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A. D. Telesh, PhD (Agriculture), senior lecturer (BSTU);
L. N. Grigortsevich, D.Sc. (Agriculture), professor (BSTU)

MYCOSIS OF THE DOMINANT TREE SPECIES IN URBAN GREEN BELTS AND THEIR DEVELOPMENT REDUCING ACTIVITY

Fungal diseases of leaves are the dominant biotic factors of deterioration of sanitary state of main wood species, used in planting of greenery in Belarusian cities. 24 phytopathogenic species are discovered in the green plantations. The following measures allow to control development of fungal leaf spots: from agrotechnical – type of planting, timely care of woody plants; from chemical – 3–4-fold spraying of fungicides scor, falcon, prozaro, previcur in nurseries. Times of treatment are coordinated with dynamics of pathogens. At the same time biological efficacy reaches 79–100%. Application of biological preparation frutin is effective on the horse-chestnut and maple plantings in the urban conditions. Biological efficacy reaches 80–86%.

Introduction. Industrialization and urbanization creates a complex ecological environment, which is particularly acute in the most developed lands of the Earth – metropolitan areas, where more than half of the planet population live. One of the quite effective and relatively cheap means of the urban environment improvement is greenery, as plantings perform several important functions: sanitary and health, environmental, landscape and recreation, architectural [1]. Only trees with a healthy appearance can fully operate. The most harmful in the city are fungal diseases of leaves and branches of tree species reducing indeed aesthetic qualities of plants. Constant severe affecting of assimilative apparatus weakens plants and reduces their resistance to abiotic and biotic factors. In this regard, investigations devoted to detection of the most damaging fungal diseases of the main trees species used in urban planting of the republic nowadays, specification of the pathogens biology and development on this basis of protective measures that restrict their development, are problems of today [2, 3].

Objects and methods of research. Studies were performed in 2008–2011 in green urban plantations of Minsk, Mogilev, Lepel, located in one of the geobotanical subzone, different by air pollution levels, population, as well as in ornamental nursery branch of Negorelskoe training and experimental forestry enterprise (Minsk region). The investigations involve parks, squares, boulevards, green areas of the urban streets. All 4708 trees were examined. The status category of a tree was assessed by the scale of Mozolevski, [4]. The average category status was determined as the arithmetic mean by the trees number of each sanitary category.

Census of the prevalence and development of diseases was performed by using generally accepted in Phytopathology techniques [5].

For isolation and cultivation of pathogens nutrient medium Malt Exstract Agar (Aplixem) was used. The identification of fungi was performed according to the methods and determinants (K. M. Stepanov, A. B. Chumakov, 1972; I. I. Zhuravlev, 1979; N. P. Cherepanov, 1981; B. N. Bilai, 1982; U. Braun, 1987; M. Ellis, R. Ellis, 1997). Identification of powdery mildew agent of buckeye leaves was performed using PCR analysis. The sensitivity of leaves mottling pathogens to fungicides was assessed by standard techniques.

Economic efficiency was calculated by using the "Methodological recommendations on evaluation of scientific research efficiency of the scientific research, development and technological results in forestry" (2005).

Research results and their discussion. In the landscape planting of public urban areas of the Republic more than 120 species and forms of trees were used. The number of woody plants taxon is reduced in proportion to the size of the city. The number of alien crops is 45%. The most popular are deciduous trees – 94.7%. The study of the structure of green plants showed that the predominant tree species used in urban landscape plantings in Belarus is horse chestnut (in Minsk – 21%, Mogilev – 14%, Lepel – 8%), tillet (respectively 24, 14, 32%), Norway maple (respectively 17, 10, 14%). The main part of urban green space is represented by trees aged 21–40 years (50–82%).

Weighted average status category of plantations permits to make the conclusion that plantings of Minsk and Mogilev are in a weakened state from 1.8 to 2.3 points (dry branches are 26–50%, the leaves are smaller or lighter than common ones, prematurely falls, the crown is thinned). It is stated that more than half of the plantation is in a weakened state as a result of the influence of abiotic and biotic factors. The number of moderately weakened trees reached 77%, greatly weakened is 25%. In the metropolitan plantings dying and shrunken trees are from 9 (horse chestnut) to 13% (tillet). The greenery of Lepel shows signs of weakening to a lesser degree; the average category of their state is 1.7 points (in the crown there is up to 25% of dry branches, foliage is green, crown is loosely laced).

