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Original article

THE PROLONGED INFLUENCE OF ROOT DRESSING OF CAJANDER LARCH (*LARIX CAJANDERY* MAYR.) ANNUAL AND BIENNIAL SEEDLINGS WITH THE GROWTH STIMULANTS ZIRCON AND EPIN ON THEIR GROWTH AT FIFTEEN YEARS OF AGE

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Cajander larch (Larix cajandery Mayr.) is the eastern race of Gmelin larch, the main forest-forming species in the Amur Region and the Primorsky Territory. It is widely used in the national economy. It is promising for landscaping. However, as a result of improper felling and forest fires, the area and stocks of larch have been significantly reduced. Its accelerated artificial restoration is necessary. One of the ways to solve this problem is the use of growth stimulants. The aim of the research was to study the stimulating effect of aqueous solutions of growth stimulants Zircon and Epin at various concentrations of solutions on biometric indicators of annual seedlings and mature Cajander larch trees at the age of 15. In the spring of 2009, grown larch seedlings were transplanted into the previously prepared soil of school department of the nursery with the placement of 0.5 × 0.6 m. During the growing season they were fed twice with Zircon and Epin in concentrations of 0.01 and 0.001%. Seedlings that were not subjected to any treatment were taken as a control sample. Seedlings were measured in terms of height, height gain, diameter of the root neck, root length and dry weight. In the spring of 2012, in the vicinity of the Mountain-taiga station named after. V.L. Komarov, an alley was created from a part of Cajander larch seedlings along the road system. 10 years after the transplantation

of seedlings, in June 2022, the state of larch cultures was assessed according to the scale given in the rules of sanitary safety [26], and the heights and diameters of the trunk at chest height were measured. The studies showed that root dressing with Epin solution at a concentration of 0.01% has the greatest effect on the growth of seedlings and mature larch trees.

Keywords: *Cajander larch; growth stimulants; Zircon; Epin; seedlings; height; height gain; diameter of root collar; length of roots; dry mass*

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Научная статья

ПРОЛОНГИРОВАННОЕ ВЛИЯНИЕ КОРНЕВОЙ ПОДКОРМКИ СТИМУЛЯТОРАМИ РОСТА ЦИРКОН И ЭПИН ОДНО-ДВУЛЕТНИХ САЖЕНЦЕВ ЛИСТВЕННИЦЫ КАЯНДЕРА (*LARIX CAJANDERY* MAYR.) НА ИХ РОСТ В 15-ЛЕТНЕМ ВОЗРАСТЕ

В.Ю. Острошенко, Л.Ю. Острошенко

Лиственница Каяндера (Larix cajanderyMayr.) – восточная раса лиственницы Гмелина, основная лесообразующая порода в Приамурье и Приморском крае. Широко используется в народном хозяйстве. Перспективна для озеленения.Однако в результате неправильных вырубок и лесных пожаров площади и запасы лиственницы значительно сократились. Необходимо ее ускоренное искусственное восстановление. Одним из способов решения этой проблемы является применение стимуляторов роста. Целью исследований являлось изучение стимулирующего эффекта водных растворов стимуляторов роста Циркон и Эпин в различных концентрациях растворов на биометрические показатели одно-двулетних саженцев и взрослых деревьев лиственницы Каяндера в 15-летнем возрасте. Весной 2009 года выращенные сеянцы лиственницы пересадили в заранее подготовленную почву школьного отделения питомника с размещением 0,5 × 0,6 м. За вегетационный период их дважды подкармливали препаратами Циркон и

Эпин в концентрациях 0,01 и 0,001%. За контрольный образец принимали саженцы, не подвергавшиеся какой-либо обработке. Проводили замеры саженцев по показателям высоты, прироста по высоте, диаметра шейки корня, длины корней и сухой массы. Весной 2012 года в окрестностях Горнотаежной станции им. В.Л. Комарова из части саженцев лиственницы Каяндера вдоль дорожной системы была создана аллея. Через 10 лет после пересадки саженцев, в июне 2022 г., проведена оценка состояния культур лиственниц по шкале, приведенной в правилах санитарной безопасности [26], а также измерены высоты и диаметры ствола на высоте груди. Проведенные исследования показали, что на рост саженцев и взрослых деревьев лиственницы наибольший эффект оказывает корневая подкормка раствором Эпина концентрацией 0,01%.

Ключевые слова: *лиственница Каяндера; стимуляторы роста; Циркон; Эпин; саженцы; высота; прирост по высоте; диаметр шейки корня; длина корня; сухая масса*

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Introduction

Larch forests – is the most common forest formation of the Far East with an area of 59,2 ha and a growing stock of 61,2% among other Far Eastern forests [9].

The areal of larch is huge and geographically stretches from Southern Primorye to the Northern limit of woody vegetation distribution – almost to 71 ° N. lat. [9].

Larch is a large tree reaching a height of 35-40 m and more than 1 m in trunk diameter. It grows for a long time, 300-400 years. Its characteristic features are rapid growth, durability and the ability to withstand various damage caused by the activity of fungi and insects. This tree species tolerates the adverse effects of climate. The wood is durable, resistant to decay. So, in Venice, many houses are built on larch piles. St. Isaac's Cathedral in St. Petersburg also stands on larch piles. Larch is widely used for various hydraulic structures. Larch firewood is the best in terms of calorie content and heat productivity. The scope of larch is quite extensive. It is actively used for the manufacture of building materials such as fiberboard, etc. Its raw materials are of high value for pulp and paper and hydrolysis production, obtaining high-quality varnishes, turpentine, camphor oil, as well as other valuable forest products. As a valuable and

fast-growing species, larch has been used in forestry production since historical times. Rapid growth, beautiful appearance, resistance to harmful gases and good survival rate put this tree species in one of the first places for landscaping [9].

Larch grows on the vast territory of the Russian Far East, forming forests in various geographical and climatic zones, which has left an imprint on its silvicultural properties. At the same time, the boundaries of the ranges of some of its species are not yet clearly defined due to the formation of hybrids that create a polymorphic group of plants.

East of the Lena River, in the basin of its tributary the Aldan River, east of its outlet to the coast of the Sea of Okhotsk, Cajander larch (*Larix cajandery* Mayr.) is widespread. It is the eastern race of Gmelin larch, the main forest-forming species in the Amur Region and Primorsky Krai [30].

On the territory of Primorsky Krai, larch occupies 918.2 thousand hectares [18].

In recent decades, the Far East has been intensively developing all natural resources. Timber harvesting, including larch, is carried out at a particularly rapid pace. As a result of improper logging and forest fires, the area and stocks of larch have been significantly reduced. It is necessary to accelerate its artificial restoration. One of the ways to solve this problem is the use of growth stimulants at various stages of growing planting material. Experimental work on the use of growth stimulants in the cultivation of various tree species has shown their effectiveness [1, 2, 5, 7-8, 10-14, 16-17, 19-23, 26, 28, 31-39].

