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SOME FEATURES OF TIMBER QUALITY OF *BETULA PENDULA* ROTH. GROWING IN CARPATHIAN AGROFORESTRY

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ABSTRACT

Betula pendula Roth has a wide natural area stretching from the forest to steppe zones in the Ukraine. Understanding the term „wood quality" was focused on the industrial importance of the end-use of the wood product. Small-sized timbers of *Silver birch* growing in the Carpathian Agroforestry were mostly used for the chemical industry. In order to produce the valuable birch timbers was proposed a pruning at the stand height exceeding about 8-10 m with the pruning height of 5–6 m using clippers. The basic wood density varied from 419 till 631 kg·m^{-3} with the mean value of 463–509 kg·m^{-3}. The coefficient of variation was almost equal to accepted reference value, because of many wood specimens from this birch stand were characterized by false core. The variables of wood shrinkage were ranged from 7.9 till 9.9% and from 4.6 till 6.6% in the tangential and radial sections respectively. The accuracy values of research results were under accepted reference value of 3.0%. It was discovered that the false core mostly reduced the wood properties of Silver birch. Two groups regards basic wood density less 499 kg·m^{-3} with wood defects „false core" and more 500 kg·m^{-3} without any wood discoloration were recommended for the industrial timber scaling and the weight method of timber volume measuring.

Key words: Silver birch, timber quality, wood density, Ukrainian Carpathians.

INTRODUCTION

In Europe, Silver birch has a wide natural area stretching from the Atlantic to eastern Siberia (Hynynen *et al*. 2010). Its timber is of the great commercial value in mechanical and chemical forest industries. In Ukraine birch wood is currently appreciated a valuable raw material using by the production of the different wood products. Understanding the term „wood quality" is of industrial importance focusing on the end-use of the wood product. The density as an integral quality indicator grounds the effective usage of wood as raw materials. Generally, wood density is significantly correlated with the mechanical properties of wood as well as influences the usability of the wood material for different purposes (Dunham *et al*. 1999). There is a relatively high correlation between the density and mechanical properties of wood. *Both* specific gravity and module of elasticity increased clearly from the pith towards the surface and decreased slightly from the base to the top of *Betula pendula* Roth. (Heräjärvi 2004). Silver birch seed origins from the Baltic countries and from Finland were not different in terms of wood density (Viherä-Aarnio, Velling 2017).

In Ukraine birch forests occupy about 0.55 Million ha. *Betula pendula* Roth is a fast growing, medium-sized deciduous tree with diffuse porous wood structure and is appreciated as a valuable material in chemical forest industries. There are often false core in the

birch stems that reduce significantly the wood quality. Therefore, higher wood density provides better pulp yields, but the decay of cell wall influences negatively on both the pulping process and the pulp quality. In the chemical industry, wood density and incidence of decay are among the most important characteristics of birch wood (Tammisola *et al*. 1995). Birch trees growing in the Carpathian Agroforestry are mostly harvested as small-sized timbers for the chemical industry producing ethylacetate, charcoal, acetous acid etc. The weight method of volume measuring plays a significant role in timber-and-chemical plants. The knowledge of the variation of wood density are needed in the industrial timber scaling and the weight method of volume measuring through sampling measurements coefficients „volume/weight" as well as to predict it based on location parameters. The objective of this article was to study some silvicultural particularities, the variation of wood density and shrinkage of Silver birch growing in the Carpathian Agroforestry as well as to set up wood quality group by density for the grading raw materials according to volumetric weight changing.

