

Evaluation of Microbiological Preparations' Effect on the Propagation of Introduced Species of Trees

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Abstract— The experimental data of 2017-2019 are presented. The influence of microbiological preparations produced in the biological laboratory of the Federal State Institution "Omsk Reference Center of the Rosselkhoznadzor" on the propagation of introducers of tree species growing on the territory of the regional nature monument "Regional Dendrological Garden named after G.I. Gense" was analyzed. Improvement of the technology for growing seedlings was carried out in open ground by various methods: green cuttings, lignified (winter) cuttings and seed propagation using environmentally friendly preparations - Elena, Azolen, Trichodermin and Black Yeast. The metabolites of the producer strains of the studied preparations are antibiotics, siderophores, hormones, enzymes, nutrients (nitrogen, phosphorus, potassium). The multifaceted mechanism of action of these preparations includes a growth-stimulating effect, suppression of the development of phytopathogens by isolating enzymes and antibiotics, as well as by direct parasitization and competition for the substrate, optimization of the processes of providing plants with mineral nutrition. Their positive effect on rooting, development of the root system, an increase in the diameter of the root neck and growth has been established. The best preparations that influence the formation of larger and more developed root systems of seedlings are Black Yeast and Trichodermin. More responsive to the use of the studied environmentally friendly preparations by tree species are brittle willow, spherical (*Salix fragilis*) and Manchurian walnut (*Juglans mandshurica*).

Keywords—lignified cuttings, green cuttings, environmentally friendly preparations, growth, diameter of the root neck, root system.

I. INTRODUCTION

Decorative-deciduous and coniferous trees are of great importance in nature and human life. Every year there is a growing need for high-quality planting material for landscaping recreational areas, as well as the renewal and replenishment of the collection of the regional dendrological garden named after G.I. Gense. The appropriateness of using microbiological preparations is well known, since many pesticides pose a danger to animals and humans, accumulating in natural ecosystems and persisting in them for a long time. The success of the use of microorganisms as the basis of biological products lies in the fact that they multiply and remain in the environment. In the United States produce more than 40 products for the biocontrol of plant pathogens [1;2]. Since 2017, work has been carried out on the basis of the dendrological garden to develop a technology for propagating introduced tree species using microbiological

preparations. These preparations are made in the biological laboratory of the Federal State Institution "Omsk Reference Center of the Rosselkhoznadzor". Trichodermin preparations are produced on the basis of the soil fungus *Trichoderma viride*, Omsk strain, Black Yeast - on the basis of a live culture of yeast-like microorganisms *Exophiala Nigrum*, Azolen - on the basis of the *Azotobacter vinelandii* strain, Elena - based on strains of *Pseudomonas aureofaciens*. The active substances of these preparations are cellular metabolites: antibiotics, enzymes, siderophores, harmonics and other biologically active compounds.

Studies are aimed at determining the effect of biological products on the development of stronger and taller seedlings, with a more developed root system [3]. This area of research is consonant with the work on the vegetative propagation of tree species by lignified, semi-lignified and green cuttings with the improvement of elements of the growing technology [4,5,6].

II. RESEARCH METHODOLOGY

The objects of the study were samples of tree-shrub species growing on the territory of the dendrological garden: *Myricaria alopecuroides*, *Tamarix gracilis*, *Salix fragilis*, *Juniperus squamata* «Blue Star», *Juniperus communis* *Pyramidalis*, *Juglans mandshurica*, *Phellodendron amurense*. Lignified (winter) cuttings were harvested in February, bundled and stored at rest until spring in snow piles. In June 2017, they were planted in previously prepared soil for rooting and treated with biological preparations. Green cuttings were harvested in June of the same year and planted in open ground the next day after treatment with preparations. Seeds of Amur velvet and Manchurian walnut were harvested in late September and sown in the first half of October 2017. Observations were carried out for 365 cuttings and seedlings in triplicate. Each subsequent year, preparations were processed on the terrestrial part of the plants. The influence of microbiological preparations during the propagation of tree-shrub species was evaluated by increasing the percentage of rooting, growth in height, diameter of the root neck, and length of the root system compared to the control without the use of preparations. Processing the results of the study was carried out using analysis of variance.