The scientific novelty of this study lies in the fact that for the first time on seedlings and mature trees of Cajander larch in condition of Primorsky Krai, the effect of two environmentally friendly growth stimulants Epin and Zircon at different concentrations was investigated.

Objective

The object of the research was to study the stimulating effect of aqueous solutions of growth stimulants Zircon and Epin in different concentrations of solutions on the biometric parameters of one-two-year-old seedlings and mature trees of Cajander larch at the age of 15.

Materials and methods

The object of the research was one-two-year-old seedlings, as well as mature trees of Cajander larch. Experimental plants were grown in the nursery of the Komarov Mountain Taiga Station of the Far Eastern Branch of the Russian Academy of Sciences. Seeds are collected in the Nikolaev forestry of the Khabarovsk Territory.

The area in which the nursery is located is characterized by special forest conditions, the presence of podzolic soils and mountain-forest brown soils.

Soil preparation consisted of spring plowing with a walk-behind tractor at a depth of 25 to 28 cm. After plowing, manual harrowing was carried out.

In the spring of 2009, the grown seedlings were transplanted into the pre-prepared soil of school department of the nursery with a placement of 0.5 × 0.6 m.

During the growing season, they were fed twice with Zircon and Epin in concentrations of 0.01 and 0.001%. The solutions were prepared before the feeding process itself.

Seedlings that have not been subjected to any treatment were taken as a control sample. In total, 25 seedlings were planted for control and experiment in triple repetition.

Observation of experimental and control specimens was carried out during 2 growing seasons.

After the end of the growing season, the method of continuous accounting was used to measure experimental and control plants according to the following indicators: stem height, height gain. In 25 selected plants, the diameter of root collar was measured using an electronic caliper. The length of roots was determined using a ruler.

The seedlings were dried to an air-dry state. Then the stems, needles and root system were weighed separately. The data obtained were compared according to the variants of the experiment.

In the spring of 2012, in the vicinity of the V.L. Komarov Mountain Taiga Station, an alley was created from part of the Cajander larch seedlings along the road system.

In June 2022, 10 years after transplanting the seedlings, the condition of larch crops was assessed according to the scale given in the sanitary safety rules [15], and the heights were measured using an altimeter and trunk diameters at chest height were measured using a measuring fork.

The research materials were subjected to statistical processing in Microsoft Excel 2007. The significance of the differences with the control was calculated using the Student's t-test.

Results and discussion

Zircon is a natural growth stimulant that is safe for both humans and animals. This drug is based on hydroxycinnamic acids. This stimulant does not pollute groundwater. It has a positive effect on root formation, growth, flowering. It has antiviral activity and activates the processes associated with the synthesis of chlorophyll [29].

Epin also provides enhanced plant growth, but unlike Zircon it is a synthetic drug. Its constituent is presented by epibrassinolide. It activates its own natural phytohormones in plants, necessary for their development. It reduces the content of nitrates, salts of heavy metals and radionuclides in plants [29].

Thanks to the use of these stimulants, it is possible to increase seed germination, accelerate growth, flowering, root formation, activate the process of chlorophyll synthesis, as well as enhance the protective function of plants, thereby improving their disease resistance to various phytopathogens and climatic factors.

The authors who conducted experiments on the use of the growth stimulants Zircon and Epin-Extra with various agricultural crops showed their positive effect. Thus, Gladysheva O.V. revealed that the treatment of tomato seeds with Epin-Extra and Zircon contributed to an increase in the sowing qualities of seeds. An increase in the energy of germination and laboratory germination of seeds was observed with the joint use of drugs [6]. Reshetnik G.V. also described the stimulating effect of Epin-Extra on the physiological parameters of winter wheat (*Triticum aestivum*) [25]. It has been proven that the use of Epin-Extra has a positive effect on the germination of seeds of victorious onion (*Allium victorialis* L.) and bear onion (*Allium ursinum* L.) [27]. Peregudov S.V. et al. noted the activation of carrot growth processes with triple spraying with Epin-Extra and Zircon [24]. The anti-stress effect of stimulants Zircon and Epin-Extra on white cabbage was established by Vakulenko V.V. The author noted the positive effect of these drugs on increasing seed germination, the volume of the root system, survival after planting in the field, as well as yield and product quality [3]. It was revealed that the use of Zircon and Epin-Extra in combination with mineral fertilizers leads to an increase in potato yields. These stimulants inhibit the development of diseases, increase resistance to late blight by 4.6-6.5% [4].

In forestry, the effectiveness of the use of the stimulants Zircon and Epin-Extra has been studied experimentally. Thus, Ustinova T.S. proved the positive effect of the stimulator Epin-Extra on root growth in seedlings of Scots pine (*Pinus silvestris* L.) [32]. Pentelkina N.V., Pentelkina Y.S. found a significant effect of foliar feeding with Zircon on the growth and development of seedlings of Crimean pine (*Pinus nigra* subsp. pallasiana) and Scots pine, Siberian larch (*Larix sibirica* Ledeb.) and Siberian pine (*Pinus sibirica* Du Tour.). An increase in the height of the seedlings and an increase in the biomass of their aerial part, as well as an increase in the length of roots and their biomass were noted [22-23]. The active effect of Epin-Extra and Zircon on the cultivation of seedlings of Khinghan fir (*Abies nephrolepis* (Trautv.) Maxim.) was revealed.

They had active root formation, an increase in height and biomass, the development of lateral shoots and the formation of the crown of plants. The possibility of reducing the period of cultivation of planting material by 1 year has been established [16]. Chukarina A.V. tested various growth stimulants, including Zircon in the cultivation of Scots pine and Crimean pine. It has been established that the effectiveness of the stimulant Zircon increases in combination with the drug Tsitovit [34].

Based on all of the above, it can be concluded that these growth stimulants are effective and actively used as preparations for pre-sowing seed treatment and root and foliar feeding of a wide variety of agricultural and forest crops, in order to increase growth rates and resistance to various diseases and climatic conditions. These stimulants are included in the List of pesticides and agrochemicals that are approved for use in Russia [29].

The results of the studies varied and depended on weather conditions, which differed significantly from the long-term average indicators.

The studies have shown, that root feeding of larch seedlings with the stimulants during the first two years of growth in the school department of the nursery had a positive effect on their growth and depended on the drug used and the concentration of its solution.

The experiments showed a significant increase in the height of the experimental seedlings in relation to the control by 11.9–26.9% in the 1st year of growth and by 16.3–54.3% in the 2nd year (Tables 1, 2).