Plantings of horse chestnut and Norway maple are severely weakened in Minsk – 14 and 22%,

respectively, in Mogilev – 11 and 3%, respectively. The number of dying maple plants in 2008-2009 reached 10.5 per cent, shrunken – 2%. In Lepel the number of severely weakened chestnut trees is 0.7%, moderately weakened is 48.5%. The situation is similar with urban plantings of lime. A significant share is the mortality in the sort of dying and shrunken trees, which in Minsk is 13%. Taking into account that a part of dying and all dead trees are promptly removed by the enterprises of housing and communal services, one can consider this number of mortality to be an annual indicator.

By the results of phytopathological survey of urban green spaces the most common and harmful diseases, among which fungal leaves mottling dominated, striking from 18 to 90% of the plants.

The prevalence of leaves mottling on horse chestnut reaches 86%, on tillet – 88%, on Norway maple – 90%.

24 pathogens species of often occurring tree species fungal diseases used in landscape planting are identified.

The results of investigations showed that in urban plantings are the most often occurring following fungal mottling of leaves: buckeye brown mottling (caused by *Phyllosticta sphaerop-soidea*), yellow mottling (*Phyllosticta casta-neae*), brown mottling (*Cylindrosporium castanicola*); Norway maple black mottling (*Rhytisma acerinum*), brown mottling (*Phyllosticta negundinis*), powdery mildew (*Uncinula aceris*); the tillet black-brown mottling (*Cercospora microsora*), brown mottling (*Phyllosticta tilia*).

In 2008–2010, the number of horse chestnut trees affected by powdery mildew ranged from 16 to 47%. By genetic identification is established that in the conditions of Belarus powdery mildew of buckeye is caused by invasive North American species, the fungus *Erysiphe flexuosa* (Peck) U. Braun et S. Takamats (number in NCBI genebank AB091774.1). Under favorable conditions (over the decade preceding the emergence of the external symptoms, the average tem-perature is 15–16°C, the number of days with precipitation is not less than 4) the first defeat signs of plants appear in the second half of may (15.05–30.05). The main symptom is the appearance on the leaves of the finely arachnoid colorless mycelium film in the form of spots, which rapidly increase in size, merge and become clearly visible due to the widening and induration of the mycelium on the upper and lower side of leaves.

When studying the morphological characteristics of the powdery mildew pathogens it was revealed that in the conditions of Belarus *E. flexuosa* forms reproductive organs of smaller sizes than within the natural areal. For example, the diameter of cleistothecia *E. flexuosa* is 19 and 14% less than this figure in terms of North America and Spain, respectively. The same pattern is observed in relation to other morphological features, which, apparently, is connected with the climatic conditions of our country.

Signs of powdery mildew on leaves are found in all parts of the crown. On the trees located in the yards and the park, the mycelium covered 30–70% of the leaf blade, and in the street plantings where trees are more weakened by abiotic factors, it was developed on the entire surface of the leaf. In the first decade of June on the underside of infected leaves cleistothecia (hasmodule) in the form of spherical or hemispherical formations located on the mycelium were formed.

The color of cleistothecia depending on age varies from light yellow to black. They have from 9 to 40 pieces of appendages of two types: *Uncinula*-similar and awl-shaped.

The formation of the sexual reproduction stage occurs in the first week of October, forming bags from 4 to 8 pieces. They have ellipsoidal-circular shape and a short leg. The walls of the bags are thick, with well-marked double outline. The number of spores in the bag is 8, less often is 6. The spores of bugs are transparent, of ellipsoidal shape.

In Belarus, as in neighboring States, powdery mildew of horse chestnut is in a progressive condition, its prevalence and development increases.

The dynamics exploring of leaves fungus mottling development in urban plantings showed that the meteorological conditions of the Republic contribute to the progressing of diseases, which growth intensity directly depends on precipitation number (especially in June), indicators of relative air humidity (over 80%). Moderate temperatures of the growing season are also predisposing factors for their development. The first signs of black-brown mottling on the leaves of the lime and brown mottling on the leaves of the chestnut on the young plants in the nursery were observed in the third week of May, in the urban conditions – in the first decade of June. Black spottiness on maple leaves appeared on a decade later. The more is a number of precipitation and relative air humidity (over 80%) in June, the more is prevalence and development of diseases. For example, by the end of the first half of the growing season of 2009, the development of the horse chestnut leaves brown mottling on planting material in the nursery was 40%, by the end of August reached 86%.

In urban areas in 2008 yellow mottling epiphytotics on leaves of chestnut (development by early September – 59%), the tendency to the epiphytotics level of powdery mildew progressing (development – 3 registered 5%) were; in 2009 chestnut fungal mottling agents (yellow, red brown, brown) also reached epiphytotics level of the development (over 50%); in 2010 epiphytotics of black and

brown mottling on the leaves of the Linden (51%) and brown mottling on the leaves of the chestnut (50%) was marked.

