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The Influence of Stem Height on Wood Density and Shrinkage of Athel Wood

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Abstract: The within-tree variations in the wood density and shrinkage of *Tamarix aphylla* were studied in three 48 years-old trees in south-eastern of Iran. Samples were taken at 10, 20, 30, 40, 50, 60, 70, 80, 90 and 95% of stem height. Results of analysis of variance showed that the stem height had significant difference on density and shrinkage of Athel wood. The values of wood density and shrinkage decreased along the stem from the base upwards. The wood properties of *Tamrix aphylla* changes in the present experiment may be due to the trees which have entered the wood maturity phase and thus displayed a corresponding the variation in different height of tree.

Key words: *Tamarix aphylla* · Wood density · Shrinkage

INTRODUCTION

Tamarix is a genus of the family *Tamaricaceae* and is composed of 54 species native only in the old world, with one major center of speciation in the Pakistan, Afghanistan, Iran, Turkmenistan, southern Kazakhstan and another in the eastern Mediterranean area [1]. There are 18 species and 1 variety of *Tamarix* in China, mainly found in northwestern China, Inner Mongolia and northern China [2].

Athel wood is additionally utilized for firewood and charcoal [3]. It may also be suitable for making ploughs, wheels, carts, tool handles, brush-backs, ornaments, turnery and fruit boxes. Its twigs are used for basket making, while its bark is a rich source of tannins and mordant for dyeing [3]. In Greece, there is a study on the physical and mechanical properties of Athel wood [4].

This species was planted for fixing of dune sands in the Iranian of warm desert region during 60 years-old ago. In Iran currently, there is not much information available on the properties of Athel wood. Determining the properties of Athel wood may provide an initial data to the researchers and offer interesting opportunities in future. Thus, the aim of the present study was to investigate the variation of physical properties (wood density and shrinkage) of Athel wood along the stem.

MATERIALS AND METHODS

Materials: All the Athel trees (*Tamarix aphylla*) were randomly selected, taking into account stem straightness and absence of obvious decay and pine wood was according to TS 2476, as defect-free, clear and normally grown (without zone lines, reaction wood, decay and insect damage, or fungal infection) from a plantation in the southeast of Iran (Zabol region). This area is located at an average altitude of 470 m with geographical direction of 61°25' E and 31°05' N. The mean annual precipitation of experimental area is less 100 mm/year; the yearly average temperature is 22°C. Three trees were cut from one provenience. These trees have been grown for 48 years at this site. The stem height and diameter of trees were 12-13 m and 40-45 cm.

Physical Properties: In each tree, samples disc of 3 cm length were taken from ten height level, at 10, 20, 30, 40, 50, 60, 70, 80, 90 and 95%. Rough boards at 25 mm thickness were radially sawn in the four directions of radius and total surface discs. Then test specimens were cut from these rough boards having dimensions of 20 × 20 × 20 mm according to ASTM D143-94 used for measuring the oven-dry density, basic density, tangential shrinkage, radial shrinkage, longitudinal shrinkage and volumetric shrinkage.

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The specimens were soaked in distilled water for 72 h to ensure that their moisture content was above the fiber saturation point. Then the dimensions in all three principal directions were measured with a digital caliper to the nearest 0.001 mm. specimens were weighed to the nearest 0.001 g for saturated weight and the saturated volume was calculated based on these dimension measurements. Finally, the samples were oven dried at 103±2°C to 0% moisture content. After cooling in desiccators, the oven-dry weights of the specimens were measured. The values of the wood oven-dry and basic density, volumetric shrinkage, tangential shrinkage, radial shrinkage and longitudinal shrinkage were calculated using the following equations:

$$D_0 = (M_0 \div V_0) \times 100$$
$$D_b = (M_0 \div V_S) \times 100$$
$$\beta_V = [(V_S - V_0) / V_S] \times 100$$
$$\beta_T = [(T_S - T_0) / T_S] \times 100$$
$$\beta_R = [(R_S - R_0) / R_S] \times 100$$
$$\beta_L = [(L_S - L_0) / L_S] \times 100$$

Where D_0, D_b, β_v, M_0, V_0, V_s, β_T, β_R, β_L, T_S, T_0, R_S, R_0, L_S, L_0, are the oven-dry density, basic density, volumetric shrinkage, dried weight, dried volume of specimen, the saturated volume of specimen, tangential shrinkage, radial shrinkage, longitudinal shrinkage, the saturated tangential dimension of specimen, dried tangential dimension of specimen, saturated radial dimension of specimen, dried radial dimension of specimen, saturated longitudinal dimension of specimen, dried longitudinal dimension of specimen, respectively.

Statistical Analysis: Analysis of variance (ANOVA) was used to determine statistically significant difference at a 0.05 significance level for the different variables (wood density and shrinkage) within the tree between height levels.

RESULTS AND DISSCUSION

Wood Density: Wood density is an important wood property for both solid wood and fiber products in conifers and hardwoods [5]. It is affected by the cell wall thickness, the cell diameter, the earlywood to latewood ratio and the chemical content of the wood [6]. Panshin and de Zeeuw (1980) reported that density is a general indicator of cell size and is a good predictor of strength, stiffness, ease of drying, machining, hardness and various paper making properties [7]. Analysis of variance results showed that the stem height had significant difference on the wood density of Athel wood in southeast of Iran. The values of wood oven-dry density and basic density decreased along longitudinal position from base to the up of stem height (Figure 1). These results were reported by Kord (2011) for Salix species [8]. The mean of wood oven dry density and basic density of athel wood were 686 and 521 Kg m^{-3} which is higher than wood oven-dry density in Greece region (660 kg m^{-3}) [4].

