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THE WOOD MECHANICAL PROPERTIES CHANGES OF NORWAY SPRUCE DYING AND DEAD TREE

The article contains results of the studies of influence of tree death prescription on the mechanical properties of dead wood in the centers of Norway spruce shrinkage. It was found that the strength and exploitative qualities of spruce wood are reduced in the direct proportion to the increase of tree death prescription. At the same time mechanical properties of wood are reduced slightly with the age of dead tree up to 5 years.

Introduction. Issues of forest stands productivity and rational use of wood resources are becoming of particular significance in the conditions of market economy.

In this regard, the quality of wood raw material is one of the important performance characteristics of the forest. Spruce is one of the main forest-forming species in Belarus. Spruce plantations perform water protection, water and other useful functions, and are characterized by a high quality wood.

Currently, in the Republic there is a massive drying spruce caused by exposure to a number of reasons: necrosis and cancerous diseases of branches and trunks, blight beasts summoned during disease trunks and roots, stem pests, modification of the hydrological regime, the windfall and others [1–3]. The main damage from drying stands is to reduce technical qualities of the wood of dead trees, the lower the output of high-quality timber and its devaluation. In this regard, rational use of raw timber from these stands is largely dependent on the technical properties of wood.

Thus to characterize the structural, technological and operational properties of wood, which is manifested at different loads and effort, the most important of such mechanical factors as compression wood, static bending, impact strength, and others [4, 5].

The study of basic physical and mechanical properties of wood in various stands (pine, oak, birch, ash) and the detection of footnote dead trees indicate a change in its qualities and properties over time, which represents a certain succession, which in one or another way closely linked different groups of insects-xylophagous and wood-decaying fungi [6–9]. At the same time it is still not fully addressed the question of the properties of the wood of dying and dead trees Norway spruce that is not possible to give recommendations for its rational use.

The aim of this work was to study the changes of mechanical properties of Norway spruce wood in drying stands.

Main part. To achieve this goal in 2013 on the territory of the state wood economic establishment "Mogilev forestry" were selected sections of dying spruce stands, in which temporary plots were laid and harvested material for the study of the mechanical properties of wood was put [10]. It was laid three experimental plots in the two pure and one mixed (with up to 30% of pine) spruce stands of 60–90 years old in the oxalis type of forest.

On sample plots 29 model trees were selected, of which the basis trees logs of length of 1.5 m at a height of 1.3 to 2.8 m were taken. Further, the logs were sawn into planks and the bars, which were kept at room temperature for 1.5–2.0 months to achieve a moisture content of 12–15% and then used to obtain samples.

The mechanical properties were determined by standard methods [11–15] on universal testing machine MTS Insight 100 and pendulum impact-testing machine. The output data and their processing were carried out in the software Test Works 4 and Microsoft Excel. The figures obtained were converted to normalized humidity.

To determine the age of dead trees with each model tree at a height of 1.3 m sawed wood were taken. Additionally core samples of wood from the control trees located in the undamaged 60-years-old oxalis spruce stands were selected. The term of model trees death was determined in the laboratory of productivity and sustainability of forest ecosystems SSI "C. F. Kuprevich Institute of Experimental Botany of the National Academy of Sciences of Belarus " by dendrochronological method [16].

The mechanical properties of total wood mortality in the shrinkage hearths of spruce trees listed in the table, and their dynamics is presented in Fig. 1–3.

This table shows that mechanical properties of spruce wood are reduced with age of snags. This is because of the emergence and development of wood-decaying fungi, action of pests, and the impact of seasonal changes of other biotic and abiotic factors.