Table 1.

The influence of the stimulator Zircon on the height and height gain of Cajander larch seedlings at the first 2 years of growth in the nursery school department

№ n/n	Growth parameters	Height, cm M±m		Height gain, cm	
		1st year of growth	2nd year of growth	1st year of growth	2nd year of growth
1.	Control	41.2 ± 1.1	52.7 ± 2.0	10.1 ± 0.1	12.5 ± 0.6
2.	C (coefficient of variability), %	13.1	18.5	11.3	22.0
3.	P (accuracy of experiment), %	2.6	3.7	2.3	4.5
Solution concentration 0.001%					
4.	Experimental seedlings	46.1 ± 0.5*	61.3 ± 1.1*	15.0 ± 0.9*	15.6 ± 0.4*
5.	Excess to control, %	+11.9	+16.3	+48.5	+24.8
6.	C (coefficient of variability), %	18.6	9.5	15.2	11.7
7.	P (accuracy of experiment), %	3.7	1.9	3.0	2.3

Solution concentration 0.01%					
9.	Experimental seedlings	49.2 ± 0.4*	76.4 ± 1.1*	18.1 ± 0.3*	26.3 ± 1.2*
10.	Excess to control, %	+19.4	+45.0	+79.2	+110.4
11.	C (coefficient of variability), %	16.7	7.5	11.2	20.0
12.	P (accuracy of experiment), %	3.3	1.5	2.2	4.4

Note: * – differences with the control are significant according to the t-test

Table 2.

The influence of the stimulator Epin on the height and height gain of Cajanderlarch seedlings at the first 2 years of growth in the nursery school department

№ n/n	Growthparameters	Height, cm M±m		Heigh tgain, cm	
		1st year of growth	2nd year ofgrowth	1st year of growth	2nd year of growth
1.	Control	41.2 ± 1.1	52.7 ± 2.0	10.1 ± 0.1	12.5 ± 0.6
2.	C (coefficient of variability), %	18.1	18.5	11.3	22.7
3.	P (accuracy of experiment), %	2.6	3.7	2.3	4.5
Solution concentration 0.001%					
4.	Experimental seedlings	48.7 ± 0.5*	65.7 ± 1.0*	17.6 ± 0.2*	17.7 ± 0.6*
5.	Excess to control, %	+18.2	+24.7	+74.3	+41.6
6.	C (coefficient of variability), %	14.9	7.2	14.1	16.4
7.	P (accuracy of experiment), %	3.0	1.4	2.8	3.3
Solution concentration 0.01%					
9.	Experimental seedlings	52.3 ± 1.2*	81.3 ± 2.2*	19.4 ± 1.5*	28.8 ± 1.0*
10.	Excess to control, %	+26.9	+54.3	+92.1	+130.4
11.	C (coefficient of variability), %	14.1	13.8	11.4	20.2
12.	P (accuracy of experiment), %	2.8	2.8	2.3	4.0

The accuracy of the experiment was in the range of 1.4-3.7%. The differences with the control are significant: $t_{fact} > t_{fact}$ at $p < 0.05$. The height gain of the seedlings was 15-19.4 cm in the 1st year and, accordingly, 15.6-28.8 cm in the 2nd year, exceeding the control indicators by 48.5-92.1% and 24.8-130.4%, respectively. Higher rates of height and height gain were noted when feeding seedlings with a stimulator Epin with a solution concentration of 0.01%. When using the drug Zircon with a concentration of 0.001%, a less positive effect was observed.

Experimental seedlings had active root formation. So, in the 1styear the length of roots of experimental seedlings increased the parameters on the control by 1.6-14.3% (Fig. 1), in the 2nd year – by18.1-47.8% (Fig. 2).

During the 1st year of seedling growth, the highest parameters of roots length were noted when fertilizing by the stimulator Zircon with a solution concentration of 0.01%.This is probably due to the fact that the hydroxycinnamic acids included in the stimulator contribute to the active root formation of plants.

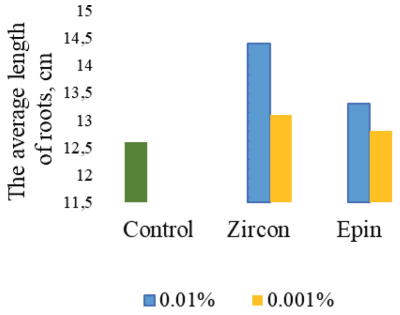

Fig. 1. Influence of the growth stimulants Zircon and Epin on the growth of Cajander larch annual seedlings along the length of roots

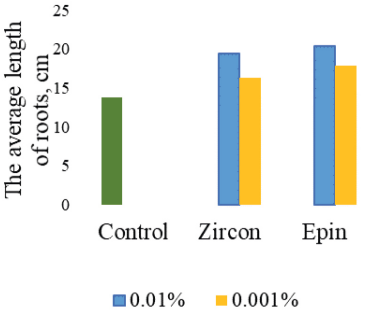

Fig. 2. Influence of the growth stimulants Zircon and Epin on the growth of Cajander larch biennial seedlings along the length of roots

The diameter of the root neck exceeded the control, respectively: by 6.7–11.2% in the 1st year of growth (Fig. 3) and by 17.1–63.8% in the 2nd year (Fig. 4). Epin with a solution concentration of 0.01% had a higher effect.

The mass of the root system of the seedlings in the air-dry state significantly exceeded the control by 80.8–115.4% in the 1st year of growth (Fig. 5) and by 98.1–173.1% in the 2nd year (Fig. 6) and amounted to 4.7–5.6 g and, accordingly, 10.3–14.2 g.

It can be seen from the presented graphs, that the total dry weight of experimental seedlings exceeded the control by 66.7–98.8% in the 1st year of growth and, accordingly, by 89.9–145.3% in the 2nd year.

In the place of growth of 15-year-old crops of Cajander larch, the soils are mountain-forest. The terrain is slightly undulating with a minimum slope. The climate in the research area is monsoonal. The temperature in July-August reaches 30-35 ° C. The distribution of precipitation is uneven. Their average number here is about 80% in the warm season and only 20% in winter. The greatest number of them falls in July-October (about 50-57%), when heavy rains are observed. In winter, snow is observed every three years, which leads to the death of plants. The dynamics of changes in air humidity is peculiar. In summer, it reaches the highest values (more than 80%), in April-May - the lowest (50-70%).