III. RESULTS

Studies have shown that the highest percentage of rooting during vegetative propagation occurs with the use of the

preparation Black Yeast both in the experiment with lignified cuttings and green. In lignified cuttings of myricaria, 95% of rooting was recorded under the influence of the Black Yeast preparation, 75% in willow brittle, spherical with the use of the Elena preparation. *Tamarix* rooted in 51% of the planted cuttings with the preparations Azolen and Black Yeast (Fig. 1).

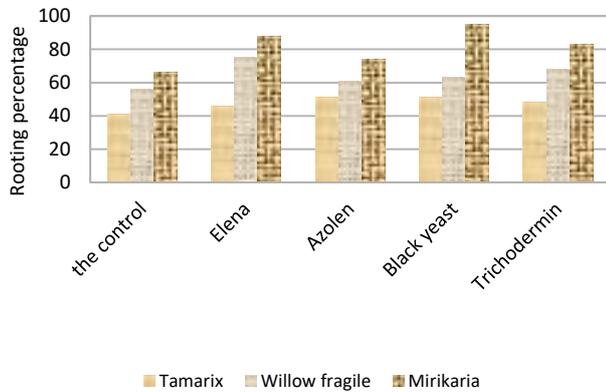


Fig. 1. The rooting lignified cuttings; $HCP_{05} = 2,9$

Green cuttings showed 96% rooting in squamous juniper and 92% in ordinary pyramidal juniper with the use of the preparation Black Yeast (Fig. 2).

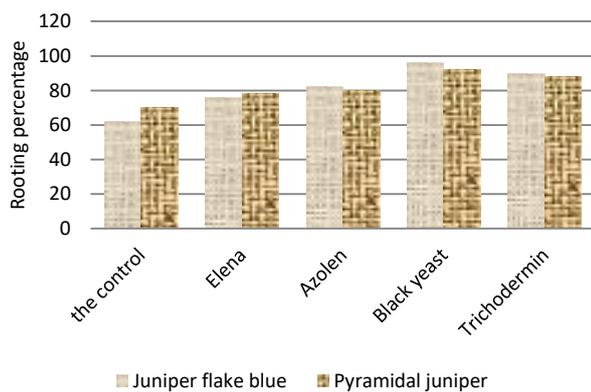


Fig. 2. The rooting green cuttings; $HCP_{05} = 3,1$

The result of seed propagation of Manchurian walnut and Amur velvet showed the best seed germination of 85% with the use of the Black Yeast preparation (Fig. 3).

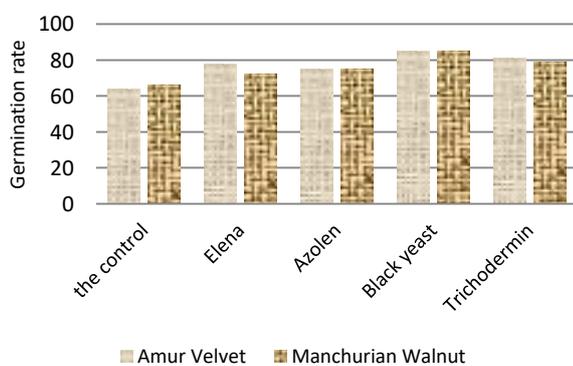


Fig. 3. The seed germination of tree species; $HCP_{05} = 3.4$

According to the results of the experiments, the best tree species, which showed high efficiency when propagated by lignified cuttings, should be recognized as myricaria, the rooting percentage ranged from 66 to 95%. Rooting in tamarix was recorded from 41 to 51%, and from 56 to 75% in willow brittle. The percentage of rooting during green grafting in flake juniper ranged from 62 to 96%, and from 70 to 90% in ordinary pyramidal juniper. The percentage of germination of seeds of Manchurian walnut varied in the range from 66 to 85% and in Amur velvet from 64 to 85%.

