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Original Article

Physical Characteristics of Tectona grandis spp. of the Vidarbha Region-A Study

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Abstract

A large portion of global teak plantations is found in India. The objective of this work is to identify possible physical characteristics of Tectona grandis spp. of the Vidarbha region to support further physicochemical analytical studies and potential uses of this species. The study focused on various Tectona grandis *plantation areas of five divisions, namely Nagpur, Bhandara, Gondia, Yawatmal, and Chandrapur of Vidarbha region, which are examined and various physical properties of Tectona grandis species were examined. Minimum girth of trees is found between 18-25 cm, and Maximum girth is observed at 262 cm. The maximum trees are found between 64 -79 cm Girth Class. Height class ranges between 3.4 - 33.5m. The age of trees is between 30-55 years, and the average Green Moisture Content (GMC) is found between the ranges of 35 to 40%. Along with this, the morphology of trees, bark, leaf pattern, fruit, and seed pattern are also studied. This study is important because several aspects, like Morphology, DBH, Height Class, Girth Class, Age, and Green Moisture Content, have been found out by observing and studying Tectona grandis plantations of the Vidarbha Region of Maharashtra. with the help of various mensuration instruments and by using the Local Volume Table. Physical characteristics are varied in trees of different locations due to different age classes and topographical and climatic conditions.*

Keywords: *Tectona grandis spp., Diameter Breast Height (DBH), Girth Class, Height Class, Local Volume Table.*

Introduction

India's megadiverse status, encompassing 8% of global biodiversity, is reflected in its vast area of 328.73 million ha, making it the seventh largest country. About one-fifth of India's geographical area is covered with forests, and approximately 45,000 plant species exist in India. The commercially important tree Tectona grandis (Teak) is classified within the Lamiaceae family and is a major species used in tree plantations, which is naturally distributed in India. (K.Palanisami et.el (2009)) India possesses the world's most extensive collection of teak genetic resources. In India Tectona grandis forests are widely distributed in Maharashtra, Madhya Pradesh, Tamil Nadu, and Karnataka. Kerala, Uttar Pradesh, Gujarat, Orissa, and Rajasthan. (India state forest report 2023) Studying the physical characteristics of Tectona grandis spp.various mensuration techniques requisite a core aspect of forestry that deals with the determination of dimensions, form, age, and increment of single trees, stands, or whole woods, or logs. (Durgesh K Tripathi, et al. (2017)). The main objective served by mensuration of the Tectona grandis plantation is-

a. **Basis for sale-**For every transaction involving the sale of trees, timber, or their products. The rising demand and limited supply of timber and other forest products are having a major impact, underscoring their growing importance
b. **Basis of Management –** To meet the demand of timber and other forest produce in perpetuity, proper management practices are needed. To ensure a continuous supply of timber and other forest products, accurate measurements of the standing timber volume and its annual or periodic growth are necessary.
c. **Measurement for research-** To maximize timber production, particular treatments are needed. Hence, it is necessary to conduct various experiments and compare the results of different treatments.

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d. **Measurement for planning** – To reduce the gap between demand and supply of forest produce, proper planning is required. Tree mensuration is a critical tool in the planning process.

Though Tectona grandis plantations are spread throughout the Vidarbha region but data is very scanty, and little is known about the characteristics of Tectona grandis spp. of the Vidarbha region. Hence, it is important to elucidate the physical characteristics of this species. Highlighting the importance of tree mensuration, during this study, physical characteristics such as morphology, height, average height of plantations, DBH, leaf color, and green moisture content were studied by using various mensuration techniques.