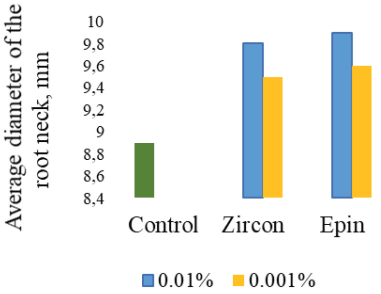

Fig. 3. Influence of the growth stimulants Zircon and Epin on the growth of Cajander larch annual seedlings along the diameter of the root neck

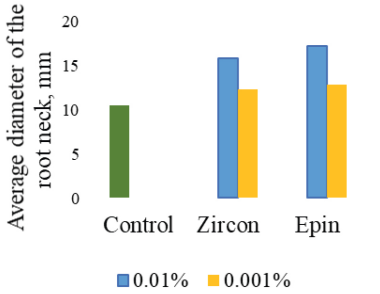

Fig. 4. Influence of the growth stimulants Zircon and Epin on the growth of Cajander larch biennial seedlings along the diameter of the root neck

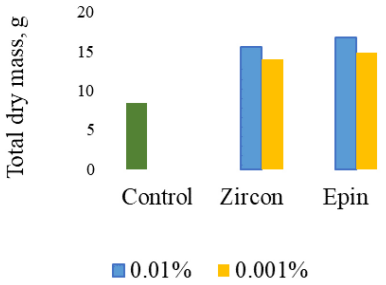

Fig. 5. Influence of the growth stimulants Zircon and Epin on the growth of Cajander larch annual seedlings dry mass

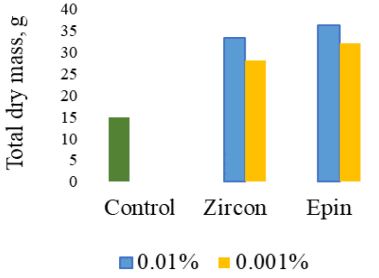

Fig. 6. Influence of the growth stimulants Zircon and Epin on the growth of Cajander larch biennial seedlings dry mass

The main area of the forest fund is occupied by oak and oak-deciduous communities, which are typical for the south-west of Primorye. The species composition of the grass cover includes Amur anemone (*Anemone amurensis* Kom.), single-pair vetch (*Vicia unijuga* A.Br.), eared kalali (*Cacalia auriculata* D.C.), meadowsweet (*Filipendula palmate* Maxim.), pink maryannik (*Melampyrum roseum* Maxim.), Ussuri sedge (*Carex ussuriensis* Kom.), Daurian bedstraw (*Galium davuricum* Turcz. ex Ledeb.), wheatgrass (*Elytrigia* sp.), dandelion (*Taraxacum officinale* (L.) Webb ex F. H. Wigg.), creeping clover (*Trifolium repens* L.), stinging nettle (*Urticaurens* L.), burdock (*Arctium* sp.).

The survival rate of larch crops was within 99%. Among the rooted crops, the trees are predominantly healthy. The fall away is insignificant. The reasons

for the fall are probably connected with damage by pests (larch fly) and with the significant amount of dust and gaseous pollutants, which causes some harm to plants.

Based on the results of tree measurements, it was found that the effect of the use of growth stimulants is preserved (Table 3).

The greatest positive effect was exerted by root feeding of one-two-year-old seedlings of Cajander larch with stimulator Epin, where the average height was in the range of 10.1–10.2 m, exceeding the control indicators by 119.6% (at a concentration of 0.001%) and by 121.7% (at a concentration of 0.01% of water).

When fertilizing seedlings with Zircon, the height indicators were 5.6 m at a concentration of 0.001% and 9.8 m at a concentration of 0.01% (excess to the control - 21.7 and 113%). The significance of the differences with the control was noted: $t_{fact} > t_{tabl}$ at $p < 0.05$.

Table 3.

Influence of the stimulants Zircon and Epin on the growth of the average parameters of the height and diameter of the trunk of fifteen-year-old Cajander larch trees

№ п/п	Growth indicators	Biometric parameters of 15-year-oldCajander larch trees	
		Height, m	Diameter of the trunk, cm
1.	Control	4,6 ± 0,1	10,0 ± 0,6
Zircon			
Solution concentration 0.001%			
2.	Experimental seedlings	5,6 ± 0,1*	12,8 ± 0,5*
3.	Excess to control, %	+21,7	+28,0
Solution concentration 0.01%			
4.	Experimental seedlings	9,8 ± 0,5*	17,0 ± 0,1*
5.	Excess to control, %	+113,0	+70,0
Epin			
Solution concentration 0.001%			
6.	Experimental seedlings	10,1 ± 0,1*	20,1 ± 0,1*
7.	Excess to control, %	+119,6	+101,0
Solution concentration 0.01%			
8.	Experimental seedlings	10,2 ± 0,1*	21,0 ± 0,1*
9.	Excess to control, %	+121,7	+110,0

Note: * - differences with the control are significant according to the t-test

When using the drug Epin, the diameter of the root neck increased by 2 times, compared with the control, amounting to 20.1–21 cm, exceeding the

control by 101–110%. Zircon is less effective. Excess to the control group was within 28–70%. The differences with the control are significant: $t_{fact} > t_{tabl}$ at $p < 0.05$. The significant effect of the stimulant Epin on the growth and development of Cajander larch is probably associated with its constituent epibrassinolide, which has a positive effect on the growth processes of plants.

Conclusion

Thus, it has been established that the growth stimulants Zircon and Epin have a positive effect on the growth of seedlings and mature trees of Cajander larch. It was revealed that the effect of root feeding with Epin solution, in comparison with Zircon, is higher in individual growth indicators. Thus, the height of larch seedlings treated with the stimulator Epin in the first year of growth exceeded the control by 18.2-26.9% and in the second year, respectively, by 24.7-54.3%. The height gain exceeded the control by 74.3-92.1% and, accordingly, by 41.6-130.4%. The diameter of the root neck and dry mass exceeded the control by 7.9-11.2, 22.9-65.8 and 76.2-98.8 and 116.2-145.3%. However, it was noted that the length of the roots in the first year of growth, to a greater extent, was influenced by Zircon, exceeding the indicators of the control group by 4-14.3% and 29-47.8% and in the second year a significant effect was produced by Epin.

Epin also had a positive effect on the height and diameter of the trunk of 15-year-old larch trees. Exceedances in relation to the control amounted to 119.6-121.7% and 101-110%.

The use of a higher concentration of solutions (0.01%) gives a more significant effect in comparison with a lower one (0.001%).