According to the experience from 2017 to 2019, the growth in tamarix in the first year was 25.5 cm with the use of the preparation Trichodermin, in the second and third years 29.9; 36.2 cm with Black Yeast. The growth in myricaria over the three years of the study was: 28.1; 66,3; 70.7 cm under the influence of the preparation Trichodermin. A similar effect of the preparation was observed in brittle willow - 38.6; 69,4; 108,6 cm (Fig. 4).

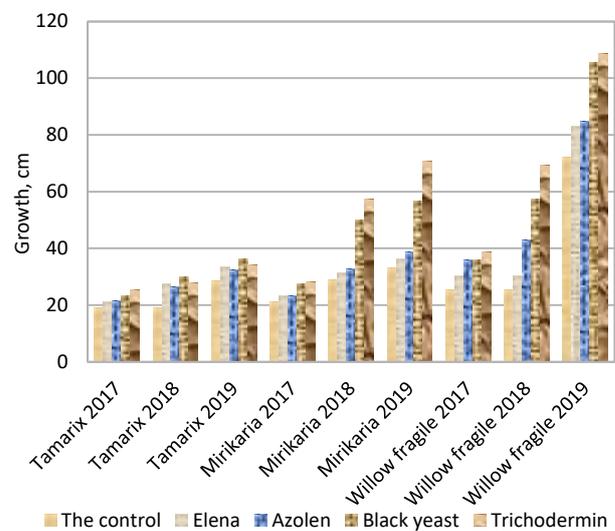


Fig. 4. The average growth of tree species propagated by lignified cuttings; $HCP_{05} = 2,15$

The positive effect of the preparation Black Yeast was recorded in the experience of green cuttings of the flake juniper blue and ordinary pyramidal in two years of research. The largest growth in squamous juniper in the first year of cultivation was 18.5 cm and 21.3 cm in the second, and in ordinary pyramidal juniper, respectively: 21.3 cm and 26.6 cm (Fig. 5).

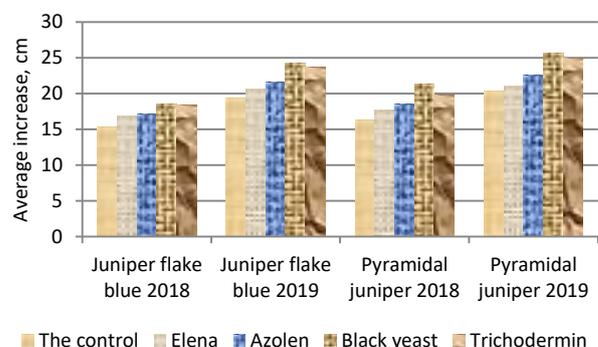


Fig. 5. The average growth of tree species propagated by green cuttings; $HCP_{05} = 2.2$

A similar effect of the preparation Black Yeast was recorded in seedlings grown from seeds. The largest growth of Manchurian walnut in the first year was 46.6 cm and 61.2 cm in the second. Amur velvet growth was observed 14.4 cm in the first and 17.7 cm in the second year of cultivation (Fig. 6).

