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Growth Performance of Mahogany (*Swietenia macrophylla*) under Different Soil Types in Northern Region of Karnataka

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***Abstract*:** The present study was carried out with an objective of assessing growth performance of mahogany (*Swietenia macrophylla*) grown under different soil types of hilly zone of Karnataka. Mahogany plantations with an age gradation of 1, 2, 3, 4 year grown in black and red soils were selected for the study. Growth parameters such as height and girth at breast height were recorded at 12 months interval for a period of one year from January 2022. Growth attributes such as height, girth at breast height, basal area and volume of mahogany at initial stage and at 12 MASE (month after start of experiment) of mahogany differed significantly due to soil type and age gradation. Volume per hectare at initial stage and at 12 MASE was significantly higher in black soil than in red soil. Significantly higher tree volume was recorded in 4-year-old mahogany plantation at initial stage (18.25 m^3) and at 12 MASE (40.55 m^3). Interaction between soil type and age gradation had significant influence on volume per hectare at initial and 12 MASE. The study concluded that growth performance of mahogany was superior in black soil in northern region of Karnataka.

***Keywords*:** Growth performance, Soil types, Fast growing species, Mahogany, *Swietenia macrophylla*

Swietenia macrophylla is a straight grained, reddish brown tropical hardwood species of the family Meliaceae. It is distributed naturally in central and south America. The species has been widely cultivated in south East Asia and the Pacific including India, Indonesia, Philippines and Sri Lanka. It is commonly known as mahogany. With *Swietenia macrophylla*, the species *Swietenia mahagoni* and *Swietenia humilis* are known to be genuine mahoganies. Mahogany was introduced to Royal Botanical Garden, Kolkata from West Indies in 1795. Thereafter this species has been extensively grown in southern India (Akhilraj and Inamati 2023). Mahogany grows normally taller than 30 m and attains a diameter of 150 cm at breast height. It grows in a wide range of soils and environmental conditions. Normally, mahogany requires deep, fertile, well-drained soils with a pH of 6.5-7.5 for its optimum growth and it requires a mean annual rainfall between 1000 and 2500 mm with a 4-month dry period for good growth. Mahogany can grow at an altitude of 0-1500 m above sea level, in areas with a mean annual temperature of 20-28°C (Krisnawati et al 2011). Mahogany is a light demander, frost tender, fire hardy species. It avoids water logging and moderately coppice. The mahogany wood is used for manufacturing doors, windows, composite wood, boat, sports goods and musical instruments. Fruit is known as sky fruit and which is having medicinal properties such as it is used to treat blood sugar, cholesterol and Alzheimer's disease (Akhilraj 2023).

In recent times, incorporation of fast-growing tree species into the agroforestry systems has received more attention among farmers in India due to its diversified outputs and sustained agricultural productivity. Among such fast-growing tree species, mahogany is a promising important tree species considered by the farmers. Its deep rooting nature, moderate fast growth, adoptability, outstanding wood qualities, better form and higher sawn out turn and ability to withstand the stand management practices makes it popular among the tree farmers (Vikas Kumar 2016). The wood production potential is restricted to about 0.7 m^3 ha^{-1} $year^{-1}$ in the country as compared to the world average of 2.1 m^3 ha^{-1} $year^{-1}$, this results in a huge gap between demand and supply of timber (Bijalwan and Dobriyal 2015). Agroforestry plantations including fast growing tree species is an attractive option because they reduce land competition for biomass and food production while providing tree benefits (Chavan et al 2015). Fast growing species are considered as those capable of a mean annual increment of at least 10 cubic meters per hectare under favourable site conditions (FAO 1965). Fast growth of tree is influenced by edaphic, climatic, topographic and biotic factors. Farmers of north Karnataka have started cultivating mahogany extensively in their farm land without prior knowledge on site specificity. Knowledge on suitability of the species to particular soil is crucial in raising the plantation successfully hence present

investigation was carried out with an objective of assessing the growth performance of mahogany under different soil types of northern region of Karnataka.

