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**RESEARCH PAPER**

# Growth performance and carbon sequestration potential of mahogany plantations in northern transition zone of Karnataka

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**Abstract:** Mahogany (*Swietenia macrophylla*) became a popular among the tree growers of Karnataka. With its superior wood quality, beautiful grain, fast growing nature, high economical returns on invested capital and adoptability made huge attraction on this species. Raising agroforestry plantations of fast growing tree species became more successful and a realistic approach to climate resilient farming. The objective of the experiment was to assess the growth and carbon sequestration potential of different aged mahogany plantations in northern transition zone of Karnataka. Twenty five trees selected from each age gradation of one and half year to four and half year old mahogany plantations of this zone by considering similar growing and edaphic conditions. Growth attributes such as height and girth at breast height was measured. Derived parameters such as basal area, tree volume, total biomass and carbon sequestration potential of mahogany plantations were calculated and the results revealed that four and half year old mahogany plantation recorded higher tree volume (25.22 $m^3$ $ha^{-1}$) and carbon sequestration potential (8.42 t $ha^{-1}$) as compared to other age gradations selected for study. The study concluded that as age increases the tree volume and carbon sequestration potential of mahogany increases.

**Keywords:** Carbon sequestration, Fast growing tree species, Growth performance, Mahogany, *Swietenia macrophylla*

## Introduction

*Swietenia macrophylla* is one among the three genuine mahoganies grown in the world. The other two genuine mahoganies are *Swietenia mahogani* and *Swietenia humilis*. It belongs to the family Meliaceae and is one of the highly prized timber species in the world. Mahogany is native to central America. The species has been extensively planted in South east Asian countries including India, Indonesia, Philippines and Sri Lanka. British introduced Mahogany into India in 1795. It was planted first at Royal Botanical Garden, Kolkata. Number of mahogany plantations is increasing in south east Asian countries mainly due to its high-quality light wood mainly used for furniture and cabin manufacture (Akhilraj and Inamati, 2023). *Swietenia macrophylla* is a large evergreen tree with an umbrella shaped crown with a tree height about 30 m and a dbh of 1.5 m and above. The leaves are normally paripinnate, sometimes imparipinnate, 12-45 cm long and are made up of 3-6 pairs of lanceolate or ovate leaflets. The leaflets are asymmetrical, 5-12 cm long and 2-5 cm wide, with a whole margin and an acute or acuminate apex. It can grow in a wide range of soils and site conditions. Deep, fertile, well-drained soils with a pH of 6.5-7.5 is best for its good growth. It requires a mean annual rainfall between 1000 and 2500 mm with a 4-month dry period for best performance. Mahogany tree can grow at an altitude up to 1500 m above mean sea level, in areas with a mean annual temperature of 20-28°C (Krisnawati *et al*., 2011). Recently, a wide acceptance of mahogany among the tree growers of Karnataka witnessed due to its moderately fast growth, adoptability, ability to withstand environmental fluctuations, attracting wood qualities, economic importance of timber *etc*. The objective of the present study was to know the growth performance and carbon sequestration potential of different aged *Swietenia macrophylla* plantations in northern transition zone of Karnataka.

## Material and methods

Northern transition zone (14º 13' to 16º 41' N latitude and 74º 13' to 75º 38' E longitude) characterized by shallow to medium black clay soils and red sandy loamy soils in equal proportion. The climate in the zone is tropical and 50 per cent of rainfall receives during June to September. Average weather data of study area is given in Table 1. The present study was conducted at Bailhongal and Dharwad in northern transition zone of Karnataka during 2022. Similar growing conditions and edaphic conditions were considered while selecting the plantations with utmost care has been given. The spacing between the mahogany trees were 3 × 3 m and sample plot size for growth measurements was taken as 15 × 15 m. With three replication seventy-five trees have been selected in each plantation of age gradation from one and half year to four and half year. Measurements of 25 trees averaged in to five replications. Tree height measurement was carried out by using Ravi altimeter and girth at breast height (gbh) was measured by using a measuring tape at 1.37 m from the tree base. Derived parameters were calculated by using following formula,

Basal area = $gbh^2/4\pi$. (Chaturvedi and Khanna, 1984)

Volume of the tree = Basal area × tree height × Form factor (Chaturvedi and Khanna, 1984)

Above ground biomass (AGB) = Tree volume × Wood density (MacDicken, 1997)

Table 1. Average meteorological data of northern transition zone during the year 2022

| Particulars | Recorded value |
|---|---|
| Maximum temperature | 29.78ºC |
| Minimum temperature | 18.98ºC |
| Mean annual rainfall | 1246.67 mm |
| Relative humidity (Maximum) | 79.98% |
| Relative humidity (Minimum) | 60.14% |
| Sunshine hours | 6.13 hr |
| Wind speed | 5.98 km $hr^{-1}$ |

Table 2. Growth parameters of mahogany plantation as influenced by the tree age

| Age of the plantation (yr) | Mean tree height (m) | Mean GBH(cm) | Basal area ($m^2$ $ha^{-1}$) | Volume ($m^3$ $ha^{-1}$) |
|---|---|---|---|---|
| 1.5 | 2.69 | 11.46 | 1.16 | 2.44 |
| 2.5 | 3.82 | 16.60 | 2.44 | 7.43 |
| 3.5 | 4.48 | 22.04 | 4.14 | 13.18 |
| 4.5 | 5.15 | 28.32 | 7.09 | 25.22 |
| S.Em± | 0.04 | 0.15 | 0.05 | 0.18 |
| C.D.at 5% | 0.13 | 0.47 | 0.17 | 0.56 |

Below ground biomass (BGB) = AGB × 0.26 (Ravindranath and Ostwald, 2008)

Total biomass (TB) = AGB + BGB (MacDicken, 1997)

Carbon sequestration potential = TB × 0.5(MacDicken, 1997)

The current investigation was conducted in a non-destructive method, standard wood density of mahogany (530 kg $m^{-3}$) was taken for calculations. The results were expressed in to respective unit.

