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CLASSIFICATION OF TREES ON THE BASIS OF SPATIAL STRUCTURE WHEN ASSIGNING FOR CUTTING

The technique of classification trees into 3 classes of competition in the assigning for thinning on the basis of indicators of the spatial structure and competitive interactions between the trees. The method was tested on 19 plots materials incorporated at the age of 30 to 70 years in mossy pine forests of artificial origin, evenly spaced on the territory of the Republic of Belarus.

The indicators characterizing the spatial structure show the position of a tree specimens in the vertical and horizontal planes. The "growth area" of the tree played the role of the horizontal characteristics of wood in relation to other individuals. The indicators characterizing the position of individuals in the vertical plane is the height of the tree. Competition classes of trees were determined based on their position in the vertical plane relative to competitors and the trees received the following names: dominant, medium and oppressed.

The advisability of the proposed separation was confirmed by a visually-graphic way, which showed the presence of a clear influence of the spatial structure of the trees on the performance of the stand. Using this classification will increase the productivity of crops by reducing the competition between trees and optimizing the use of the area under the stands.

Key words: classification, Scots pine, area of growth, competition area, tree height, the horizontal projection of the crown, performance.

Introduction. Currently, the classification of trees based on the spatial structure of the forest stand in the assigning of the trees for the tending cuttings is considered in the forest science along with other topical problems. This question is directly related to the influence of the spatial distribution of trees on the plantation productivity. In the studies of this nature to isolate the impact of individual factors on the studied parameters the classification is applied – the separation of the forest stand into homogeneous groups. N. P. Anuchin attached great importance to the classification of trees in the plantation. According to him, a well-composed classification system extends the concepts of objects, facilitates the identification of the general laws and internal relationships [1]. In preparing the tables of the current growth of V. V. Antanaitis also used the classification and grouped forest stands, taking into account the species, age, bonitet (yield class) and fullness, which allows to create a relatively homogeneous group of tree stands [2]. Based on the above, the decision was made in the study of influence of the spatial structure on the performance of tree stands to apply the classification of trees.

Main part. The material for the research were 19 plots laid in age 30 to 70 years old in mossy pine forests of artificial origin, evenly spaced on the territory of the Republic of Belarus.

The classification of trees implies the division of trees into the homogeneous group on a certain feature within the boundaries of the forest stand. The features on which a classification of trees is carried outdescribed in this article, are indicators of the spatial structure and the competitive relationships between the trees. In order to justify the chosen indicators we should clarify the notion of the spatial structure and the parameters characterizing it. V. Ya. Gribanov suggests the mutual arrangement of trees relative to each other due to habitat features, the origin and formation of stands being the spatial structure of the forest stand [3]. In other words, this is the position of all the species of the forest stand in three dimensional spaces relative to each other. The indicators characterizing the spatial structure should reflect this position in the vertical and horizontal planes.

The researchers used the average distance between the trees and the average distance to the nearest trees (there are various methods to determine the nearest trees) as the horizontal wood characteristics in relation to other trees [4]. We have chosen a more complex figure, which expresses more correct the competitive relationship between trees in numerical terms – a "growth area" of the tree.

The concept of "growth area" appeared in the forest terminology together with the research on the calculation of the optimal thickness over an area of growth (A. P. Tyabera) [5]. Later, a more general term "growth area" appeared – the space available to the tree and not used by neighbors. "Growth area" largely corresponds to the concept of "feeding area", which is associated with the area of the root system (P. P. Izyumky, E. Assmann, A. K. Polyakov, I. Zhelev). Also, this term is found in the works of V. V. Kuz'michev, T. N. Mindeleyeva, V. P. Cherkashin.

The most effective method of determining the "area of growth", according to A. A. Weiss, is the method of Fraser [6]. Its essence lies in the fact that the entire plot is divided into elementary sections and trees occupy an area nutrition proportional to their cross-sectional area at breast height, and inversely proportional to the distance from this tree to the elementary section. The tree, the sectional area ratio of the distance of which will be greater, will be a contender for a square piece of territory. The overall "growth area" of wood specimens is determined by summing the squares of the elementary sections.