MATERIAL AND METHODS

The present study was conducted in Hilly zone (11º 56' to 15º 46' N latitude and 74º 31' to 76º 45' E longitude), one among the 10 agroclimatic zones present in Karnataka. It is characterized by red clay loamy soil, lateritic soil and black soil. This zone has a tropical climate with an annual rainfall of 2500-3000 mm. There were two factors considered for the study, factor one was soil type viz. black soil and red soil and factor two was age gradation viz. 1, 2, 3, 4 year. Different aged mahogany plantations grown in black soil and red soils were selected from this agroclimatic zone based on similar growing conditions with utmost care. In each plantation three sample plot of 15 m × 15 m was laid out for measuring the growth parameters. In each sample plot, there were 25 trees with a spacing of 3 × 3 m. The study was conducted in the year 2022 and observations were taken twice ie. at initial stage and at 12 MASE and average data per hectare was calculated. Growth parameters such as tree height (m), girth at breast height (cm) were recorded and derived parameters such as basal area, total tree volume, current annual increment and mean annual increment (Chaturvedi and Khanna 1984) were calculated.

Basal area = $g^2/4\pi$, where g is girth at breast height

Total volume = Tree height × basal area × form factor

The replicated data were statistically were compared using post-hoc test (Duncan's multiple range test) at ($p < 0.05$) level using OPSTAT software.

RESULTS AND DISCUSSION

Growth attributes such as height and girth at breast height significantly differed due to soil type and age gradation. Tree height at initial was significantly higher in black soil (3.71 m) than red soil (3.54 m). Tree height at initial was significantly higher in 4-year plantation (4.93 m) than in 1-3 year similarly tree height at 12 MASE was significantly higher in black soil (4.83 m) than red soil (4.56 m) and significantly higher in 4-year plantation (5.70 m) than 1-3 year of plantation (Table 1). Height growth is directly related to the site quality. Good height growth may be due to the higher potential of black soil in terms of water holding and nutrient status in comparison with red soil. Vasudev et al (2020) indicated similar trend where *Melia dubia* grown in black soil recorded maximum height at initial and at the end of 12 months as compared to red soil. Generally, as tree age increases, the growth in trees also increases. In the present study, mean tree height of mahogany increases as the stand age increases. Similar kind of results were reported by Divya et al (2022) in eucalyptus and Patel et al (2022) in *Ailanthus excelsa*. GBH at initial was significantly higher in black soil (16.53 cm) than red soil (15.87 cm) similarly GBH at 12 MASE was significantly higher in black soil (26.16 cm) than red soil (25.02 cm). Reis et al (2018) reported that soil type and plant age both influenced the increment in diameter at breast height of *Swietenia macrophylla*. Trees from the red yellow acrisol had recorded statistically higher diameter at breast height values than trees from the nitisol (40.05 and 33.57 cm, respectively). GBH at initial was significantly higher in 4-year plantation (24.82 cm) than 1–3-year plantation. GBH at 12 MASE was significantly higher in 4-year plantation (Table 2). Vasudev et al (2020) reported that *Melia dubia* exhibited a higher diameter at beast height in black soil in comparison with red soil.

Volume per hectare at initial stage and at 12 MASE of mahogany differed substantially due to soil type and age gradation (Table 3). Volume per hectare at initial stage was significantly higher in black soil (8.62 m^3) than red soil (7.72 m^3). Volume per hectare at initial stage was significantly higher in 4-year plantation (18.25 m^3). Interaction between soil type and age gradation had significant effect on volume per hectare at initial stage. This was significantly higher in black soil than red soil. Volume per hectare at 12 MASE was significantly higher in black soil (23.26 m^3) than red soil (20.34 m^3) and volume per hectare at 12 MASE was significantly

Table 1. Mean height of mahogany at initial and at 12 MASE as influenced by soil type and age gradation

Soil types / Plantation age	Height (m) at initial stage					Height (m) at 12 MASE				
	1	2	3	4	Mean	1	2	3	4	Mean
Black soil	1.94	3.66	4.22	5.03	3.71	3.62	4.76	5.12	5.83	4.83
Red soil	1.86	3.41	4.06	4.83	3.54	3.36	4.51	4.80	5.56	4.56
Mean	1.90	3.53	4.14	4.93		3.49	4.64	4.96	5.70	
CD (p=0.05)										
Soil type (S)				0.04					0.02	
Plantation age (P)				0.06					0.03	
Interaction (S × P)				0.08					NS	

higher in 4-year-old plantation (40.55 m^3). Interaction between soil type and age gradation had significant influence on volume per hectare at 12 MASE. The higher tree volume obtained in plantation raised in black soil may be due to the fertility and water holding capacity of it. In addition to it mahogany prefers neutral to alkaline soil, black soil provides optimum conditions for the growth than red soil. Vasudev et al (2020) in *Melia dubia* grown in black soil recorded maximum volume as compared to red soil. Current annual increment (CAI) of volume per hectare of mahogany differed considerably due to soil type and age gradation (Fig. 1). Increasing trend of CAI indicate that mahogany grows faster in its early growing stage. Higher CAI and MAI is obtained in plantation grown on black soil compared to red soil. Interaction between soil type and age gradation had significant influence on CAI of volume per hectare. Whereas