Study Area:

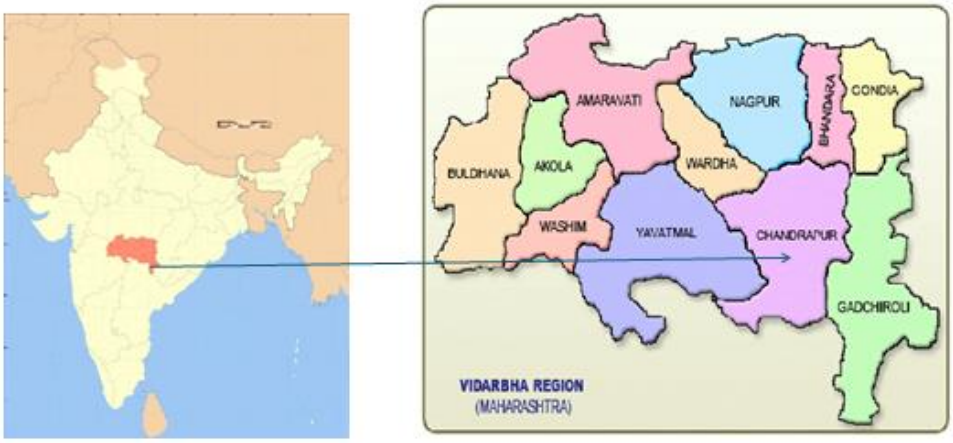


Figure 1. Map of study area

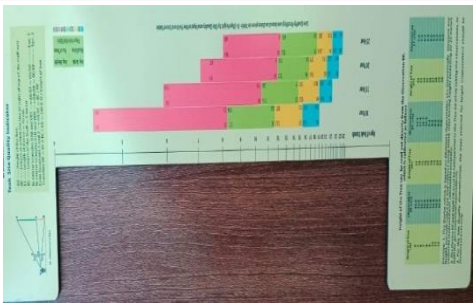
Tectona grandis spp. is widely spread over the Vidarbha region; accordingly, five representative divisions are selected for examination wherein teak plantations are distributed, these are- Nagpur, Bhandara, Gondia, Yawatmal, and Chandrapur.

Materials and Methods

In this study, various Tectona grandis plantation areas of five divisions of Vidarbha region, i.e., Nagpur, Bhandara, Gondia, Yawatmal, and Chandrapur, were examined, and various physical properties of Tectona grandis species were studied.

To ensure the objective of the present study, a detailed literature survey has been completed to address these challenges, and the implementation of established protocols is vital for achieving reliable and consistent results, free from any personal bias. Based on the litrature survey a standard method of studying physical properties of Tectona grandis trees is developed, because *Tectona grandis* plantations often exhibit variations in tree age, size, and health, requiring a consistent approach to data collection as there is combination of even aged trees and irregular and uneven aged crops/ trees along with one or more girth classes, either completely missing or suppressed, and also having malformed, crooked, decesed, dying and dead trees and coppices. Key measurements, such as morphology, Height Class, Girth Class, Diameter at Breast Height (DBH) and Green Moisture Content (GMC), are studied by laying representative sample plots. With the 5 m long graduated measuring tape, DBH, is measured, height and girth class are measured using the wedge prism and Christens Hypsometer. Green Moisture Content (GMC) is measured with the help of KERRO-KT-10 moisture meter (Figure 2. a, b, c)

(a) Wedge Prism,



(b) Hypsometer

(c) Moisture Meter used for the study.

Figure 2.

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Laying of sample plots

The areas that are representative of that division are identified, and the boundaries of plantations are vindicated. When there is a large plantation then it is divided into different sections. There is a substantial difference between the rate of growth of *Tectona grandis* spp. at different sites selected in this study, so the area is studied from stock maps of that particular plantation. 20 X 20 meters representative sample plots are laid, and 100 % enumeration of trees in that sample plot was done, after measurement of DBH, Height Class, and Girth Class, site qualities are determined with the help of top height by site quality and age table of Maharashtra Forest Records No.III, Silviculture Manual.

While selecting the sample plot following standards are followed:

1. No sample plot shall be selected on the edge of the representative area selected.
2. Sample plots, strategically located, are used to assess varying terrain and crop conditions., are selected judiciously.
3. The sample plot must be rectangular.
4. By marking the trees, the boundary of the sample plot needs to be marked.
5. The sample plots within each site quality class should encompass at least 3% to 5% of the total area.

