УДК 630*443.3

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OCCURRENCE OF ASH DIEBACK IN STANDS AND PLANTINGS

The results of forest pathology investigation carried out in 2014 in ash stands of the republic are analyzed. Incidence of damaged branches is 100%. Occurrence of the disease on the first and second stand stories are 89.9% and 73.3% consequently, and on underbrush is 14.8%. Less disease stability have young plants in forest nurseries, occurrence of the necrosis is 91.6%.

The development of ash dieback in forest sites differes insignificantly and increases weakly in South-North line. Average category of tree state 3.3 refers the stands to weakened hard. Ash decline is continued in forests, the number of wind-fallen trees in eight years is up 15.6 to 96.8%. On grows plots of some forestries ash trees fully died in this period.

Branch necrosis develops together with *Armillaria* root rot (correlation coefficient is 0.81). Crone declining is faster than root rot formation, some water sprouts form even on weakened trees. This gives evidence of increasing the intensity of pathogen *Hymenoscyphus fraxineus* development in Belarus and decreasing the disease stand stability in last 6 years.

Key words: ash dieback, *Hymenoscyphus fraxineus*, common ash, *Fraxinus excelsior*, widespread dieback.

Introduction. European ash (*Fraxinus excelsior* L.) is one of the valuable forest-forming species naturally growing in the forests of Belarus. To the middle of the twentieth century the given kind was relatively resistant to pest and diseases and had a rather good phytosanitary condition [1]. However now it is observed a mass dieback of ash forests and intensive loss of specie from the planting stock, caused by action of the causative agent of the branches necrosis *Hymenoscyphus fraxineus* (= *Chalara fraxinea*, = *H. pseudoalbidus*) (T. Kowalski) Baral, Queloz, Hosoya and white rot caused by *Armillaria* spp.

On the territory of Belarus the mass dieback of ash plantings began in 2003. In 2010 with the help of the molecular-genetic analysis method the causative agent of ash branches necrosis *H. fraxineus* [2] was found, later it was detected on the whole territory of Belarus, and that permitted to make a formal record of symptoms caused by the disease pathogen.

The disease development begins with a lamina lesion. The leaf necrosis spreads along the primary rib onto the leaf petioles, moves into shoots and subsequently spreads on branches and leads to the crown drying. Old necrotic cankers can be formed in the contamination places on large branches. The disease is most dangerous to young plants, leading to their destruction during one vegetation period. Mature trees can have a chronic form of necrosis, leading to their general weakening and subjecting them to attacks of others pathogens and pests. There is contamination with root rots caused by *Armillaria* fungi, and as a result, intensive windfall phenomena are observed.

In 2014 the total area of ash plantings in Belarus was 15.4 thousand of hectares, it is 54% less in comparison with 2001 [3]. Ash forests degradation reason was considered affection by armillarious rot of roots against the background of sharp weather-climatic anomalies. The necrosis caused by *H. fraxineus*, was found only in plantings of some timber enterprises, and it's role in the process of ash dieback in Belarus remained unrevealed. In this connection the purpose of our work was to reveal the occurrence of necrosis on the republic territory, to study the ash contamination intensity in plantings and forest nurseries, and also to study the interconnection of the given disease with attacks of white sapwood rot of roots.

Research materials and methods. Forest pathological inspection of some ash-trees was done in ash plantings on permanent and temporary sample plots, and also of ash plantings in three forest nurseries. Permanent sample plots are located in 10 timber enterprises of three geobotanical subzones and were laid in 2006 to carry out phytopathologic monitoring. In the branch of Negoreloe experimental timber enterprise the permanent sample plot was laid in 2014. Temporary sample plots were laid in ash plantings of timber enterprises in Ivatsevichy, Loev and Gomel. Inspection of trees of European ash was carried out in the Central Botanical Garden of the National Academy of Sciences of Belarus in Minsk.

While doing the plantings inspection the trees state category was registered, the crown condition and presence of armillarious rot on root habits was assessed by eye, presence of epicormic branches and stem pests density were recorded, and also number and condition of the fallen trees. Besides the condition of mature trees the affection character of young growth – plant and lamina affection percentage was introduced.

The connection of ash dieback symptoms with the causative agent was confirmed with the help of the molecular-genetic analysis methods.

Inspection time is June – September, 2014.

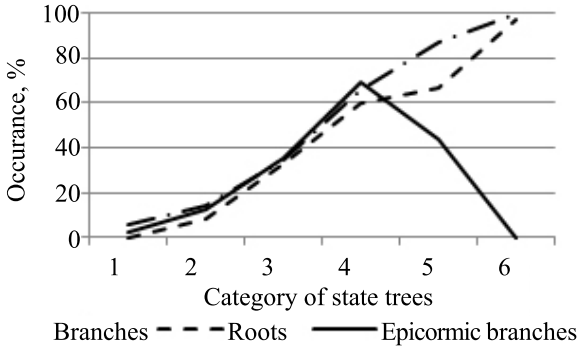
Results and discussion. According to the inspection results the ash branches necrosis occurrence in mature plantings was 100%. On the first story trees the occurrence of the given disease was 89.9% on the average in the republic, (42.9 ± 4.2)% of branches was necrotized. On the second story trees the necrosis occurrence was slightly lower – 73.3%, the share of the affected branches was (21.3 ± 10.3)%.