It is stated that in the complex of fungal diseases in the nursery the horse chestnut leaves brown mottling, which development in the years of research reached 81–86%, dominate; on Linden leaves – black-brown mottling (69–99%); on leaves of maple – black one (57–63%). Urban green belts are dominated by yellow mottling, which development was 33–59%, brown chestnut mottling (28–50%), powdery mildew (31–35%); on leaves of tillet – black-brown mottling (38–58%); on leaves of Norway maple – black mottling (development is 41–51%).

To reduce the development of fungus leaves mottling in urban green belts we have developed a number of measures, including agronomic, chemical, and biological.

When carrying out agrotechnical activities one of the most important elements is applicable type of planting. The studies found that the most preferable are the group landscape plantings in park areas where the plantings are growing in the conditions close to natural. Weight average status category in such plantings is 1.1 points, which is much better compared to this indicator when growing plants in the plantings of other types. Then, as the conditions for the growth of tillet, maple, chestnut plantings being worth, there are plantings one row in a strip of lawn, one row in the hole. Application of foliar and root fertilizing, trimming, washing of crowns in combination with the optimal types of plantings promote reducing of the dying trees number in 1.6-3 times.

Aiming the development of effective measures for chemical and biological defense, laboratory studies and a number of field tests of modern fungicides of different action mechanism in the ornamental nursery Department of Negorelskoe training and experimental forestry (contact-systemic - Ridomil gold; systemic – Scor, Topaz, Previcur, Prosaro, Falcon), as well as biologicals (Frutin, Phytoprotectine) in the nursery and on the plants in plantations of Minsk (in joint research with the Institute of Microbiology of the national Academy of Sciences of Belarus). First, the growth inhibition of pathogens colonies of mycosis trees diseases study has been carried out in the laboratory. The most effective preparations have been used for field experiments.

The processing terms were appointed, taking into account the dynamics of the disease development: preventive – before the first signs of disease – the first – second decade of May; the second – when the first symptoms of affecting (the third decade of May – the first decade of June, the disease development up to 10%); the third and fourth – with increasing prevalence of diseases in connection with the creation of favorable conditions for the development of the fungus leaves mottling (frequent rainfall, relative air humidity over 80%, moderate temperatures of 18–20°C), which coincides with the second – third decade of June and July (the development of disease is over 10%).

It is stated that in nurseries 4-multiple spraying by fungicides Scor (0.2 l/ha), Falcon (0.5 l/ha), Prosaro (0.5 l/ha), Previcur (0.5 l/ha) are efficient. Biological efficiency is 79–100%.

It is known that under conditions of epiphytotics development of brown mottling in chestnut plantings fungicide Scor is effective. Biological efficiency reached 94%. The use of preparations Falcon, Prosaro, Previcur helped to reduce disease development on 58–71%. Biological efficiency was 73–90%.

The same trend has been observed in nursery, on Norway maple and tillet (Tilia cordata). Biological efficacy of preparations against black leaves mottling of maple was 100%.

High biological efficiency was obtained when using the fungicide Prosaro against black and brown mottling on the leaves of tillet. The development of *C. microsora* was 8%, the biological efficiency is 92%. In the control variant (without treatment) the disease development has reached 99%, the standart version is 52%. Application of fungicides Falcon, Swift, Previcur also led to the reduction of disease development up to 18–26%. In comparison with the control variant, it decreased in 73–81%, biological efficiency was 74–82%.

Thus, in the nurseries on young plants of horse chestnut against brown mottling it is effective the use of fungicides Falcon, K (rate – 0.5 l/ha) and Scor, K (0.2 l/ha). In tillet plantations against black and brown leaves mottling (*C. microsora*) and in those of maple against black mottling (*R. acerinum*) it is advisable to use fungicides, Prosaro, K (rate – 0.5 l/ha), Falcon, K (0.5 l/ha), Scor, K (0.2 l/ha) and Previcur, VK (0.5 l/ha).

The use of chemicals limits the further spread of the disease and permits to improve the aesthetic qualities of the plants, but their use in the city is prohibited. In this regard, in urban plantings of Minsk and in the young plants nursery the study of the efficiency of the following biological preparations was carried out (resolution of UP "Minskzelenstroy" No. 08-49-24/756 from 22.03.2010):

– Frutin, ZH titre (5–8)×109 viable spores/ml (spores and metabolic products of the bacteria *Bacillus subtilis*, strain BIM b-262);

– Phytoprotection, ZH titre (4–7)×109 viable spores/ml (spores and metabolic products of the bacteria *Bacillus subtilis*, strain BIM b-334).