Enumeration survey:

After laying the representative sample plots, 100% enumeration of the trees in the sample plots is carried out during the enumeration of physical characteristics, morphology, DBH, Height Class, and Girth Class of Tectona grandis spp. is studied. The enumeration is done as follows: (Figure 3)

1. The enumeration is followed in a successive narrow strips, with each strip being observed once and in the opposite direction to the previous strip.
2. Visible, shallow blazes are used to mark trees, facilitating the identification of completed survey areas. By placing the blazes on the side of the trees that face away from the remaining survey, researchers can easily determine the extent of the previous survey work during ongoing surveying.
3. Serial numbers are given on the blaze by pencil.
4. Morphology, DBH, Height Class, and Girth Class of each tree are studied and calculated.
5. The Wedge Prism of a suitable Basal Area Factor (BAF) is to be used to measure the Existing Average Basal Area per hectare in each sample plot.
6. After the computation of the volume of growing stock with the help of measurements taken from the sample plot by using the quarter girth formula. *(Maharashtra Forest Records No.III, Silviculture Manual.2022)*

Figure 3. Representative Sample Plot

Figure 4. Height measurement with Hypsometer

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(a)

(b)

(c)

(d)

Figure 5. (a) Leaf, (b) Fruits, (c) Crown, and (d) Seeds of *Tectona grandis* Spp.

Morphology

Morphological characteristics, i.e., leaf characteristics of leaf and crown, as well as fruits and seed pattern, crown surface area, are studied for morphological determination. (Figure 5. (a), (b), (c), (d) (Table 1).

Diameter Breast Height (DBH) Measurement

Breast Height is marked using a measuring tape on standing trees at 1.37 m (4 ft 6 in) above the ground level, and measurements of diameter (girth) are taken as per standard rules for different types of trees such as straight tree, leaning tree, forked tree, and buttress formed tree by using 5 m long graduated measuring tape with hook. *(A.N Chaturvedi et.el (2013)*

Volume measurement by quarter girth formula

$V = (G/4^2) \times L$.

V=Volume of a tree

G, in this case, is the girth of a tree

L- Tree length

Measurement of Height

The height of trees is measured with the help of a Christens Hypsometer.

Results and Discussions

The total forest cover under the selected five divisions is Nagpur, Bhandara, Gondia, Yawatmal, and Chandrapur, depicted in Figure 5. In Maharashtra, moist teak forest cover is 10.71% and dry teak forest cover is 17.40 % means out total teak forest cover is 28.11 %, and out of these, the major *Tectona grandis* forests are found in the districts depicted above. Different plantation sites are selected from the above five divisions, and the physical characteristics of Tectona grandis spp. are observed and calculated. Representative Sample plots are laid, and 100% enumeration of every sample plot is done. The Local Volume Table is used to determine site quality and age.

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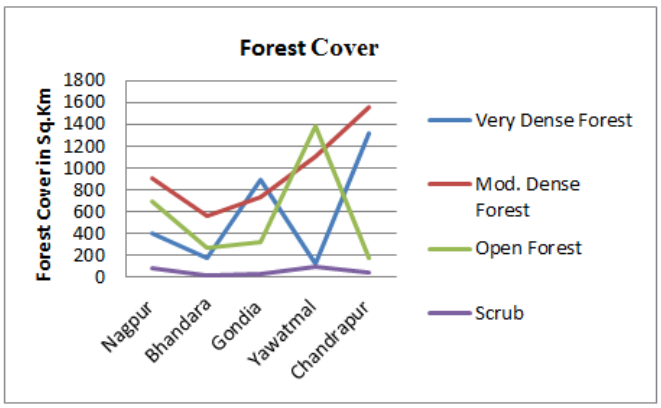