In the republic plantings the ash dieback recorded in 2006–2008 period goes on [4]. Number of windfall trees on the inspected territories is 37.9% on the average in the republic. In some timber enterprises sample plots are almost completely destroyed, and this factor reached 96.8% (SFI "Pinsky timber enterprise"), 73.8% (SFI "Bogushevsky timber enterprise"), 48.8% (SFI "Luninetsky timber enterprise") (Table). In ash plantings of SFI "Vasilevichsky timber enterprise" the total sanitary felling was carried out.

In the first story plantings the greatest quantity of trees belonged to the category of weakened and strongly weakened (31 and 25% accordingly), fresh and old dead wood made 19%. 22% of trees had epicormic branches, some trees had a considerable percentage or a complete crown of such branches. Fresh and old dead wood was not found in the second story of drying trees.

On the whole there is little difference in the necrosis development in the republic; it increases a little in the direction from south to north. The weight average category of the trees state in the republic amounts to 3.3 and allows to classify the plantings as strongly weakened.

During the branches dieback process a complete or partial replacement of branches by their "secondary" crown takes place, it is formed by mass development of epicormic branches with bundles of green leaves on them. Separate epicormic branches can be seen on trees of the second category of state, their formation is most intensive on drying trees (Figure).



Occurrence dynamics of epicormic branches, branches drying and of roots rot of ash trees of different state category (average data on 13 sample plots and trees of the Central Botanical Garden)

Incidence of disease in branches and roots of trees of ash plantings

Timber enterprise	Number of inspected trees	Average number of affected branches, %	Average number of affected roots, %	Number of windfall trees, pieces/%
Subzone of oak-dark coniferous forests (northern)				
Bogushevsky	61	43.4	50.9	45/73.8
Vitebsky	45	62.3	56.3	14/31.1
Borisovsky experimental	52	68.5	63.0	22/42.3
Negorelsky experimental	20	43.5	50.3	–
CBG of the NAS of Belarus	57	13.6	13.3	0/0
In all in the subzone	235	46.3	46.8	81/34.4
Subzone of hornbeam-oak-dark coniferous forests (central)				
Liubansky	64	58.9	56.9	10/15.6
Ivievsky	68	35.7	23.9	23/33.8
Ivatsevichsky	12	37.9	33.3	–
In all in the subzone	144	44.2	38.0	33/22.9
Subzone of broad-leaved-pine forests (southern)				
Pinsky	93	33.3	46.7	90/96.8
Luninetsky	80	36.2	24.3	39/48.8
Svetlogorsky	97	57.3	51.1	41/42.3
Loevsky	57	49.4	50.8	4/7
Gomelsky	54	33.9	21.3	–
In all in the subzone	381	42.0	38.8	174/45.7
In all	760	44.2	41.2	288/37.9

Root systems of the weakened by *H. fraxineus* necrosis ash trees are affected to a large degree by armillarious rot; it considerably accelerates their dying off and leads to intensive windfall phenomena. The expressed dependence between affection of trees branches and roots is observed. The correlation coefficient vary from 0.70 (SFI "Bogushevsky timber enterprise") to 0.98 (SFI "Pinsky timber enterprise"), the correlation coefficient is equal to 0.81 on the average in the republic (confidence interval is 95%). The Central Botanical Garden (Minsk) was an exception, where a low ash trees affection was observed by *Armillaria* fungi, the correlation coefficient is 0.16. Affected area by root rots is lower than the crowns affected area – trees of II state category at the average quantity of dried branches equal to 14%, only 7.8% of roots were affected by root rots (Figure). For comparison, during the inspection of ash plantings in 2006–2008 the trees of the second state category at the average quantity of necrotized branches of 17% on more than 40% of roots there was white sapwood rot. Ratio change of the dried branches share relative to the share of roots affected by armillarious rot testifies to necrosis process intensity increase of the European ash trees crown in the last six years.

On ash sowings and plantings in forest nurseries and in young growth the necrosis acquires an acute form, affecting leaves, outgrowth and frequently leading to death of a young plant. Disease occurrence on young growth made (14.8 ± 4.2)%, quantity of affected leaves – (44.6 ± 6.3)% at the average affection area of a lamina of (25.9 ± 5.1)%. On the nurseries plants the occurrence turned out to be and maximal and made 91.6%, quantity of affected leaves – (80.9 ± 1.6)% at the average affection area of a lamina of (25.6 ± 1.2)%. Also there were some cases of affection of young growth by powdery mildew – mainly in Gomel region of the republic and a mass affection of the nurseries plants by different blotches.

Doing inspection of ash plantings symptoms of piecemeal and bacterial cancer were observed on separate trees. Symptoms of emerald borer *Agrilus planipennis* Fairmaire were not found by us in Belarus forests.

Conclusion. As the analysis result of the republics ash tree forests state it was found out that plantings are affected by a highly aggressive pathogen ascomycete *H. fraxineus* on the whole territory of the country with weak reduction of the disease development in the direction from north to south. The given disease develops with affection of roots of the weakened by pathogen trees by armillarious rot and leads to intensive windfall phenomena. Crown dying off goes faster than the roots rot formation, however it can disguise itself by a "secondary" crown from green epicormic branches – some epicormic branches can grow on the already weakened trees. It speaks about the pathogen development intensity increase in plantings as compared to the previous inspections and about the plantings resistance decrease to the causative agent. Young plants are heavily affected in the forest nurseries, and also the ash young growth, owing to that the renewal of ash plantings is made difficult. In this connection protective measures complex development is necessary, first of all in the republic forest nurseries.

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Received 23.02.2015