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References

1. Aliev E.V., Sivolapov A.I. Vliyanie predposevnoy obrabotki semyan na vskhozhest' i rost seyantsev sosny obyknovennoy rostovymi veshchestvami [Impact of growth substances on Scotch pine seed pretreatment]. *Sovremennye problemy nauki i obrazovaniya* [Modern problems of science and education], 2013, no. 4, p. 369.
2. Baryshnikova S.V., Mukhina M.A. Vliyanie kompleksnykh preparatov na rost i razvitie seyantsev tui koreyskoy (*Thuja koraiensis* Nakai) [Influence of complex

preparations on growth and development of seedlings of Korean thuja (*Thuja koraiensis* Nakai)]. *Byulleten' botanicheskogo sada Saratovskogo gosudarstvennogo universiteta* [Bulletin of the Botanical Garden of the Saratov State University], 2013, no. 11, pp. 111-114.

3. Vakulenko V.V. Epin-ekstra i Tsirkon effektivny na kapuste [Epin-Extra and Circon are effective on cabbage]. *Kartofel' i ovoshchi* [Potato and vegetables], 2014, no. 4, pp. 14-15.
4. Gazdanova I.O., Gerieva F.T., Morgoev T.A. Effektivnost' primeneniya biostimulyatorov" Epin-ekstra" i" Tsirkon" na posadkakh kartofelya v agroekologicheskikh usloviyakh RSO-Alaniya [Efficiency of application of "Epin-extra" and "Zircon" biostimulants on potato landings in agroecological conditions of Republic of North Ossetia-Alania]. *Agrarnyy vestnik Urala* [Agrarian bulletin of the Urals], 2020, no. 8 (199), pp. 2-8. https://doi.org/10.32417/1997-4868-2020-199-8-2-8
5. Galdina T.E., Shevchenko K.V. Otsenka vliyaniya biostimulyatorov na sostoyanie i kachestvo seyantsev eli evropeyskoy (*Picea abies*) [Evaluation of the impact of biostimulants on the condition and quality of European spruce seedlings (*Picea abies*)] [Electronic resourse]. *"Studencheskiy nauchnyy forum": IV mezhdunar. stud. elektron. nauch. konf.* ["Student Scientific Forum": mater. IV Int. stud. electron. sci. conf.] (Moscow, 15 February-31 March 2021): The Russian Academy of Natural Sciences, 2012, no. 7. https://www.rae.ru/forum 2012/13/559 (accessed 15 November 2022).
6. Gladysheva O.V. Vliyanie Epin-Ekstra i Tsirkona na energiyu prorastaniya i laboratornuyu vskhozhest' semyan nekotorykh sortov tomatov [Effect of Epin-Extra and Zircon on germination energy and laboratory germination of seeds of some tomato varieties]. *Nauchnyy al'manakh* [Scientific almanac], 2019, no. 2-2 (52), pp. 115-118. https://doi.org/10.17117/na.2019.02.02.115
7. Gukov G.V., Ostroshenko V.V., Morozov S.A., Ostroshenko L.Yu. Predposevnaya obrabotka semyan khvoynykh stimulyatorami rosta [Presowing treatment of coniferous seeds with growth stimulators]. *Trudy mezhdunar. foruma po problemam nauki, tekhniki i obrazovaniya* [Proc. of int. forum on problems of science, technology and education], 2002, pp. 75-77.
8. Gukov G.V., Ostroshenko V.V., Ostroshenko L.Yu. Novaya tekhnologiya vosstanovleniya khvoynykh lesov Dal'nego Vostoka [New technology for the restoration of coniferous forests in the Far East]. *Lesnoe khozyaystvo* [Forestry], 2006, no. 4, pp. 35-37.
9. Gukov G.V. *Listvennitsy i listvennichnye lesa rossiyskogo Dal'nego Vostoka* [Larch and larch forests of the Russian Far East]. Vladivostok: GTS DVO RAN, 2009, 350 p.

10. Kabanova S.A., Danchenko M.A., Kochegarov I.S., Kabanov A.N. Opyt intensivnogo vyrashchivaniya odnoletnikh seyantsev sosny obyknovennoy v Pavlodarskoy oblasti Respubliki Kazakhstan [The experience of intensive cultivation of one-year-old seedlings of *Pinus sylvestris* L. in Pavlodar region of the republic of Kazakhstan]. *Lesnoy zhurnal* [Russian Forestry Journal], 2019, no. 6, pp. 104-117. https://doi.org/10.17238/issn0536-1036.2019.6.104
11. Kirienko M.A., Goncharova I.A. Vliyanie kontsentratsii stimulyatorov rosta na gruntovuyu vskhozhest' semyan i sokhrannost' seyantsev glavnykh lesoobrazuyushchikh vidov Sredney Sibiri [Influence of the concentration of growth stimulants on the soil germination of seeds and the safety of seedlings of the main forest-forming species of Central Siberia]. *Sibirskiy lesnoy zhurnal* [Siberian Journal of Forest Science], 2016, no. 1, pp. 39-45. https://doi.org/10.15372/SJFS20160104
12. Larionova N.A. Primenenie gormonal'nykh veshchestv dlya uluchsheniya kachestva semyan i rosta seyantsev khvoynykh porod v Krasnoyarskom krae [The use of hormonal substances to improve the quality of seeds and the growth of seedlings of coniferous species in the Krasnoyarsk Territory]. *Lesnoe khozyaystvo* [Forestry], 1997, no. 6, pp. 28-30.
13. Mustaev F.A. Effektivnost' novogo stimulyatora rosta Navruz [The effectiveness of the new growth stimulator Navruz]. *Zashchita i karantin rasteniy* [Plant protection and quarantine], 2008, no. 10, p. 28.
14. Nikitenko E.A., Gul L.P., Korol L.A. Izuchenie stimulyatorov rosta pri vyrashchivanii posadochnogo materiala dal'nevostochnykh drevesnykh porod [The study of growth stimulants in the cultivation of planting material of the Far Eastern tree species]. *Subtropicheskoe i yuzhnoe sadovodstvo Rossii* [Subtropical and southern gardening of Russia], 2005, no. 38, p. 171.
15. On the approval of the Rules of sanitary safety in forests. Decree of the Government of the Russian Federation № 2047 from 09.12.2020. URL: https://www.consultant.ru/document/cons_doc_LAW_370645/ (accessed 05.05.2023).
16. Ostroshenko V.V., Ostroshenko L.Yu., Ostroshenko V.Yu. Vliyanie kornevoy podkormki stimulyatorami rosta odno-dvuletnikh seyantsev pikhty pochkocheshuynoy na ikh dal'neyshiy rost [The influence of the root additional fertilizing by the growth stimulants of the annual-biennial Khingam fir seedlings on their following growth]. *Vestnik KrasGAU* [The Bulletin of KrasGAU], 2015, no. 10, pp. 160-167.
17. Ostroshenko V.Yu., Ostroshenko L.Yu. Effektivnost' primeneniya stimulyatorov rosta pri vyrashchivanii seyantsev pikhty tsel'nolistnoy (*Abies holophylla* Maxim.) [The effectiveness of the application of growth stimulants in grow-

ing Manchurian fir *(Abies holophylla Maxim.)*]. *Uspekhi sovremennogo estestvoznaniya* [Advances in current natural sciences], 2020, no. 4, pp. 41-47. https://doi.org/10.17513/use.37360

