS	NS	NS	NS

Note: MASE = Months after Start of Experiment; NS = Non-significant

Conclusion

Trees grown under black soil has recorded higher values for all the growth parameters indicates that the adoptability of species to the black soil. As age increases the growth of tree attributes were recorded higher in 8 year old plantation and it may be harvested at 8 year of age for maximum returns.

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