METHODS AND MATERIALS

The study work was done at uneven-aged plantations of Silver birch of the age of 20–30 years. The sample plots by the dimension of 50×100 m was located in Perechyn (48º45′51″N, 22º26′16″E, 441 m asl), Orikhovytsya (48º40′21″N, 22º26′33″E, 542 m asl) and Smerekove (48º48′10″N, 22º35′49″E, 447 m asl). In total there is about 2.3 Thousand ha of single-stage stands of Silver birch growing in the Carpathian Agroforestry. Each observation plot comprises a group of more than 100 birch trees. 18 model trees of Silver birch were selected for the determination of wood density and shrinkage characteristics. Sampling trees were achieved by using the destructive (discs) method. The measurements of variables were done at breast height, ⅓ of length of bole and 1 m before the beginning of tree crown to represent the whole tree. Excel procedures were used fo rstatistical analysis. Descriptive statistics were calculated to present primarily the arithmetic mean of testing samples and the variability of wood properties. The following variables were estimated basic wood density, oven dry wood density (ρ_0), green wood density (ρ_{green}), radial (β_r), tangental (β_t), liniear (β_l) and volumetric (β_V) shrinkage according the international standards (Vintoniv, Sopushynskyy and Teischinger 2007). Basic wood density was determined using the water-displacement method as the ratio of oven dry weight to green volume. The wood *shrinkage* was expressed as a percentage determining by the amount that the *wood* shrinks when going from its green to oven dry state.

RESULTS AND DISCUSSION

Silver birch occurs most frequently on fertile agricultural lands after the dissolving the collective farms and on afforested abandoned fields in Ukraine. This agricultural forest land belongs mostly to Agroforestry companies. The effect of birch on site properties is positive because of the quick decomposing (Eriksson, Johansson and Kiviste 1997). Birch growing in good biotopes of the Ukrainian Carpathianscan exceed a height of up to 15–20 m within 30 years. Being a pioneer light-demanding tree species, Silver birch grows very well in the agricultural land developing large crown and increasing stem diameter growth. Intensive thinning are required for the profitable production of sawn timber as well as to shorten the rotation (Cameron *et al.* 1995). In the case of birch stands of Ukrainian Agroforestry, where the last 25–30 years were no forest management,

in order to produce top quality timber are recommended only one artificial pruning at the stand height exceeding about 8-10 m with a pruning height of 5-6 m. In Finland, pruning is commonly carried out in two stages taking place when the stand height exceeds 6–7 m and 10 m (Hynynen *et al*. 2010). To avoid the stem damages are recommended clippers and the diameter of the pruned branches should be below 2-3 cm.

The wood properties of the specimens from different locations were represented through the variables of descriptive statistics. Coefficient of variation revealed how close a set of measurements are to an accepted reference value as for wood density was equal 10% and for wood shrinkage in the tangential and radial directions – 28% and in the volume – 16%. The statistics of wood properties of Silver birch located in Perechyn are given in the Table 1.

Table 1: Statistics of wood properties of Silver birch growing in Perechyn

Variables	N [units]	min	$M^{\pm m}$	max	V [%]	P [%]
ρ_b[kg·m^{-3}]	50	419	$509^{\pm 7.69}$	631	10.7	1.5
ρ_0[kg·m^{-3}]	50	485	$589^{\pm 8.84}$	725	10.6	1.5
ρ_{green}[kg·m^{-3}]	50	723	$934^{\pm 8.52}$	1087	6.4	0.9
β_t [%]	50	7.9	$8.9^{\pm 0.08}$	9.9	6.1	0.9
β_r, [%]	50	4.9	$5.6^{\pm 0.06}$	6.6	7.9	1.1
β_l[%]	50	0.2	$0.4^{\pm 0.02}$	0.7	34.9	4.9
β_V[%]	50	12.6	$13.6^{\pm 0.08}$	14.7	4.3	0.6

Notes: N – number of samples; min – minimum; $M^{\pm m}$ – mean an its standard error; max – maximum; V – coefficient of variation; P – accuracy value; ρ_b – basic wood density; ρ_0 – oven dry wood density; ρ_w–green wood density; β_r, β_t, β_l and β_v – radial, tangential, linear and volumetric shrinkage.

The basic wood density varied from 419 till 631 kg·m^{-3} with the mean value of 509 kg·m^{-3}. The coefficient of variation was almost equal to accepted reference value, because of many wood specimens from this birch stand were characterized by false core. The variables of wood shrinkage were ranged from 7.9 till 9.9% and from 4.9 till 6.6% in the tangential and radial sections respectively. The accuracy values of research results were under accepted reference value of 3.0% using for the determination of wood properties in wood science. Descriptive statistics of wood properties of Silver birch growing in the agricultural land of Smerekove are filed in the Table 2.