18. Official site of the Administration of the Primorsky Territory and executive authorities of the Primorsky Territory. URL: https://www.primorsky.ru/authorities/executive-agencies/departments/forestry/folder 2/index.php (accessed 01.03.2021).
19. Pentelkin S.K. Primenenie Agata-25K v lesnom khozyaystve [Agata-25K application in forestry]. *Lesnoe khozyaystvo* [Forestry], 2001, no. 2, pp. 41-43.
20. Pentelkin S.K. Itogi izucheniya stimulyatorov rosta i polimerov v lesnom khozyaystve za poslednie 20 let [Results of the study of growth stimulants and polymers in forestry over the past 20 years]. *Lesokhozyaystvennaya informatsiya* [Forestry information], 2003, no. 11, 20 p.
21. Pentelkina N.V. Ekologicheski chistye tekhnologii na osnove ispol'zovaniya stimulyatorov rosta [Environmentally friendly technologies based on the use of growth stimulants]. *Ekologiya, nauka, obrazovanie, vospitanie* [Ecology, science, education, upbringing], 2002, vol. 3, pp. 69-71.
22. Pentelkina N.V., Pentelkina Yu.S. Stimuliruyushchee deystvie tsirkona na rost seyantsev khvoynykh introdutsentov [Stimulating effect of zircon on the growth of seedlings of coniferous introducents]. *Lesnoy vestnik* [Forestry bulletin], 2002, no. 2, pp. 24-28.
23. Pentelkina Yu.S. Ispol'zovanie stimulyatorov rosta pri vyrashchivanii tsennogo introdutsenta [The use of growth stimulants in the cultivation of a valuable introducent]. *Aktual'nye problemy lesnogo kompleksa* [Actual problems of the forest complex], 2005, vol. 10, pp. 121-125.
24. Peregudov S.V., Talanova L.A., Peregudova A.V. Otsenka deystviya preparatov Epin-Ekstra i tsirkona na rost i produktivnost' morkovi [Estimation of efficiency of Epina-Ekstra and Zircon preparations' action on growth and productivity of carrot]. *Agrokhimicheskiy vestnik* [Agrochemical Herald], 2010, no. 2, pp. 30-31.
25. Reshetnik G.V., Zaichenko O.S. Vliyanie sinteticheskikh regulyatorov rosta Siliplant i Epin-Ekstra na fiziologicheskie parametry ozimoy pshenitsy (*Triticum aestivum* L.) i yachmenya (*Hordeum vulgare* L.) na rannikh etapakh ontogeneza [Influence of synthetic growth regulators Siliplant and Epin-Extra on the physiological parameters of winter wheat (*Triticum aestivum* L.) and barley (*Hordeum vulgare* L.) at the early stages of ontogenesis]. *"Biologicheskaya zashchita rasteniy – osnova stabilizatsii agroekosistem": mater. mezhdunar. nauch. - prakt. konf.* [*"*Biological protection of plants − the basis for the

stabilization of agroecosystems": mater. international scientific - pract. conf.] (Krasnodar, 11-13 September 2018): The Printing House "Granat", 2018, pp. 277-280.

26. Rodin S.A., Prokazin N.E., Kazakov V.I., Lobanova E.N., Pentelkina N.V. Otsenka tselesoobraznosti primeneniya rostovykh preparatov pri vyrashchivanii seyantsev khvoynykh porod [Evaluation of the expediency of using growth preparations in the cultivation of seedlings of coniferous species]. *"Lesa Rossii: politika, promyshlennost', nauka, obrazovanie": mater. vtoroy mezhdunar. nauch. - tekhn. konf.* ["Forests of Russia: politics, industry, science, education": mater. of the second int. sci. - techn. conf.] (St. Petersburg, 24-26 May 2017): Saint Petersburg State Forest Technical University named after S.M. Kirova, 2017, pp. 134-136.
27. Savchenko O.M., Malankina E.L., Kozlovskaya L.N. Vlijanie reguljatorov rosta na prorastanie semjan luka pobednogo *(Allium victorialis L.)* i luka medvezh'ego *(Allium ursinum L.)* [Effect of growth regulators on seed germination of victorious onion (*Allium victorialis* L.) and bear onion (*Allium ursinum* L.)]. *Izvestiya TSKhA* [Izvestiya of Timiryazev Agricultural Academy], 2010, issue 6, pp. 61-66.
28. Saltsevich Yu.V. Primenenie biopreparatov pri vyrashchivanii sazhentsev eli sibirskoy v otkrytom grunte [The use of biopreparations in the cultivation of seedlings of Siberian spruce in open ground]. *"Lesnoy i khimicheskiy kompleksy – problemy i resheniya": sb. mater. po itogam Vseros. nauch. - prakt. konf.* ["Forestry and chemical complexes - problems and solutions": coll. of mater. according to the results of the All-Russian sci. - pract. conf.]ю Krasnoyarsk, 02–04 September 2019. Reshetnev Siberian State University of Science and Technology, 2019, pp. 110-112.
29. Pesticide guide 2023. URL: https://www.Agro- xxi.ru/goshandbook (accessed 30.07.2023).
30. Usenko N.V. *Derev'ya, kustarniki i liany Dal'nego Vostoka* [Trees, shrubs and lianas of the Far East]. Khabarovsk, Priamurskiye Vedomosti Publ., 2009, 272 p.
31. Ustinova T.S., Plotnikova G.P. Primenenie stimulyatorov pri vyrashchivanii khvoynykh porod [The use of stimulants in the cultivation of conifers]. *Aktual'nye problemy lesnogo kompleksa* [Actual problems of the forest complex], 2006, issue 13, pp. 249-250.
32. Ustinova T.S., Chmurova I.M. Vliyanie preparata Epin-Ekstra na rostovye protsessy sosny obyknovennoy [Effect of Epin-Extra on the growth processes of Scots pine]. *Aktual'nye problemy lesnogo kompleksa* [Actual problems of the forest complex], 2011, issue 28, pp. 153-155.