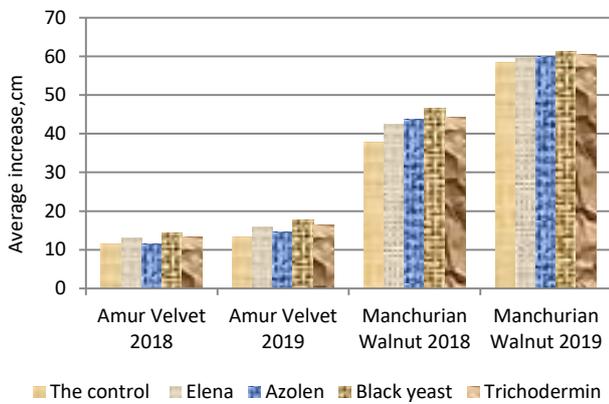


Fig. 6. The average increase in tree species grown from seeds; HCP₀₅ = 1.8

The diameter of the root neck of seedlings grown from lignified cuttings in the control in the first year varied from 5.1 to 5.3 mm, from 5.4 to 6.5 mm in the second year and from 5.6 to 9.4 mm in the third. In variants of the experiment using microbiological preparations, the diameter increased from 5.3 to 5.6 mm in the first year, in the second from 5.6 to 10.6 mm and from 6.1 to 18.8 mm in the third. More effective preparations that affect the increase in the root neck of the first year should be recognized as the preparation Elena and Azolen 5.6 mm in tamarix and myricaria. In the second year of myricaria, the diameter of the root neck increased to 6.6 mm and 8.7 mm in the third year under the influence of the Black Yeast preparation. In tamarix, an increase of 6.3 mm was observed in the second year and 7 mm in the third year under the influence of the Trichodermin preparation. The formation of the root neck of the willow brittle during all three years of observations was more intense under the influence of the Black Yeast and Trichodermin preparations: 5.5 mm in the first year, 10.5; 10.6 mm on the second and 18.5; 18.8 mm on the third (Fig. 7).

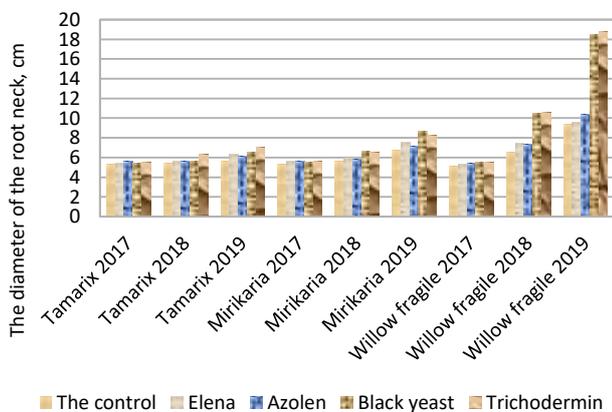


Fig. 7. The average diameter of the root neck of tree species propagated by lignified cuttings; HCP₀₅ = 0,15

In grown seedlings from green cuttings, the diameter of the root neck in the control varied from 2.4 to 4.1 mm in the first year, and from 3.3 to 4.9 mm in the second. Under the influence of biological preparations, the diameter increased from 3.9 to 6.1 mm in the first year and from 4.4 to 6.6 mm in the second. Black Yeast and Trichodermin should be recognized as more effective preparations, that affect the increase in the root neck. The diameter of the root neck of squamous juniper in the first year of cultivation was 4.6 mm under the influence of the preparations Trichodermin and Black Yeast. A similar effect of the drugs was observed in the second year of cultivation: 5.5; 5.6 mm, respectively. The effect of the Black Yeast preparation was also effective in the first and second years of growing common pyramidal juniper seedlings, respectively: 6.1; 6.6 mm (Fig. 8).

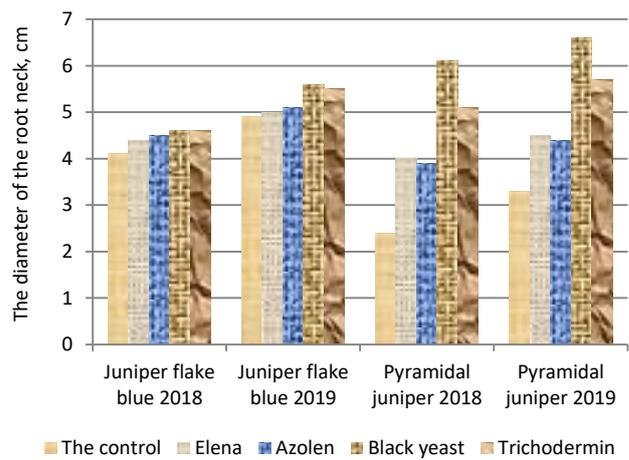


Fig. 8. The average diameter of the root neck of tree species propagated by green cuttings; HCP₀₅ = 0,22

