УДК 630*562.1

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INFLUENCE OF BIRCH ADMIXTURE ON RADIAL GROWTH OF PINE IN MIXED PINE-BIRCH STANDS

The article deals with the analysis of the influence of the birch trees impurity in pine-birch forest standss on the radial growth of pine trees. With the help of software Q-GIS forest trees mapping was done. Also using Q-GIS features, some analysis of the influence of the forest stands spatial structure on pine trees characteristics was carried out. Based on an assessment of the radial growth of pine stems, some classification into three groups according to the growth intensity was done. As a result of a regression analysis the effect of forest stands characteristics of birch trees in biogroups on radial growth of pine stems was indicated and researched.

Introduction. Mixed stands have great importance to fill the national economy needs and also perform the soil-protective, water regulating, sanitary and hygienic, recreational and other useful functions. Now because of the increasing interests of forestry before foresters specialists are faced with a problem of what kind of plantings – mixed or pure –will be able to solve problems of the forest industry. G. F. Morozov, M. K. Tursky revealed advantages of the mixed forest standss.

According to K. A. Gavrilova and V. P. Kornev birch growth has positive impact on type and amount of soil fauna and leads to accumulation of a humus, total nitrogen, reduction of exchangeable acidity and increase of degree of soil saturation with bases. Introduction of deciduous impurity to the top bed curtains or to an underbrush of plantings of a pine in the conditions of a sod-podzol and sabulous can accelerate decomposition of a laying that promotes release of nutrients [1].

Mixed stands in the woods of Belarus have a wide circulation. Pine and birch stands are met everywhere and differ in high productivity. However questions of management in the forestry are still being developed.

The analysis of silvicultural experience shows that it is better to create mixed pine plantings even in extreme conditions of growing. Relationship of tree species can be various depending on climatic and soil conditions. But such plantings are steadier against harmful insect and especially to mushroom diseases. In the conditions of pine forest stands planting of a pine is pure, in the subor stands they are pure or mixed with a birch, and in richer conditions they are mixed with a fir-tree [2, 3].

I. N. Rakhteenko and G. I. Kabashnikova [4, 5] conducted researches in pine and birch plantings of various structure and found out that they pass 3 stages. The first stage is 30 years when the pine is under bed curtains of a birch and experiences some oppression from its party, the second stage is 30–40 years when a pine on height is compared to a birch, and at last, the third stage is a pine as breed durable, using positive influence of a birch it and occupies the dominating situation.

Growth and development of a pine and birch in the mixed stands depend on its structure. Small impurity of a birch (20–30%) positively influences growth and development of a pine. When mixed stands it is necessary to consider relationship of a pine and other wood types at joint growth.

Main part. To analyze the impact of impurity of a birch on a radial gain of a pine the trial area (TA) was taken in the 6th apportionment of the 29th quarter of Negoreloe forestry experimental station which is presented by pine-fern of the 1th class of site class at the age of 67 years. In process of field works taxation indicators of 408 trees on a site of the trial square were defined: diameter north-south and west-east , height, age, diameter of crown. north-south and west-east crown extent, qualitative category, feature of crown, the area of cross section and volume of each trunk, and also coordinate of X and Y.

During processing of experimental data and mapping, the coordinates collected in the course of field works the spatial structure of a forest stands were determined.

With the help of Quanktum GIS software the scheme of trees location on the trial square is made (Fig.1). For the pictorial view of influence of different wood types of trees on the based of data of mapping of crowns the scheme of their location on the trial area with the indication of diameters of crown was constructed in Quantum GIS. In Fig. 2 the competition of a birch and pine in planting is quite strong. To identify the level of influence of impurity of a birch the analysis of a gain of a pine in planting is carried out. For 10% of trees of a pine the radial gain was defined (by means of an incremental drill cores are taken and width of year rings in 10 years is measured. All obtained data were divided into three groups on extent of influence of a birch on a pine gain: the strong – a radial gain in 10 years of 0-10 mm, average – 10–20 mm and weak – 20 mm and more. Thus, three ranks of biogroups of wood plants were received where the pine has three states: oppressed, average and dominating.

The average distance of tree trunks of birches was found to the nearest pine tree, thus biogroups

were formed. Those trees were birches that were about 2 times the diameter of the Crown of pine. Beyond this distance influence of birch growth was not so much more influenced by specific relations was in the pine stands part.