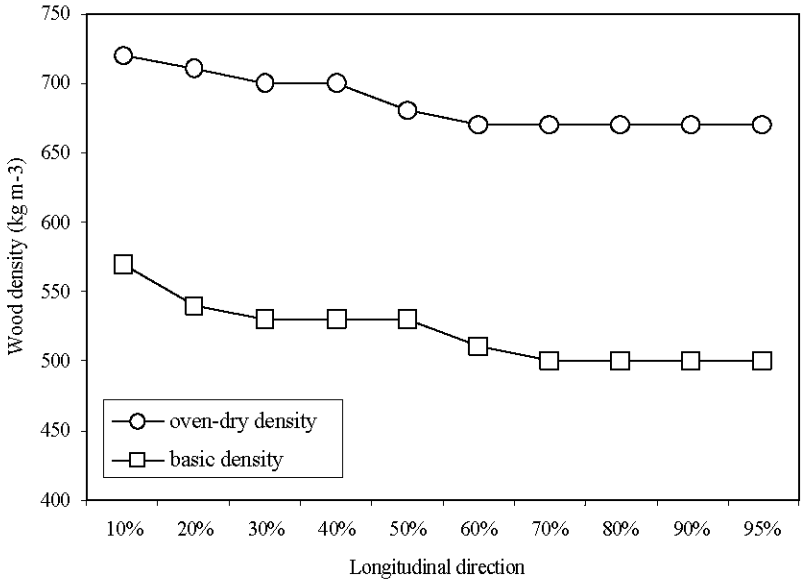

Fig. 1: Variations of wood density along longitudinal direction the base upwards

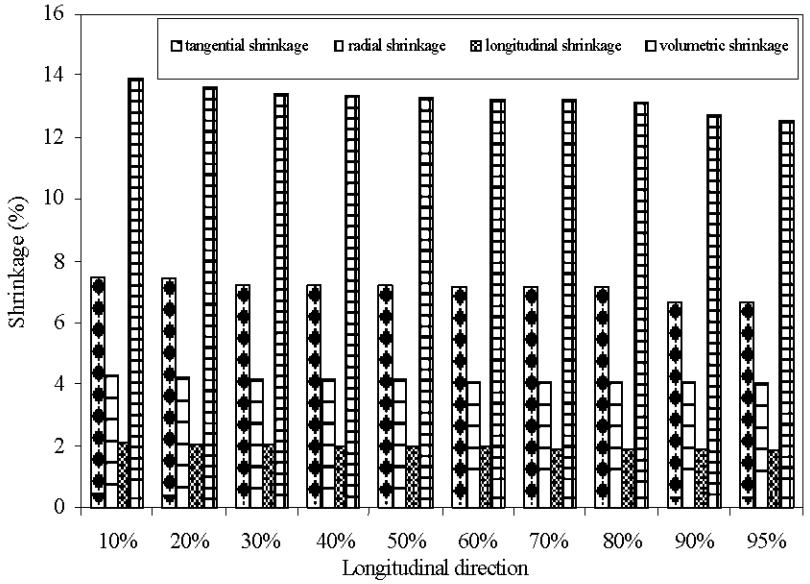

Fig. 2: Variations of shrinkage along longitudinal direction the base upwards

Wood Shrinkage: It is well known that wood is an anisotropic material which presents differential dimensional changes in different structural directions. The magnitude of shrinkage and s welling is affected by the amount of moisture gained or lost by wood when the moisture content fluctuates between zero and fiber saturation point [9-10]. The tangential, radial and longitudinal shrinkage of Athel wood were determined 7.13, 4.14 and 1.96%, respectively. The value of volumetric shrinkage was 13.23%, which is a little lower than the volumetric shrinkage at the Greece region (14%) [4]. The value of tangential shrinkage in Iran site (present study) is lower than tangential shrinkage in Greece region (10.8%), while the radial shrinkage is high (3.2%) [4]. Analysis of variance results showed that the stem height had significant difference on the tangential shrinkage, longitudinal, radial shrinkage and volumetric shrinkage Athel wood in southeast of Iran. The values of wood shrinkage decreased along longitudinal position from base to the up of stem height (Figure 2). These results were reported by Kiaei and Nouri Sadegh (2011) and Kiaei (2010) for eucalyptus and cypress wood [11-12].

CONCLUSION

This work focused on the main physical properties of *Tamarix aplylla* wood in southeast of Iran (Zabol region). The following conclusions could be drawn from the results of the present study:

- The values of oven-dry density, basic density, longitudinal shrinkage, tangential shrinkage, radial shrinkage and volumetric shrinkage decreased along the stem height the base upward.
- The wood density in the present research are higher than Athol wood in Greece region.
- The physical properties of Athel wood changes in the present experiment may be due to the trees which have entered the wood maturity phase and thus displayed a corresponding the variation in different height of tree.

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