The result of the experience of growing seedlings from seeds showed that the diameter of the root neck in the control varied from 2 to 4.3 mm in the first year and from 2.2 to 9 mm in the second year. With the use of biological preparations, the root neck increased in the first year from 2.1 to 6.8 mm in diameter and from 2.3 to 10.7 mm in the second. Black Yeast should be recognized as a more effective preparation that affects the increase in the root neck of seedlings of Amur velvet and Manchurian walnut. The diameter of the root neck was 2.4 and 6.8 mm in the first; 2.65 and 10.7 mm in the second. The use of the preparation Trichodermin gave an increase in the diameter of the root neck, respectively: 2.2; 6.7 mm in the first year and 2.5; 10.4 mm in the second (Fig. 9).

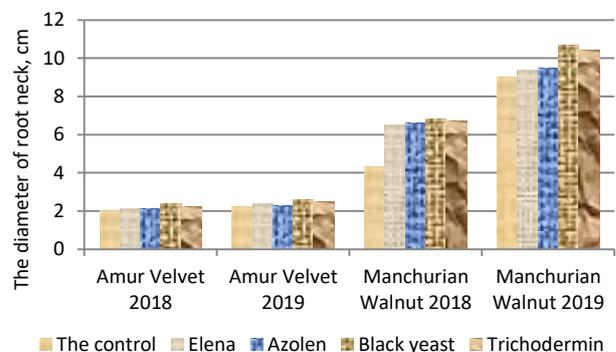


Fig. 9. The average diameter of the root neck of tree species grown from seeds; HCP₀₅ = 0,2

The development of the root system of the second and third years of growing seedlings showed that the most powerful root system develops in a willow brittle with a root length of 25.3; 25.8 cm in the second year and 42.5; 42.9 cm - the third when using the preparations Black Yeast and Trichodermin. In myricaria, for two years of research, the length of the root system was 12 and 18 cm under the influence of the Black Yeast preparation. The development of a more powerful root system in tamarix seedlings in the second year of cultivation was observed with the preparation Elena 10.2 cm, in the third year 16.7 cm under the influence of the preparation Trichodermin (Fig. 10).

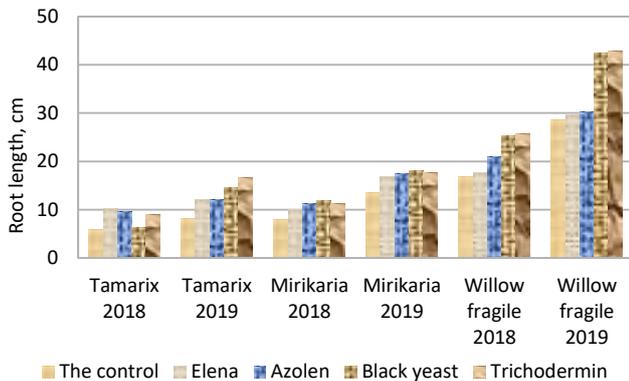


Fig. 10. The average length of the root system of tree species propagated by lignified cuttings; HCP₀₅ = 0,57

A more powerful and developed root system developed in junipers under the influence of the Black Yeast preparation. According to the first year, the length of the root system of scaly juniper was 19 cm; in the second year 22.3 cm. A similar effect of the drug was observed in juniper pyramidal ordinary for two years of research 21.4; 29.4 cm, respectively (Fig. 11).