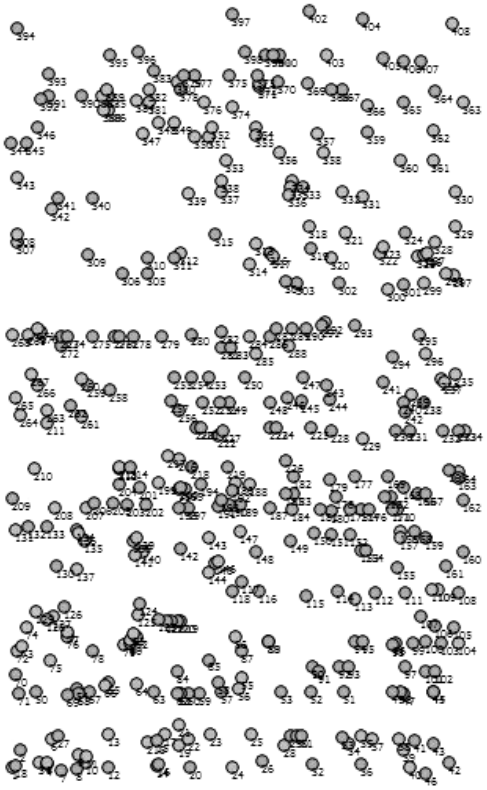

Fig. 1. The scheme of trees location on the trial area (Quantum GIS)

Analysis of the experimental material was carried out according to the programm Quantum GIS. To prepare the data we used the tables of attributes of layers.

Influence of taxation indicators of trees of a birch on a radial gain of a pine was defined by means of the regression analysis in the software package of STATISTICA 10.0.

The main criteria for evaluating the regression equations were the correlation coefficient, stands error and the Fisher criterion. Dependent variable was the radial gain of trunks of a pine (central in bio group), as parameters of the equations height, diameter of crown and volume of trunks of trees of a birch served as the average distance to birch trees (table). It was verified a large number of different kinds of regression models, whose task is to display the most accurate picture of the relationship between birch and pine in forest plantations.

The study revealed that the highest correlation between the radial growth of pine oppressed and inventory indices in birch biogroups is obtained by using the equation:

$$Z_{r_1} = \frac{L}{b_1 + b_2 L + b_3 h} + b_4 h + b_5 V^3 + b_6 d_k,$$

where – Z the radial growth, mm; L – average distance to the birch trees in the two radii crowns of pine trees, m; h – the average height of birch trees in biogroups, m; V – average volume of birch trees in biogroups, m^3; d_k – the average diameter of the birch tree crowns in the group, m.

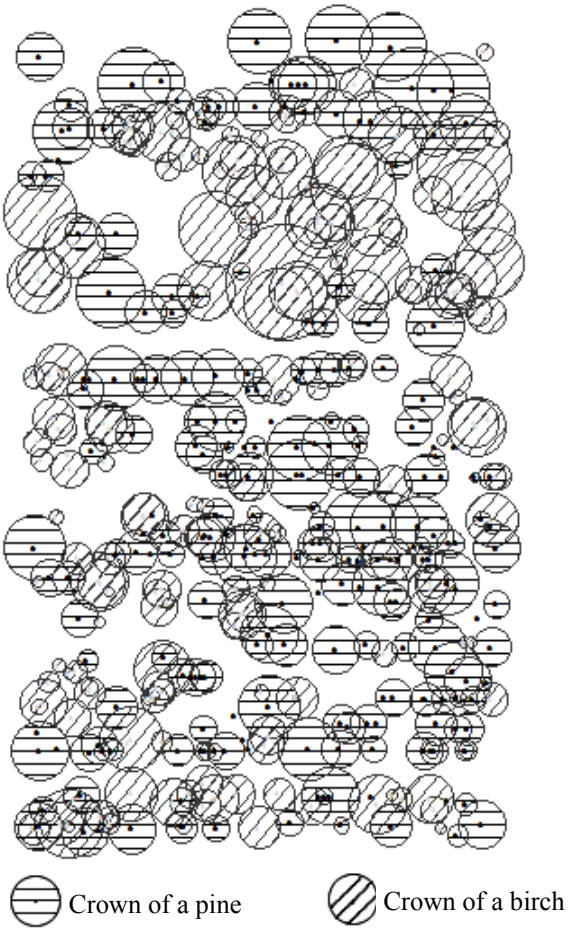

Fig. 2. The scheme of trees location and crowns of birch and pine on the trial area

The correlation coefficient of the equation is 0.705. This demonstrates the significant impact of selected birch forest indices on growth pine in mixed stands.