33. Chilimov A.I., Pentelkin S.K., Pentelkina N.V. Ispol'zovanie stimulyatorov rosta dlya adaptatsii seyantsev eli posle vesennikh zamorozkov [The use of growth stimulants for the adaptation of spruce seedlings after spring frosts] *Lesnoe khozyaystvo* [Forestry], 1996, no. 1, pp. 38-40.
34. Chukarina A.V. Regulyatory rosta i agrokhimikaty, ikh rol' pri vyrashchivanii posadochnogo materiala dlya iskusstvennykh lesov Rostovskoy oblasti [Growth regulators and agrochemicals, their role in growing planting material for artificial forests in the Rostov region]. *Aktual'nye problemy lesnogo kompleksa* [Actual problems of the forest complex], 2014, vol. 39, pp. 99-102.
35. Fraga H.P.F., Vieira L.N., Heringer A.S., Puttkammer C.C., Silveira V., Guerra M.P. DNA methylation and proteome profiles of *Araucaria angustifolia* (Bertol.) Kuntze embryogenic cultures as affected by plant growth regulators supplementation. *Plant Cell Tiss Organ Cult*, 2016, vol. 125, no. 2, pp. 353-374. https://doi.org/10.1007/s11240-016-0956-y
36. Kuneš I., Baláš M., Linda R., Gallo J., Nováková O. Effects of brassinosteroid application on seed germination of Norway spruce, Scots pine, Douglas fir and English oak. *iForest*, 2016, vol. 10, pp. 121-127. https://doi.org/10.3832/ifor1578-009
37. Ostroshenko V., Ostroshenko L. Efficiency of the Application of Growth Stimulants Ribav-Extra and Zircon in the Germination of Manchurian Fir (*Abies holophylla* Maxim.) Seeds. *Fundamental and Applied Scientific Research in the Development of Agriculture in the Far East (AFE-2021). AFE 2021. Lecture Notes in Networks and Systems*, 2022, vol. 353, Springer, Cham. https://doi.org/10.1007/978-3-030-91402-8_71
38. Ostroshenko V.Yu., Ostroshenko L.Yu. Influence of growth stimulants Ribav-Extra and Epin-Extra on the germination of seeds of Khinghan Fir (*Abies nephrolepis* (Trautv.) Maxim.). *Siberian journal of life sciences and agriculture*, 2022, vol. 14, no. 5, pp. 111-133. https://doi.org/10.12731/2658-6649-2022-14-5-111-133
39. Truța A.M., Viman O., Dohotar V.D., Sîngeorzan S., Truța P., & Holonec L. The influence of certain types of substrate and biochemical substances in seed germination and plant development of spruce (*Picea abies*). *Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca. Horticulture*, 2020, vol. 77, no. 1, pp. 128-135. https://doi.org/10.15835/buasvmcn-hort:2020.0010

Список литературы

1. Алиев Э.В., Сиволапов А.И. Влияние предпосевной обработки семян на всхожесть и рост сеянцев сосны обыкновенной ростовыми веществами // Современные проблемы науки и образования. 2013. № 4. С. 369.

2. Барышникова С.В., Мухина М.А. Влияние комплексных препаратов на рост и развитие сеянцев туи корейской (*Thuja koraiensis* Nakai) // Бюллетень ботанического сада Саратовского государственного университета. 2013. № 11. С. 111-114.
3. Вакуленко В.В. Эпин-экстра и Циркон эффективны на капусте // Картофель и овощи. 2014. № 4. С. 14-15.
4. Газданова И.О., Гериева Ф.Т., Моргоев Т.А. Эффективность применения биостимуляторов» Эпин-экстра» и» Циркон» на посадках картофеля в агроэкологических условиях РСО-Алания // Аграрный вестник Урала. 2020. № 8 (199). С. 2-8. https://doi.org/10.32417/1997-4868-2020-199-8-2-8
5. Галдина Т.Е., Шевченко К.В. Оценка влияния биостимуляторов на состояние и качество сеянцев ели европейской (*Picea abies*) [Электронный ресурс] // «Студенческий научный форум»: матер. IV междунар. студ. электрон. науч. конф. (Москва, 15 февраля - 31 марта 2021 г.). Москва: Российская Академия Естествознания, 2012. № 7. URL: https://www.rae.ru/forum 2012/13/559
6. Гладышева О.В. Влияние Эпин-Экстра и Циркона на энергию прорастания и лабораторную всхожесть семян некоторых сортов томатов // Научный альманах. 2019. № 2-2 (52). С. 115-118. https://doi.org/10.17117/na.2019.02.02.115
7. Гуков Г.В., Острошенко В.В., Морозов С.А., Острошенко Л.Ю. Предпосевная обработка семян хвойных стимуляторами роста // Тр. междунар. форума по проблемам науки, техники и образования. Москва: АНЗ, 2002. С.75-77.
8. Гуков Г.В., Острошенко В.В., Острошенко Л.Ю. Новая технология восстановления хвойных лесов Дальнего Востока // Лесное хозяйство. 2006. № 4. С. 35-37.
9. Гуков Г.В. Лиственницы и лиственничные леса российского Дальнего Востока. Владивосток: ГТС ДВО РАН, 2009. 350 с.
10. Кабанова С.А., Данченко М.А., Кочегаров И.С., Кабанов А.Н. Опыт ин-тенсивного выращивания однолетних сеянцев сосны обыкновенной в Павлодарской области Республики Казахстан // Известия высших учебных заведений. Лесной журнал. 2019. № 6. С. 104-117. https://doi.org/10.17238/issn0536-1036.2019. 6.104
11. Кириенко М.А., Гончарова И.А. Влияние концентрации стимуляторов роста на грунтовую всхожесть семян и сохранность сеянцев главных лесообразующих видов средней Сибири // Сибирский лесной журнал. 2016. № 1. С. 39-45. https://doi.org/10.15372/SJFS20160104

