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# DISTRIBUTION OF WOOD DENSITY IN A SINGLE STEM OF *POPULUS EURAMERICANA*

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Four 12-years old trees of *Populus euramericana* harvested in Faisalabad and Toba Tek Singh Districts were analysed to determine the density distribution in the stem. Density increased with age and increasing height. Minimum density noted was 0.25 g/cm$^3$ and maximum density was 0.56g/cm$^3$.

***Key words:*** Distribution, Wood density, Stem, *P. euramericana.*

## Introduction

*Populus euramericana* (Dode), guinier hybrid poplar is one of the best farm trees in irrigated tracts due to its peculiar characteristics such as rapid growth rate, deciduous nature of its foliage, conical shape of the crown with ascending branches, desirable wood characteristics and relative resistance to common diseases and insect pests.

One of the important characteristics of this species which requires detailed investigations is horizontal and vertical distribution of wood density in the bole. It determines the quality of logs and leads to its efficient and proper utilization. The role of wood density in this regard is clear from its use in packing, pulp and in manufacturing matches.

This species has not been investigated so for in detail under varying soil and climatic conditions in Pakistan. The present studies were conducted to find out the horizontal and vertical and overall picture of density distribution in the stem.

Akhtar [1] observed that specific gravity of *Pseudotsuga taxifolia* (Douglas fir) increased with age from the pith towards the periphery in the juvenile wood. This increase in specific gravity from pith was fairly steep for the first 15 rings, which showed a strong influence of age over specific gravity. He concluded from study that the specific gravity in general decreased with increasing height with the exception of slight but definite increase in specific gravity at approx. half the way upto the stem. Scara Muzzi [2] studied the density of 77 *Populus euramericana* trees. He reported that peripheral density was always higher than core density in all the cases examined. In 1975, Hicks and coworkers determined the specific gravity of 60 trees of *Betula nigra* in Texas and observed that it varied from 0.410 to 0.503, and there was a positive linear relationship between stem diameter and specific gravity. Martz and Koel [3] and Loenz and Haul [4] reported that stem density increased with the age and height of the tree. Moul and Lopes [5] found that the stem density increases with the age of tree.

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## Materials and Methods

Wood density was determined from small representative samples of any size or shape which were taken from each growth layer of each section. These were boiled in distilled water and were kept for 5-6 weeks. These were then weighed with analytical balance up to three decimals. The samples were dried in the oven at 25°C for a week or so and then weighed again.

In addition, 6 samples of known apparent volume were weighed when fully saturated with water and oven dried. The density determined by maxim. moisture content by applying the following formula:

$$\text{Density of solid wood} = \frac{\text{Oven dry weight}}{\text{Apparent vol.} - \text{vol. of water}}$$

$$\text{Density of wood} = \frac{\text{Oven dry weight}}{\text{Vol. of water}^* + \text{vol. of solid wood}^{**}}$$

* = Weight of saturated wood sample – oven dry weight of the sample.

** = Weight of oven dry wood x density of solid wood

The regression analysis was made in minitab package and the density of stem wood was plotted against the stem height and age in order to determine their effects on its distribution. Density of different growth layers at various heights was shown on a longitudinal section of stem in order to get an over all view of density distribution in the stem.

## Results and Discussion

The regression equation density on age and density on height show that densities are positively dependent upon age and height. In both the cases the p values are 0.00, so the results are highly significant (Table 1).

Figure 1 shows the effects of age and height on distribution of density of stem. Graph 'a' suggests that density did not increase for the first four years. It , however, increased almost linearly for the next 6-7 years at an annual rate of 0.014 g/cm$^3$. The density tended to be constant or decreased slightly during 11th and 12th year. The above distribution suggests that poplars boles at this stage were very suitable as poles, since these had an outer shell of denser (stronger) wood. Such findings were also reported by Curro [6], Gotze [7], Isaeva and Brjubanova [8] and Akhtar [1].

Graph 'b' depicts the relationship of tree height and stem density. Inspite of severe fluctuation, the average density tended to increase with increase in height. Similar results were reported by Curro [6], Gotze [7] and Markovic [9]. These results conflict with those of Isaeva *et al.* [8] and Akhtar [1].

TABLE 1.

MTB > regr c2 1 c1

The regression equation is:
Den (g) = 0.275 + 0.0114 age

| Predictor | Coef | Stdev | t-ratio | P |
|---|---|---|---|---|
| Constant | 0.274545 | 0.007952 | 34.52 | 0.000 |
| Age | 0.011416 | 0.001080 | 10.57 | 0.000 |

S = 0.01292 R-sq = 91.8% R-sq(adj) = 91.0%

ANALYSIS OF VARIANCE

| Source | DF | SS | MS | F | P |
|---|---|---|---|---|---|
| Regression | 1 | 0.018637 | 0.018637 | 111.63 | 0.000 |
| Error | 10 | 0.001669 | 0.000167 | | |
| Total | 11 | 0.020306 | | | |

MTB > regr c5 1 c4

The regression equation is:
Dens (g) = 0.340 + 0.00324 Height

| Predictor | Coef | Stdev | t-ratio | P |
|---|---|---|---|---|
| Constant | 0.339947 | 0.005758 | 59.04 | 0.000 |
| Height | 0.0032421 | 0.0005050 | 6.42 | 0.000 |

S = 0.01206 R-sq = 70.8% R-sq(adj) = 69.1%

ANALYSIS OF VARIANCE

| Source | DF | SS | MS | F | P |
|---|---|---|---|---|---|
| Regression | 1 | 0.0059914 | 0.0059914 | 41.22 | 0.000 |
| Error | 17 | 0.0024710 | 0.0001454 | | |
| Total | 18 | 0.0084624 | | | |

UNUSUAL OBSERVATIONS

| Obs. | Height | Dens (g) | Fit | Stdev.fit | Residual | St.resid |
|---|---|---|---|---|---|---|
| 4 | 4.0 | 0.38000 | 0.35292 | 0.00410 | 0.02708 | 2.39R |

R denotes an obs. with a large st. resid.