The same equation to describe relationship between a pine and a birch for the following number of biogroups with an average gain of a pine is impossible.

Further data processing was carried out, the best indicators of the regression analysis were revealed as a result of the following equation of a radial gain of a pine of the average level Z_{r_2} l with taxation indicators of trees of a birch in biogroup:

$$Z_{r_2} = b_1 L e^{-b_3 L} + b_4 e^{-b_5 h} + b_4 \log V.$$

The data for the regression analysis

Radial gain of a pine in 10 years, mm	Average distance to birches in bio-group, m	Height of a birch, m	Crown diameter of birch, m	The volume of the trunk of birch, m^3
Low growth of pine trees				
6.0	2.63	19.5	3.3	0.1967
9.5	4.13	23.3	3.7	0.2282
9.0	2.82	20.2	3.0	0.2699
4.0	2.40	17.5	1.7	0.1401
5.0	2.52	27.8	3.8	0.3977
6.0	3.00	22.1	3.4	0.2383
3.5	3.28	16.3	2.2	0.0997
5.5	3.35	21.2	3.3	0.1934
6.0	2.28	23.9	3.0	0.2981
6.5	3.22	22.1	2.7	0.2318
5.0	3.69	26.3	7.0	0.7240
5.0	3.21	24.3	4.7	0.4411
5.5	2.86	24.7	4.0	0.3945
6.0	2.65	18.8	1.7	0.1129
The average growth of pine trees				
10.0	2.03	18.1	3.3	0.1873
16.0	1.96	21.6	3.6	0.1578
14.5	2.59	19.8	3.3	0.2177
17.5	5.07	16.8	2.7	0.1200
15.5	3.21	20.0	2.3	0.2300
18.0	3.77	23.7	3.0	0.2642
14.0	3.02	22.2	2.9	0.2297
12.5	3.03	21.1	3.0	0.2150
12.5	3.50	21.2	2.5	0.1954
10.5	3.87	19.3	2.4	0.1462
13.5	3.63	21.1	3.5	0.2316
15.0	2.45	18.5	2.7	0.1702
12.0	3.39	23.9	3.0	0.2981
10.0	2.50	20.3	2.9	0.1996
15.0	3.90	22.7	1.8	0.2892
18.0	4.19	22.5	5.8	0.3756
18.5	3.58	17.8	2.2	0.1284
19.5	4.44	20.6	3.3	0.2426
11.0	6.70	21.3	4.3	0.2977
High growth of pine trees				
26.0	4.74	25.4	3.5	0.3237
24.5	3.99	22.5	2.9	0.2170
22.5	4.13	26.3	3.3	0.3336
30.0	5.17	20.7	3.4	0.1932
23.0	2.86	20.8	2.3	0.2143
25.3	7.42	22.9	4.5	0.5181
25.4	5.43	22.3	5.0	0.3786
32.0	5.25	20.6	4.8	0.3081
20.0	3.45	22.0	2.6	0.2318

The correlation coefficient in this case is 0,564. The interrelation between indicators decreases as relationship of a pine and a birch are counterbalanced and trees are in the equal competition among themselves. The graphic representation is presented in Fig. 3.

For biogroup where the pine holds dominant position in the relation to birches the following equation for definition of a radial gain Z_{r_3}: was defined:

$$Z_{r_3} = b_1 + b_2 L + b_3 h + b_4 d_k + b_5 V^3.$$

The value of coefficient of correlation is 0.876 that indicates considerable mutual influence between trees of a pine and a birch in a forest stands, and the birch can render and a positive effect on a radial gain of a pine.

As a result of the analysis of distances between trees of a pine and a birch within biogroup it was revealed:

– the average distance to the next birches in biogroups with an oppressed pine is 3.0 m and less;

– the pine has an average gain where within two diameters of its crown there are trunks of a birch and distance between them makes about 3.5 m;

– the pine holds a dominant position in biogroups with average distance to trees of a birch is 4.7 m.

Conclusion. In Belarus the most part of the forested area is occupied by the mixed plantings which have high efficiency. Tree species (a pine and a birch) possess similar biological properties such as insistence to light, humidity and richness of soils.

The mixed pine and birch stands most fully meet the needs of a national economy as they provide bigger number of different types of assortments, including high technical qualities. And separate birch plantings isn't required: assortments on this breed turn out when felling of the mixed forest stands is carried out.

The work is devoted to topical issue: impact of taxation indicators of a birch on a pine gain in ten years is defined. As a result of modeling their efficiency was defined and described.

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Received 18.01.2014