12. Ларионова Н.А. Применение гормональных веществ для улучшения качества семян и роста сеянцев хвойных пород в Красноярском крае // Лесное хозяйство. 1997. № 6. С. 28-30.
13. Мустаев Ф.А. Эффективность нового стимулятора роста Навруз // Защита и карантин растений. 2008. № 10. С. 28.
14. Никитенко Е.А., Гуль Л.П., Король Л.А. Изучение стимуляторов роста при выращивании посадочного материала дальневосточных древесных пород // Субтропическое и южное садоводство России. 2005. № 38. С. 171.
15. Об утверждении Правил санитарной безопасности в лесах. Постановление Правительства РФ от 9 декабря 2020 г. № 2047. 2020. [Электронный ресурс]. URL: https://www.consultant.ru/document/cons_doc_LAW_370645/ (дата обращения 05.05.2023 г).
16. Острошенко В.В., Острошенко Л.Ю., Острошенко В.Ю. Влияние корневой подкормки стимуляторами роста одно-двулетних сеянцев пихты почкочешуйной на их дальнейший рост // Вестник КрасГАУ. 2015. № 10. С. 160-167.
17. Острошенко В.Ю., Острошенко Л.Ю. Эффективность применения стимуляторов роста при выращивании сеянцев пихты цельнолистной (*Abies holophylla* Maxim.) // Успехи современного естествознания. 2020. № 4. С. 41-47. https://doi.org/10.17513/use.37360
18. Официальный сайт Администрации Приморского края и органов исполнительной власти Приморского края. 2021. [Электронный ресурс]. URL: https://www.primorsky.ru/authorities/executive-agencies/departments/forestry/folder 2/index.php (дата обращения: 01.03. 2021).
19. Пентелькин С. К. Применение Агата-25К в лесном хозяйстве // Лесное хозяйство. 2001. № 2. С. 41-43.
20. Пентелькин С.К. Итоги изучения стимуляторов роста и полимеров в лесном хозяйстве за последние 20 лет // Лесохозяйственная информация. 2003. № 11. 20 с.
21. Пентелькина Н.В. Экологически чистые технологии на основе использования стимуляторов роста // Экология, наука, образование, воспитание. 2002. Вып. 3. С. 69-71.
22. Пентелькина Н.В., Пентелькина Ю.С. Стимулирующее действие циркона на рост сеянцев хвойных интродуцентов // Лесной вестник (Forestry bulletin). 2002. №. 2. С. 24-28.
23. Пентелькина Ю.С. Использование стимуляторов роста при выращивании ценного интродуцента // Актуальные проблемы лесного комплекса. 2005. Вып. 10. С. 121-125.

24. Перегудов С.В., Таланова Л.А., Перегудова А.В. Оценка действия препаратов Эпин-Экстра и циркона на рост и продуктивность моркови // Агрохимический вестник. 2010. № 2. С. 30-31.
25. Решетник Г.В., Зайченко О.С. Влияние синтетических регуляторов роста Силиплант и Эпин-Экстра на физиологические параметры озимой пшеницы (*Triticum aestivum* L.) и ячменя (*Hordeum vulgare* L.) на ранних этапах онтогенеза // Биологическая защита растений основа стабилизации агроэкосистем: матер. междунар. науч. - практ. конф. (Краснодар, 11-13 сентября 2018 г.). Краснодар: типография «Гранат», 2018. С. 277-280.
26. Родин С.А., Проказин Н.Е., Казаков В.И., Лобанова Е.Н., Пентелькина Н.В. Оценка целесообразности применения ростовых препаратов при выращивании сеянцев хвойных пород // Леса России: политика, промышленность, наука, образование: матер. второй междунар. науч. - техн. конф. (Санкт-Петербург, 24-26 мая 2017 г.). Санкт-Петербург: Санкт-Петербургский государственный лесотехнический университет им. С.М. Кирова, 2017. С. 134-136.
27. Савченко О.М., Маланкина Е.Л., Козловская Л.Н. Влияние регуляторов роста на прорастание семян лука победного (*Allium victorialis* L.) и лука медвежьего (*Allium ursinum* L.) // Известия ТСХА. 2010. Вып. 6. С. 61-66.
28. Салцевич Ю.В. Применение биопрепаратов при выращивании саженцев ели сибирской в открытом грунте // Лесной и химический комплексы – проблемы и решения: сб. матер. по итогам Всерос. науч. - практ. конф. (Красноярск, 02–04 сентября 2019 г.). Красноярск: Сибирский государственный университет науки и технологий имени академика М.Ф. Решетнева, 2019. С. 110-112.
29. Справочник пестицидов 2023. 2023. [Электронный ресурс]. URL: https://www.agroxxi.ru/goshandbook (дата обращения: 30.07.2023).
30. Усенко Н.В. Деревья, кустарники и лианы Дальнего Востока: справочная книга. 3-е изд., перераб. и доп. Хабаровск: Издательский дом «Приамурские ведомости», 2009. 272 с.
31. Устинова Т.С., Плотникова Г.П. Применение стимуляторов при выращивании хвойных пород // Актуальные проблемы лесного комплекса. 2006. Вып. 13. С. 249-250.
32. Устинова Т.С., Чмурова И.М. Влияние препарата Эпин-Экстра на ростовые процессы сосны обыкновенной // Актуальные проблемы лесного комплекса. 2011. Вып. 28. С. 153-155.
33. Чилимов А.И., Пентелькин С.К., Пентелькина Н.В. Использование стимуляторов роста для адаптации сеянцев ели после весенних заморозков // Лесное хозяйство. 1996. № 1. С. 38-40.

34. Чукарина А.В. Регуляторы роста и агрохимикаты, их роль при выращивании посадочного материала для искусственных лесов Ростовской области // Актуальные проблемы лесного комплекса.2014. Вып. 39. С. 99-102.
35. Fraga H.P.F., Vieira L.N., Heringer A.S., Puttkammer C.C., Silveira V., Guerra M.P. DNA methylation and proteome profiles of *Araucaria angustifolia* (Bertol.) Kuntze embryogenic cultures as affected by plant growth regulators supplementation // Plant Cell Tiss Organ Cult, 2016, vol. 125, no. 2, pp. 353-374. https://doi.org/10.1007/s11240-016-0956-y
36. Kuneš I., Baláš M., Linda R., Gallo J., Nováková O. Effects of brassinosteroid application on seed germination of Norway spruce, Scots pine, Douglas fir and English oak // iForest, 2016, vol. 10, pp. 121-127. https://doi.org/10.3832/ifor1578-009
37. Ostroshenko V., Ostroshenko L. Efficiency of the Application of Growth Stimulants Ribav-Extra and Zircon in the Germination of Manchurian Fir (*Abies holophylla* Maxim.) Seeds // Fundamental and Applied Scientific Research in the Development of Agriculture in the Far East (AFE-2021). AFE 2021. Lecture Notes in Networks and Systems, 2022, vol. 353, Springer, Cham. https://doi.org/10.1007/978-3-030-91402-8_71
38. Ostroshenko V.Yu., Ostroshenko L.Yu. Influence of growth stimulants Ribav-Extra and Epin-Extra on the germination of seeds of Khinghan Fir (*Abies nephrolepis* (Trautv.) Maxim.) // Siberian journal of life sciences and agriculture, 2022, vol. 14, no. 5, pp. 111-133. https://doi.org/10.12731/2658-6649-2022-14-5-111-133
39. Truța A.M., Viman O., Dohotar V.D., Sîngeorzan S., Truța P., &Holonec L. The influence of certain types of substrate and biochemical substances in seed germination and plant development of spruce (*Picea abies*) // Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca. Horticulture, 2020, vol. 77, no. 1, pp. 128-135. https://doi.org/10.15835/buasvmcn-hort:2020.0010

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