Figure 5. Forest cover of the selected region for this study

Girth Class

After enumeration of different sample plots in the above five divisions, the height class and girth class were calculated/determined. With the help of the height and girth data of the tree, the volume of the tree is calculated by applying the quarter girth formula, and accordingly average volume is calculated for each plantation site. In *Tectona grandis* spp, the minimum girth of trees is 18-25 cm, and the maximum girth is observed to be 262cm. The maximum *Tectona grandis* species are found in all five divisions, is between 64 -79 cm and 94-109 cm girth class. From the above girth class, it is observed that the crop/ plantation has having uneven age group of trees, and most of the middle-aged trees. (Figure 6)

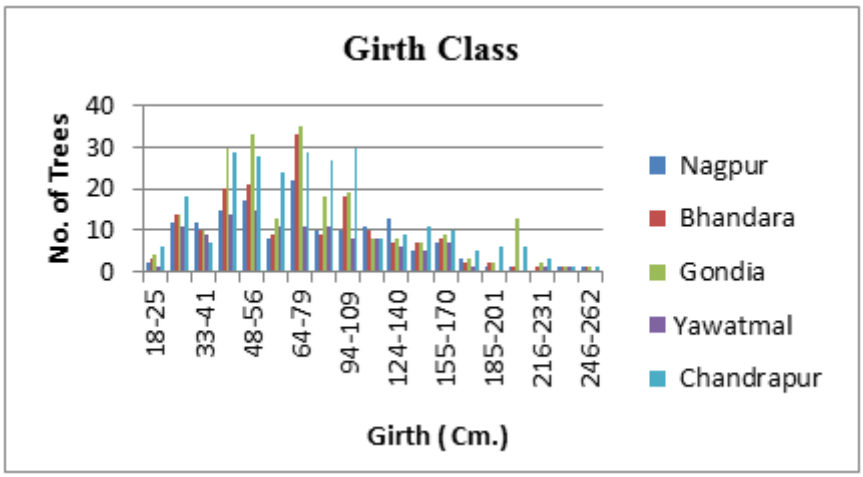

Figure 6. Girth class of Tectona grandis spp., at the selected region for this study

Height Class

The height class ranges between 3.4 -33.5 m. After studying the height class, it is observed that Gondia division has a maximum number of tall Tectona grandis spp. compared to Yawatmal and Nagpur Division. Minimum height attained by *Tectona grandis* spp., in Yawatmal division is 3.4-9.1 m, and maximum height is found in Gondia division is 27.4-33.5 m. Average Age of plantations calculated by knowing height and girth class, plantation year, plantation history and with the help of local volume table, and the average age of trees found in Nagpur Division is 30 years, Bhandara Division 45 years, Gondia Division 50 years, Yawatmal Division 40 years and Chandrapur Division 55 years. Different heights and girth observed in different divisions are due to different environmental and topographical conditions such as soil, climate, and intensity of light. (Figure 7).

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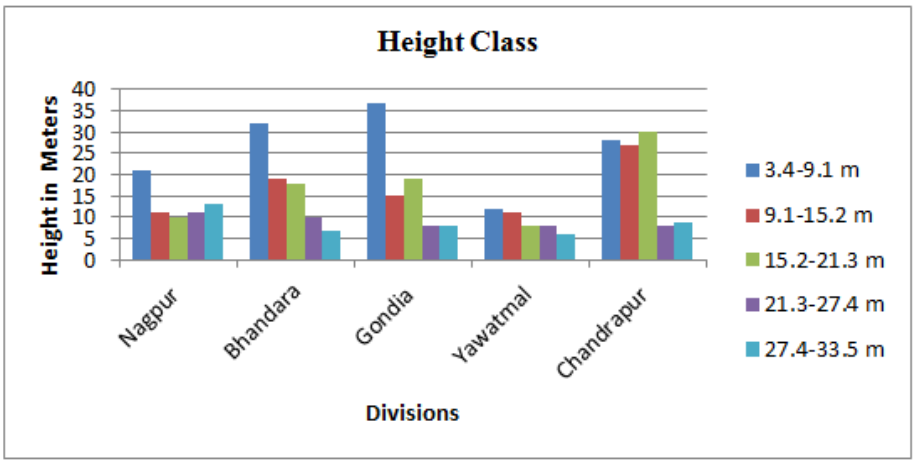