**Results and discussion**

The study area received a mean annual rainfall of 1246.67 mm (Table 1) and plantations were grown in deep black soil which supported the growth of mahogany trees in this region. This is in conformity with Krisnawati *et al*. (2011). He reported that growth and productivity of mahogany is optimum when it grows in well drained soil with a pH of 6.5 to 7.5 and it requires a mean annual rainfall between 1000 and 2500 mm with a 4 month dry period for best growth and development

Mean tree height of mahogany was significantly differed due to age (Table 2). The maximum mean height was recorded in four and half year-old mahogany (5.15 m) and the minimum height was recorded in one and half year-old mahogany (2.69 m). The maximum mean girth at breast height of mahogany was recorded in four and half year-old plantation (28.32 cm) and the minimum mean gbh was recorded in one and half year-old plantation (11.46 cm). An increasing trend of mean tree height and mean girth at breast height from one and half year to four and half year was witnessed. Growth of any stand mainly influenced by the stand age, stand density and other management practices. Patel *et al*. (2022) reported that height and gbh was increased from one year to five-year-old plantations in *Ailanthus excelsa* and Divya *et al*. (2022) reported that gradual increase in height and gbh when the age of eucalyptus increases.

Basal area and tree volume was significantly differed due to tree age (Table 2). Four and half year-old mahogany plantation recorded the maximum basal area (7.09 $m^2$ $ha^{-1}$) whereas one and half year-old plantation recorded the minimum basal area (1.16 $m^2$ $ha^{-1}$). The total tree volume was ranged from 2.44 $m^3$ $ha^{-1}$ (one and half year-old plantation) to 25.22 $m^3ha^{-1}$ (four and half year-old plantation). Volume is increased with increase in age. This may be due to the higher basal area that in turn in relation with higher gbh and height. This result was in conformity with Divya *et al*. (2022) and they stated that mean volume of standing eucalyptus trees was maximum in five-year-old plantation (171.09 $m^3$ $ha^{-1}$). Akhilraj and Inamati (2023) recorded a higher tree volume (24.18 $m^3$ $ha^{-1}$) in four and half year-old mahogany at hilly zone, Karnataka.

Above ground biomass and below ground biomass was significantly differed due to tree age (Table 3). Highest above ground biomass was recorded in four and half year-old mahogany plantation (13.37 t $ha^{-1}$) and lowest above ground biomass was recorded in one and half year-old mahogany plantation (1.30 t $ha^{-1}$). Below ground biomass was ranged from 0.34 t $ha^{-1}$ (one and half year old plantation) to 3.48 t $ha^{-1}$ (four and half year old plantation). Similar kind of results were reported by Akhilraj and Inamati (2023) in mahogany and Divya *et al*. (2022) in eucalyptus.

Total biomass and carbon sequestration potential was differed significantly due to tree age (Table 3). Maximum total biomass (16.84 t $ha^{-1}$) and carbon sequestration potential (8.42t $ha^{-1}$) was recorded in four and half year old plantation whereas minimum total biomass (1.63 t $ha^{-1}$) and carbon sequestration potential (0.82 t $ha^{-1}$) was recorded in one and half year-old plantation. Carbon sequestration potential was increased as age of the tree increased. Biomass is directly proportional to age. As age increases, biomass increases which in turn increase the carbon sequestration potential. A similar biomass and carbon sequestration potential was reported in four and half year-old mahogany plantations of hilly zone Karnataka (Akhilraj and Inamati, 2023).

Table 3. Biomass and carbon sequestration potential of mahogany plantation as influenced by tree age

| Age of the plantation (yr) | Above ground biomass (t $ha^{-1}$) | Below ground biomass (t $ha^{-1}$) | Total biomass (t $ha^{-1}$) | Carbon sequestration potential (t $ha^{-1}$) |
|---|---|---|---|---|
| 1.5 | 1.30 | 0.34 | 1.63 | 0.82 |
| 2.5 | 3.94 | 1.02 | 4.96 | 2.48 |
| 3.5 | 6.99 | 1.82 | 8.80 | 4.40 |
| 4.5 | 13.37 | 3.48 | 16.84 | 8.42 |
| S.Em± | 0.10 | 0.03 | 0.12 | 0.06 |
| C.D. at 5% | 0.30 | 0.08 | 0.37 | 0.19 |

## Conclusion

Present study concludes that growth attributes such as height and girth at breast height increased as age increases. Tree volume and total biomass were directly proportional to the tree age. Carbon sequestration potential of mahogany plantation was increased from one and half year to four and half year. Due to its fast growth, carbon sequestering potential, mahogany can be effectively used for mitigating climate change by incorporating in farms thereby farmers able to get additional revenue from carbon credit too.

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