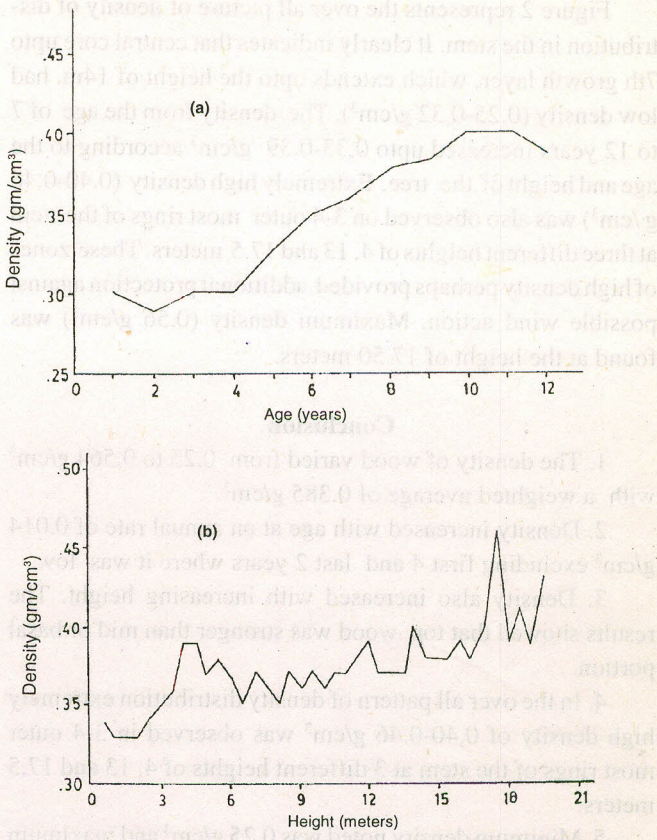


Fig. 1. (a) Density versus age. (b) Density versus height.

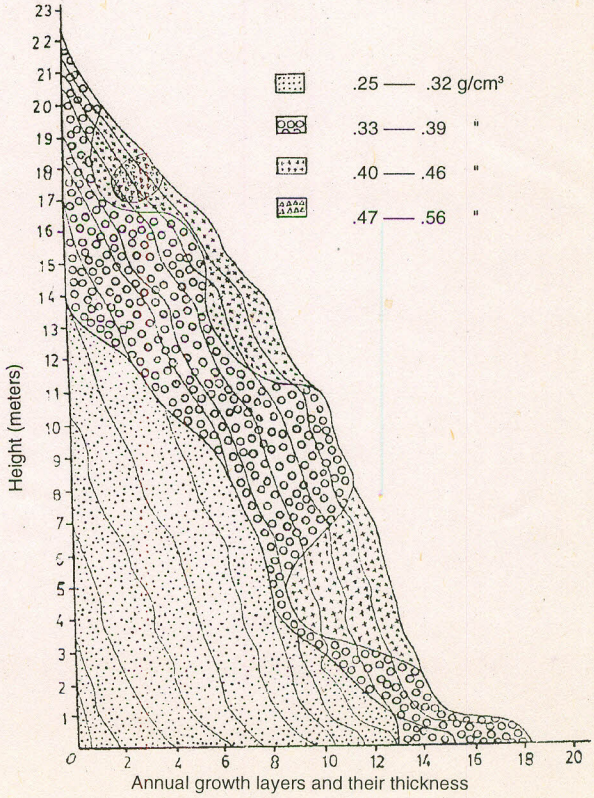


Fig. 2. Overall pattern of density distribution in the stem.

Figure 2 represents the over all picture of density of distribution in the stem. It clearly indicates that central core upto 7th growth layer, which extends upto the height of 14m, had low density (0.25-0.32 g/cm$^3$). The density from the age of 7 to 12 years increased upto 0.33-0.39 g/cm$^3$ according to the age and height of the tree. Extremely high density (0.40-0.46 g /cm$^3$) was also observed on 3-4 outer most rings of the stem at three different heights of 4, 13 and 17.5 meters. These zones of high density perhaps provided additional protection against possible wind action. Maximum density (0.56 g/cm$^3$) was found at the height of 17.50 meters.

## Conclusion

1. The density of wood varied from 0.25 to 0.564 g/cm$^3$ with a weighted average of 0.385 g/cm$^3$.

2. Density increased with age at an annual rate of 0.014 g/cm$^3$ excluding first 4 and last 2 years where it was low.

3. Density also increased with increasing height. The results showed that top wood was stronger than mid or basal portion.

4. In the over all pattern of density distribution extremely high density of 0.40-0.46 g/cm$^3$ was observed in 3-4 outer most rings of the stem at 3 different heights of 4, 13 and 17.5 meters.

5. Minimum density noted was 0.25 g/cm$^3$ and maximum density was 0.56 g/cm$^3$.

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