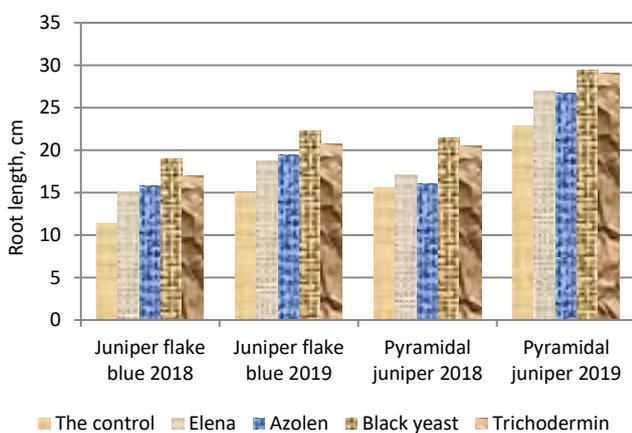


Fig. 11. The average length of the root system of tree species propagated by green cuttings; HCP₀₅ = 2,7

The development of the root system over two years of growing seedlings obtained from seeds showed that a more developed root system was recorded in the Manchurian walnut 25.7; 25.3 cm in the first year and 27.5; 26.6 cm in the second under the influence of the preparations Black Yeast and Trichodermin, respectively. A similar effect of drugs was recorded in seedlings of Amur velvet 14,1; 13.9 cm in the first and 16.6; 16.5 cm in the second year of cultivation (Fig. 12).

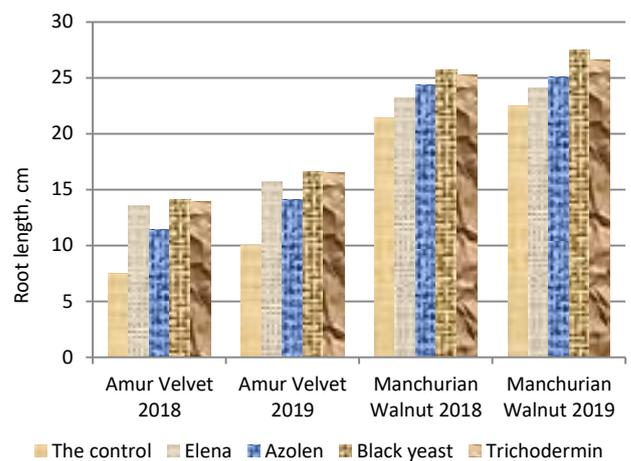


Fig. 12. The average length of the root system of tree species grown from seeds; HCP₀₅ = 2,1

IV. CONCLUSION

According to the results of growing wood species, the best preparations that affect the formation of taller seedlings with the most developed root system of plants are Black Yeast and Trichodermin. Apparently, this is due to the multifaceted mechanism of action of these preparations. Thus, fungi of the genus *Trichoderma* inhibit the development of phytopathogens by direct parasitization, competition for the substrate, isolation of enzymes, antibiotics (glyoxin, viridin, trichodermin, etc.), which reduces the spread of pathogens and inhibits their reproductive ability. The preparation Black Yeast is produced on the basis of a live culture of yeast-like microorganisms *Exophiala Nigrum*, which produces enzymes and hormones that increase the overall resistance of plants and inhibit the development of pathogenic microflora. The yeast culture fluid contains nutrients: nitrogen, phosphorus, potassium, which optimize the processes of providing plants with mineral nutrition. This is consistent with data obtained by other researchers showing that when mineral elements are introduced into the soil, alpine plants increase their biomass and specific leaf surface [7]. The use of mineral fertilizers in the norm N₆₀P₆₀K₆₀ guarantees 100% production of standard seedlings of ordinary ash in the first year of cultivation [8]. The positive effect of mineral nutrition during the cultivation of common pine seedlings in open ground was obtained in Belarus in the form of an increase in growth in height and diameter, as well as an increase in the survival rate of created forest crops by 3-5% compared with production experiments [9].

In our experiments, brittle willow, spherical (*Salix fragilis*) and Manchurian walnut (*Juglans mandshurica*) were more responsive to the use of the studied microbiological preparations of tree species. Our research allows us to recommend these species to expand the range used in urban landscaping.

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