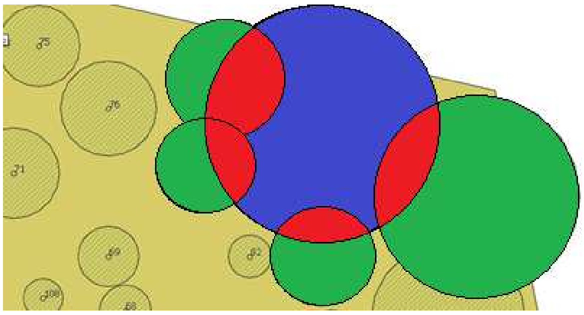
In the studies presented in this article, we have used the method in which the "growth area" of the tree was limited by a circle around the center of the trunk radius equal to the average radius of the horizontal projection of the crown. In constructing the "growth areas" of all the trees in the plot the sites of intersection of "growth area" – the area of competition appear. The size of the competition area displays the amount of competitive relations between the trees.

The disadvantage of the given method from the described above is the average value of the "growth area". However, there are a number of positive points. For example, the calculating of the parameter in this way reduces the time and labor. But the main advantage of this method is that when defining the "growth area" we also get a digital expression of the competitive relations between the trees – the value of the area of competition. This indicator is of great importance in the study of the influence of the spatial structure of trees on the productivity of stands.

The indicator characterizing the position of an individual in the vertical plane is the height of the tree. Based on the values of the indicators of the "growth areas" and the height of the tree, the classification of trees will be carried out.

A competition class of the tree is determined based on its position in space relative to the group of trees separated from it in close proximity. In order to establish a group of trees, affecting the test tree, a horizontal stand structure is analyzed on the basis of the "growth areas". For each of the tree trees-competitors were determined. The tree-competitor – is a tree standing nearby, with which a tree has an intersection "areas of growth", or, in other words, the competition area (Fig. 1).

The number of trees competing in various stands varies from 1 to 7 pieces (due to the variations in the age and density of plantings). In the rarefied stands only 1–2 trees-competitors are found, thus, the basic number of trees stand apart, and do not have the intersection circles of growth. This situation occurs after cutting when the distance between trees is increased, and the area of horizontal crown projections remains unchanged. In the dense stands the opposite situation develops, and up to 7 competitors have an impact on trees.



– the competition area;

– "growth area" of the analyzed tree;

– "growth area" of the tree-competitor.

Fig. 1. Identification of trees-competitors

Further we made a comparison of the analyzed tree and trees-competitors. If the height of the central tree has a value greater than the height of the tree-competitor, then a value of +1 is attached to their relationship; if the height of the central tree has a value less than the height of the tree-competitor, then a value of –1 is attached; if the values of the heights are equal, then the relationship has a value of 0. After evaluating of each relationship with trees-competitors or each tree the values of all its relationships are summed up. After performing these actions we have obtained the sums of values of the relationships –6 to +7.

The division of all studied trees into the three classes of the competition allowed to form a sufficiently homogeneous group of trees. The classes of the competition received the following names: dominant, medium and oppressed trees.

The division took place on the following algorithm. When the amount of bonds is +2 or more, the central tree belongs to the dominant class, as its height is greater than the average height of trees-competitors; if the amount of bonds is in the range from +1 to –1, inclusive, the tree belongs to the middle class and is equal to the average height of trees-competitors; if the amount of bonds has a value of –2 or less, the tree belongs to the oppressed class of trees (its height is lower than the average height of the trees-competitors).

A visual graphic method has been used to confirm the feasibility of the proposed separation. The values of the annual radial growth over the past 10 years for the trees of three classes of competition were plotted (Fig. 2).