Figure 7. Height class of Tectona grandis spp., at the selected region for this study

		Leaf Characteristics							Bark Color						
Name of the Division	**Location**	**Leaf Tip**	**Leaf Margin**	**Leaf Surface Texture**	**Leaf Venation**	**Flowering**	**Fruit**	**Seed**	**Inner Bark**	**Outer Bark**	**Shape of trees**	**Avg Height (M)**	**Avg Girth (Cm.)**	**Avg Age (Years)**	**Avg Green Moisture Content% %**
Nagpur	21.31700N 79.20000E	Tapered	Flat	Rough	Pinnate	Profuse	Drupe, Globose	Brownish	Whitish	Brown	Tapered	7.95	7.947	30	40
Bhandara	21.07360N 79.82970E	Tapered	Flat	Rough	Pinnate	Profuse	Drupe, Globose	Brownish	Light green	Brown	Tapered	9.32	9.316	45	38
Gondia	20.390N 86.420E	Tapered	Flat	Rough	Pinnate	Profuse	Drupe, Globose	Brownish	Whitish	Brown	Tapered	12.11	12.105	50	36
Yawatmal	20.11700 N 78.11080E	Tapered	Flat	Rough	Pinnate	Profuse	Drupe, Globose	Brownish	Whitish	Brown	Tapered	6.32	6.316	40	39
Chandrapur	20.20950N 79.56030S	Tapered	Flat	Rough	Pinnate	Profuse	Drupe, Globose	Brownish	Whitish	Brown	Tapered	13.58	13.579	55	35

Table 1. Morphological characteristics observed in *Tectona grandis spp.* at the selected region

Outer Bark- The Color of the Outer bark is whitish, brown, or light brown is noticed.

Leaves- Opposite leaves, elliptic to obovate broadly, about 30-70 cm long and 20-40 cm broad, at the base rounded to acute and at apex obtuse to acute, and for the petiole stout and 5-6 cm long. *Tectona grandis* spp. defoliates from November to February and remains leafless for 2-3 months, and the new leaves appear from April to June, according to locality.

Flowering Phenology- The *Tectona grandis* spp. observed in the above five divisions, generally flowering occurs in the trees with the age group of 6 – 40 years, but profuse flowering occurs in the trees that are having age more than 15 years. The Following the emergence of new leaves in late May, flowers occur, lasting through August or September, which marks the start of the southwest monsoon.

Fruit- Fruit is globose, drupe, 5-20 mm in size, protected by an accrescent calyx with thick shaggy exocarp of matted hairs, epicarp inflated, spongy and stellate pubescent, endocarp stony, 4 celled seeds1-4, oblong and exalbuminous. The fruit undergoes ripening from November to January and falls gradually, some remaining on the trees throughout the hot season. The fruits are brownish yellow, and the number varies from 1150 to 2800 per kg.

Conclusion

The above study is carried out focusing on the various physical characteristics of Tectona grandis spp., of Nagpur,

Bhandara, Gondia, Yawatmal, and Chandrapur Divisions, as the physical characteristics are varied in trees due to different topographical and climatic conditions. The good distribution of these tree species around the Vidarbha region is due to suitable rainfall and a marked dry period. Both height and girth classes in Gondia and Chandrapur districts were found to be good, which may be due to old plantations in this area. Morphological characteristics are similar for all sites. Green moisture content variation (GMC) is not to a large extent. Overall, the morphology of this species around the study region is satisfactory. Further study is needed to examine different chemical characteristics and the effect of this species on soil, and further potential uses of this species can also be studied.

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Conflicts of interest
The authors declare that there are no conflicts of interest regarding the publication of this paper.

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