Mechanical properties of wood in Norway spruce depending on the time of formation of deadwood

Type of test	Indicators	Without signs of weakening	Dying	Deadwood of current year	Deadwood of last year	Deadwood (5 years)	Deadwood (7 years)	Deadwood (10 years and more)
Compression along fibers	Number of samples, pieces	265	234	201	192	643	462	252
	Breaking point, MPa	51.4 ± 0.9	53.0 ± 1.2	47.2 ± 0.8	45.3 ± 1.1	41.5 ± 0.5	39.6 ± 0.7	35.5 ± 0.5
	The coefficient of variation, %	13.8	16.8	12.7	16.5	15.1	18.8	12.4
	Accuracy, %	0.9	1.1	0.9	1.2	0.6	0.9	0.8
Static bending	Number of samples, pieces	39	67	36	40	88	114	61
	Breaking point, MPa	73.6 ± 6.0	76.4 ± 4.5	63.3 ± 2.8	58.4 ± 4.1	51.4 ± 4.0	51.3 ± 2.4	40.8 ± 1.9
	The coefficient of variation, %	25.0	24.2	13.1	21.8	36.7	24.7	17.9
	Accuracy, %	4.0	3.0	2.2	3.5	3.9	2.3	2.3
Bending drums viscosity	Number of samples, pieces	36	86	40	35	56	81	46
	Impact strength, j/cm^2	5.3 ± 0.7	5.6 ± 0.5	4.6 ± 0.7	4.2 ± 0.6	3.5 ± 0.3	3.4 ± 0.2	2.8 ± 0.3
	The coefficient of variation, %	39.4	42.7	46.8	41.4	37.0	19.9	31.4
	Accuracy, %	6.6	4.6	7.4	7.0	4.9	2.2	4.6

It should also be noted that the mechanical properties deteriorate at the dead wood of the current year compared to the wood of trees with no signs of weakening.

The tensile strength of spruce wood in compression along the fibers varies from 51.4 to 35.5 MPa depending on the state of the tree. The coefficient of variation within each tree group state ranges from 12.4 to 18.8%, and the accuracy of indicator is from 0.6 to 1.2%. The ultimate strength in static bending changes over time from 73,6 to 40.8 MPa and impact strength flexural – from 5.3 to 2.8 j/cm^2. The variability of these indicators is significant (the coefficient of variation in average is more than 20%).