The dominant trees showed an intermittent dynamics of growth in the range of 1.0 to 3.0 mm. Significant fluctuations may be due to the effect of groundwater level, climate and other environmental factors, which may change every season.

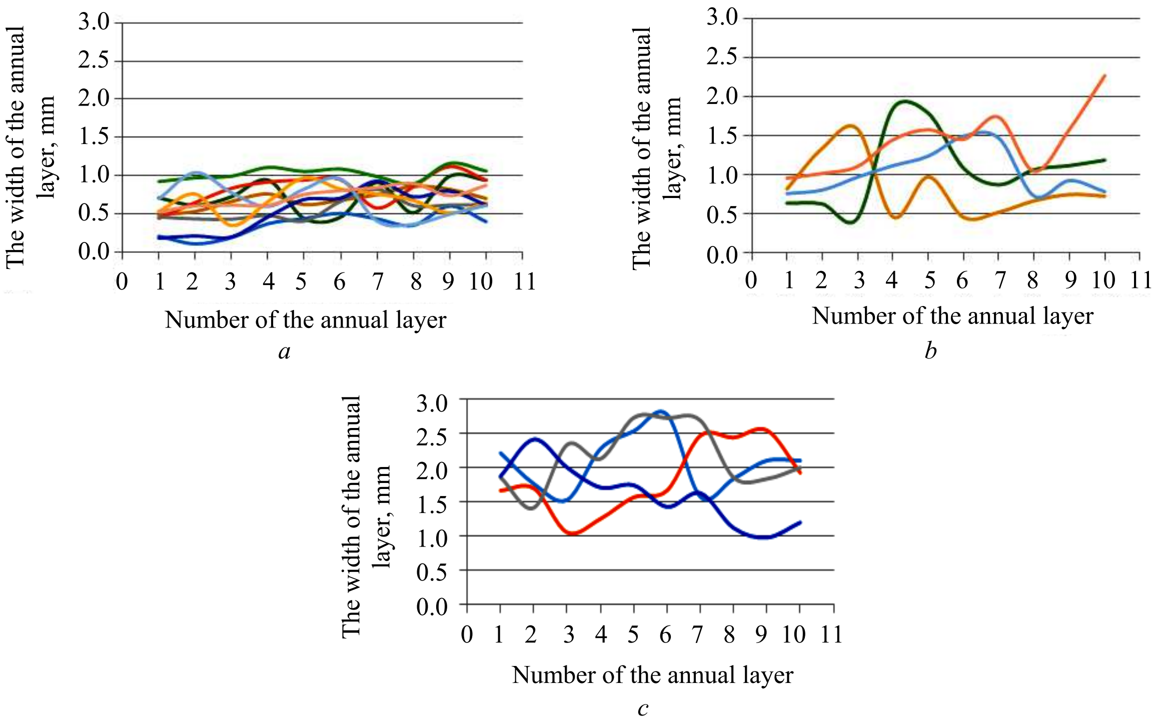


Fig. 2. The dynamics of radial growth:
a – the trees of the oppressed class; *b* – trees of the middle class; *c* – the trees of the dominant class

The dynamics of the current average growth of trees of the middle class of competition varies from 0.5 to 2.0. Oppressed trees have an almost linear dynamic range from 0 to 1.0 mm. This may be a consequence of the strong oppression by trees-competitors and act as a limiting factor. As an example, the analysis of the plot of 60 years of age is made. Similar studies were carried out on the materials of all plots.

Conclusion. The investigation of the effect of spatial structure on the performance of pine forest stands by class of competition showed an explicit a presence of a relationship between the spatial structure of trees and of the stand productivity; the nature of the impact of each class being specific. Therefore, to achieve a maximum performance through the tending cuttings the selection of the trees thinning should be carried out on the basis of the developed classification and spatial arrangement of trees. Such an approach will reduce the competition in the tree stand and maximize the potential productivity of habitats.

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