In 2009, 2-multiple use of Frutin and Phytoprotection in concentrations respectively: 5, 6, and 7%

and 2, 3 and 4% did not inhibit epiphytic development of leaves mottling.

In 2010, the number of treatments increased in 4 with a maximum concentration of biologi-cal preparations.

The terms of spraying: the first treatment is preventive, before the manifestation of symptoms of the disease; the second is when symptoms are apparent; the third and fourth, with increasing of prevalence and development of disease (according to records).

Application of Frutin (7% concentration) on planting material against black leaves mottling of maple and brown leaves mottling of chestnut reduced disease development up to 7% and 16% respectively. Biological efficiency was 87% and 80% respectively. In control variants (without treatment) the disease development has reached 81%.

Application of Frutin and Phytoprotection on tillet in the nursery against black and brown mottling showed a low efficiency, the spread and development of the pathogen remained at the level of the control variant.

Spraying of urban plantings by Frutin reduced the development of brown mottling on leaves of chestnut to 29%, the biological efficiency was 69%; the development of black leaves mottling of maple did not exceed 8%, the biological efficiency was 87%.

Thus, the use in nurseries and urban plantings of biological preparation Frutin (7% suspension) effectively inhibited the development of brown leaves mottling of horse chestnut (pathogen is *P. sphaeropsoidea*) and black leaves mottling of maple (pathogen – *R. acerinum*).

The estimations showed that the complex care activities for green plantings and their protection have a high efficiency. On 1 RUB of investment cost the recoupment was received from 3.8 to 5.1 RUB. Economic efficiency of protective measures in the green plantings depends on tree species and type of planting. Higher economic indicators were obtained in 1-row maple plantings on the lawn – 5,1 RUB, and in 1-row horse chestnut plantings in the hole – 4,3 RUB.

Conclusion. Investigation of 4708 horse chestnut, tillet and maple trees in urban plantings showed their mainly weakened state that significantly degrades with increasing of size of the city. The number of dying trees ranges from 1% in Lepel to 12% in Minsk. The evaluation of phytopathological situation revealed that in urban green belts, the most common are fungal leaves mottling.

In the plantings of horse chestnut their prevalence has reached 86%, in the tillet ones – 88%, Norway maple – 90%. In urban plantings on the main tree species 24 species of phytopathogenic fungi were identified, the most common of which are: *Phyllosticta sphaeropsoidea* (Ellis & Everh.) Petrak (*Guignardia aesculi*), *Phyllosticta castaneae* Ell. et Ev., *Cylindrosporium castani-cola* (Desm..) Berl. in plantations of horse chestnut; *Rhytisma acerinum* Fr. – in Norway maple trees plantins; *Cercospora microsora* Sacc., *Phyllosticta tilia* Sacc. et Spegazini – in plantations of tillet.

In the complex of nursery fungus mottling diseases on the leaves of the horse chestnut brown mottling, the development of which in the years of research reached 81–86%; on the lime leaves - black-brown mottling (69–99%); on the leaves of maple – black mottling (57–63%) dominate.

In urban green landscape plantings on the horse chestnut leaves yellow mottling, the development of which was 33–59%), brown mottling (28–50%), powdery mildew (31–35%); on leaves of tillet – black-brown mottling (38–58%); on leaves of maple – black mottling (41–51%) dominate.

The first symptoms in the form of spots appear on the leaves in late May – early June. With increased rainfall and relative air humidity (over 80%) in June is the growth of the disease.

To hinder the development of the fungus leaves mottling the following activities help: the agro-technical ones – selection of planting methods, (group plantings on the lawn; 1-row plantings on the lawn), compliance with the rules of caring for trees (pruning, spraying of crowns, root and foliar nutrition), which reduces the development of diseases in 1.6–3 times; the chemical ones – 4-multiple spraying in nurseries by fungicides Scor, K (0.2 l/ha), Falcon, K (0.5 l/ha), Prosaro, K (0.5 l/ha), Previcur, VK (0.5 l/ha). Biological efficacy of fungicides is 79-100%. In urban environments to protect plantings of horse chestnut and Norway maple biological preparation Frutin, ZH titre (5–8)×109 viable spores/ml (20 l/ha) are effectively used. Biological efficacy of preparation is 80–86%. Recoupment of 1 rouble spent on these activities, ranges from 3.8 to 5.1 RUB.

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