Table 2: Statistics of wood properties of Silver birch locating in Smerekove

Variables	N [units]	min	$M^{\pm m}$	max	V [%]	P [%]
ρ_b[kg·m^{-3}]	50	415	$502^{\pm 7.37}$	619	10.4	1.5
ρ_0[kg·m^{-3}]	50	478	$583^{\pm 8.59}$	713	10.4	1.5
ρ_{green}[kg·m^{-3}]	50	679	$870^{\pm 9.39}$	999	7.6	1.1
β_t [%]	50	7.9	$9.1^{\pm 0.07}$	9.9	5.9	0.8
β_r, [%]	50	4.6	$5.5^{\pm 0.08}$	6.4	9.9	1.4

Variables	N [units]	min	$M^{\pm m}$	max	V [%]	P [%]
β_l [%]	50	0.0	$0.5^{\pm 0.03}$	0.9	46.9	6.6
β_V [%]	50	12.2	$13.8^{\pm 0.09}$	15.2	4.6	0.7

Oven dry wood density varied from 478 till 713 kg·m^{-3} with mean value of 583 kg·m^{-3}. The data of wood properties of Silver birch locating in Perechyn and Smerekove weren't characterized by significant differences. The coefficient of variation and accuracy value wereequal to an accepted reference values. Wood properties of Silver birch locating in Orikhovytsya showed that stem wood density decreased in birch trees growing at the altitude of 542 m asl (Table 3).

Table 3: Statistics of wood properties of Silver birch locating in Orikhovytsya

Variables	N [units]	min	$M^{\pm m}$	max	V [%]	P [%]
ρ_b[kg·m^{-3}]	50	401	$463^{\pm 6.27}$	603	9.6	1.4
ρ_0[kg·m^{-3}]	50	464	$536^{\pm 7.48}$	701	9.9	1.4
ρ_{green}[kg·m^{-3}]	50	704	$836^{\pm 7.32}$	976	6.2	0.9
β_t [%]	50	8.1	$9.1^{\pm 0.07}$	9.9	5.6	0.8
β_r [%]	50	4.7	$5.3^{\pm 0.06}$	6.6	7.7	1.1
β_l [%]	50	0.2	$0.5^{\pm 0.03}$	0.9	42.1	6.0
β_V [%]	50	12.6	$13.7^{\pm 0.08}$	14.9	4.3	0.6

The green wood density of three sites were in the range from 679 kg·m^{-3} till 1087 kg·m^{-3}. The mean value of basic and oven dry wood densityof Silver birch growing in Orikhovytsya was lower than in Perechynon 46 kg·m^{-3} and 54 kg·m^{-3}respectively. The difference of green wood density exceed 98 kg·m^{-3}causing a significant impact on the volume measuring through „volume/weight" in timber-and-chemical plants. The variation of volumetric shrinkage revealed no consistent differences between wood specimens selected in the three sites. There was some differences between mean values of the wood shrinkage in the tangential and radial directions. These variances in wood properties were caused by the wood defect „false core" detecting by the birch trees growing at the higher altitude of Orikhovytsya. The site conditions were better at the basal area of Perechyn and Smerekove. The false core in stems reduced significantly the volumetric mass of birch wood. Resuming the received data, it was proposed for the industrial timber scaling and the weight method of volume measuring, two groups regards basic wood density less 499 kg·m^{-3}with wood defects „false core" and more 500 kg·m^{-3} without any wood discoloration.

CONCLUSIONS

Small-sized timbers of *Betula pendula* Roth growing in the Carpathian Agroforestry were mostly harvested for the chemical industry. In order to produce top quality timber was recommended only one artificial pruning at the stand height exceeding about 8–10 m with the pruning height of 5–6 m using clippers. The false core mostly reduced the wood properties of Silver birch. Two groups regards basic wood density less 499 kg·m^{-3}with wood defects „false core" and more 500 kg·m^{-3} without any wood discoloration

were recommended for the industrial timber scaling and the weight method of timber volume measuring.

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