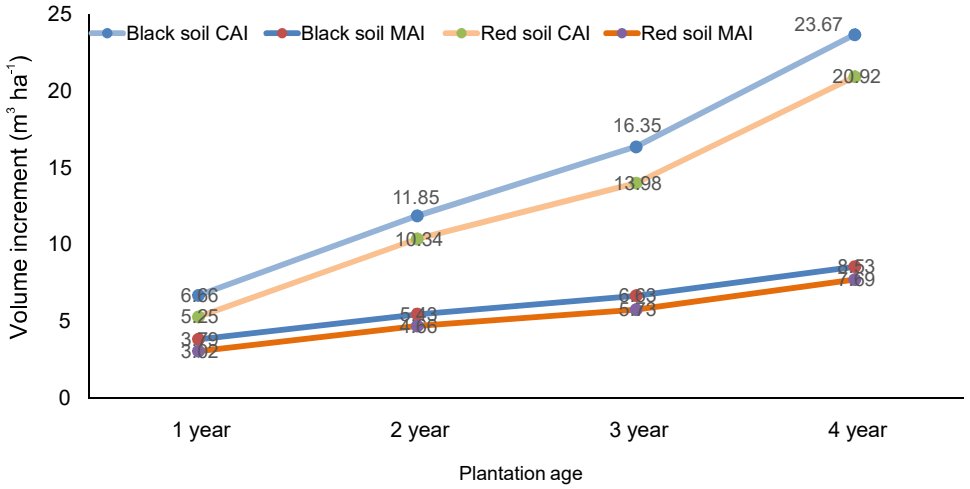

Fig. 1. CAI and MAI of volume (m^3 ha^{-1}) of mahogany as influenced by soil type and age gradation

Table 2. Mean gbh of mahogany at initial stage and at 12 MASE as influenced by soil type and age gradation

Soil types / Plantation age	GBH (cm) at initial stage					GBH (cm) at 12 MASE				
	1	2	3	4	Mean	1	2	3	4	Mean
Black soil	8.17	13.45	19.46	25.05	16.53	17.65	23.18	28.94	34.87	26.16
Red soil	7.72	12.58	18.58	24.58	15.87	16.34	22.06	27.76	33.92	25.02
Mean	7.95	13.02	19.02	24.82		17.00	22.62	28.35	34.40	
CD (p=0.05)										
Soil type (S)				0.28					0.23	
Plantation age (P)				0.40					0.32	
Interaction (S × P)				NS					NS	

Table 3. Total tree volume of mahogany at initial stage and at 12 MASE as influenced by soil type and age gradation

Soil types / Plantation age	Volume (m^3 ha^{-1}) at initial stage					Volume (m^3 ha^{-1}) at 12 MASE				
	1	2	3	4	Mean	1	2	3	4	Mean
Black soil	0.91	4.45	10.17	18.97	8.62	7.58	16.29	26.53	42.63	23.26
Red soil	0.78	3.64	8.92	17.54	7.72	6.03	13.98	22.90	38.46	20.34
Mean	0.85	4.04	9.55	18.25		6.80	15.14	24.72	40.55	
CD (p=0.05)										
Soil type (S)				0.31					0.37	
Plantation age (P)				0.44					0.52	
Interaction (S × P)				0.62					0.74	

interaction between agroclimatic zone and age gradation had no significant influence on MAI of volume per hectare at 12 MASE.

CONCLUSION

Swietenia macrophylla grown in black soil recorded a higher mean tree height, mean girth at breast height and total tree volume per hectare. Hence study concluded that growth performance of mahogany was superior in black soil as compared to red soil in hilly zone of northern region of Karnataka. The current annual increment as well as mean annual increment values were also higher in the case of black soil. Thus, black soil supports the growth of mahogany species in northern region of Karnataka.

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