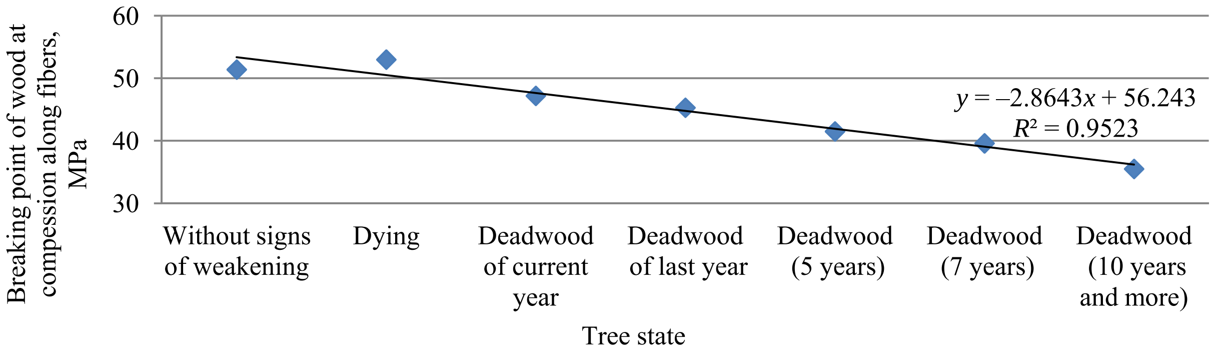

Fig. 1. Breaking point change of Norway spruce wood at compressing along fibers

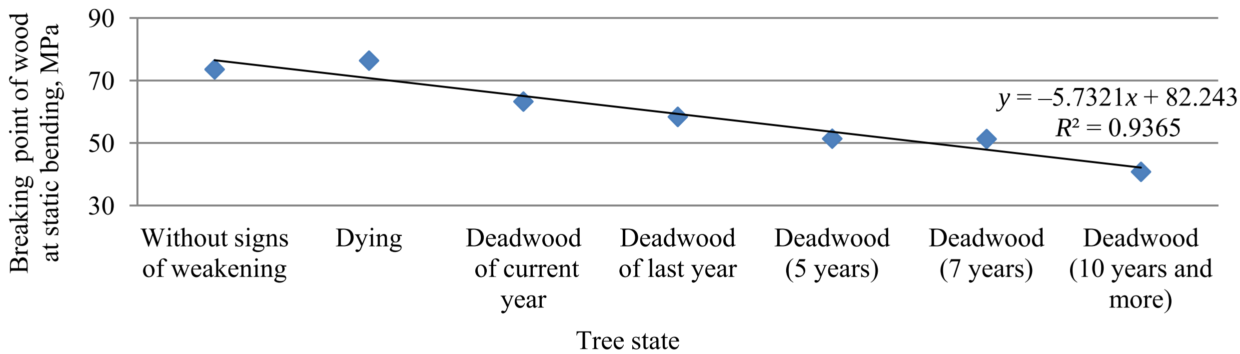

Fig. 2. Breaking point change of Norway spruce wood at static bending

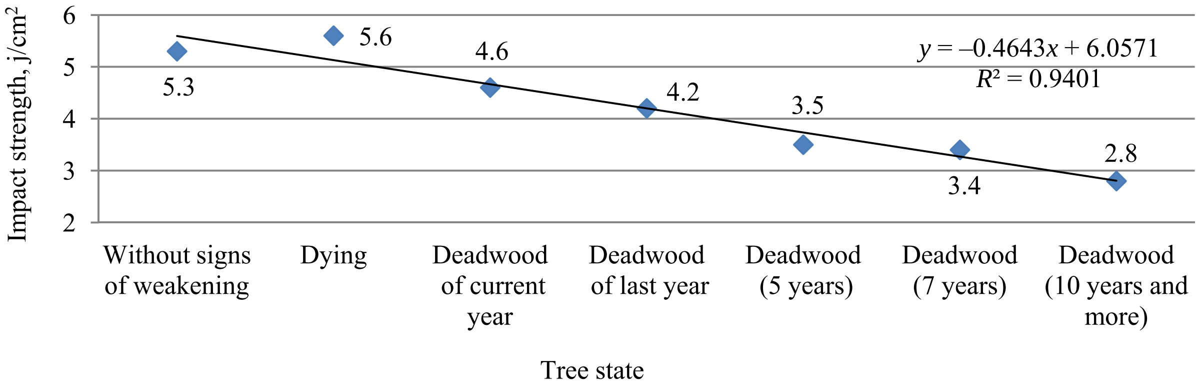

Fig. 3. Change of Norway spruce wood impact strength

The graphs show that the mechanical properties of wood and the state of dying trees are in inverse linear correlation. Since the correlation coefficient of 0.97–0,98, the correlation is strong.

The tensile strength of wood in compression along the grain at the annual dead wood is reduced by almost 12%, the tensile strength of wood in static bending and at impact strength is almost 21%.

After only 5 years after drying deviation of the mechanical properties from the wood of trees with no signs of weakening is 19–34%. It is established that the tensile strength of wood under compression along the fibers of trees in the age of dying 10 years or more is reduced by 1.4 times, in static bending – 1.8 times, and at impact strength – 1.9 times in comparison with the indicators of the healthy trees wood. The observed slight increase of dying trees mechanical properties is probably due to anatomical changes in the structure of the plant cells.

Conclusion. Thus, the study of changes in the mechanical properties of spruce wood depending on the time of drying showed that the strength and performance of timber trees with shrinkage term of up to 5 years under the influence of abiotic and biotic factors decrease slightly. A further increase of the period of drying leads to significant degradation of the wood quality.

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