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INFLUENCE OF GROWTH STIMULANTS RIBAV-EXTRA AND EPIN-EXTRA ON THE GERMINATION OF SEEDS OF KHINGHAN FIR (*ABIES NEPHROLEPIS* (TRAUTV.) MAXIM.)

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Khinghan fir (Abies nephrolepis (Trautv.) Maxim.) is the most common species among the conifers of Primorsky Krai. It plays an important role in forest consumption. However, forest fires and logging lead to a reduction in the range of this species. Thanks to the use of growth stimulants, it is possible to accelerate the restoration of the Far Eastern fir. The aim of the research was to study the effect of the growth stimulants Ribav-Extra and Epin-Extra on germinative energy, laboratory seed germination and morphometric parameters of sprouts (length and weight) of Khinghan fir (Abies nephrolepis (Trautv.) Maxim.). According to GOSTS, the experiments were carried out in four repetitions in seven different concentrations of solutions (1×10^{-3} – $1\times7\times10^{-3}$ ml/l). Control − seeds soaked in distilled water. The length of sprouts was measured with the use of an electronic caliper. The mass of sprouts was weighed on an electronic balance. The conducted studies showed, that Ribav-Extra had the greatest effect on sowing qualities of seeds (germinative energy and laboratory germination) at the solution concentrations of $1\times2\times10^{-3}$- $1\times7\times10^{-3}$ ml/l, amounting to 4-16% (excess to the control − 21.2-384.8%). For laboratory germination (21.4-33.1%) − at the concentrations of $1\times3\times10^{-3}$-$1\times6\times10^{-3}$ ml/l (excess to the control − 127.7-252.1%). Epin-Extra showed a more active effect on the energy of seed germination with the solution concentrations of $1\times2\times10^{-3}$-$1\times6\times10^{-3}$ ml/l, amounting to 4-16%. Excess to the control − 21.2-384.8%. The concentration of solutions $1\times3\times10^{-3}$ - $1\times5\times10^{-3}$ ml/l had a positive effect on laboratory germination of seeds (13-33%), exceeding the control by 38.3-251.1%. An increase in seed quality classes was noted: from the third to the second and first. These stimulants also

proved to be effective for increasing the biometric parameters of sprouts (length and weight). Thus, a significant effect of Ribav-Extra on the increase in the length of sprouts was noted at the concentrations of 1×10^{-3}-$1\times6\times10^{-3}$ ml/l (excess to the control – 7.7-50%); in Epin-Extra – with the solutions of $1\times4\times10^{-3}$-$1\times7\times10^{-3}$ ml/l, exceeding the control by 7.7-40%. Ribav-Extra had a positive effect on the increase in the mass of sprouts in all concentrations of solutions (excess to the control – 5.1-79.5%). Epin-Extra is less effective.

Keywords: *Khinghan fir; growth stimulants; Ribav-Extra; Epin-Extra; germinative energy; laboratory germination; length of sprouts; weight of sprouts*

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ВЛИЯНИЕ СТИМУЛЯТОРОВ РОСТА РИБАВ-ЭКСТРА И ЭПИН-ЭКСТРА НА ПРОРАСТАНИЕ СЕМЯН ПИХТЫ ПОЧКОЧЕШУЙНОЙ (БЕЛОКОРОЙ) (*ABIES NEPHROLEPIS* (TRAUTV.) MAXIM.)

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Пихта почкочешуйная (белокорая) (Abies nephrolepis (Trautv.) Maxim.) – наиболее распространенный вид среди хвойных пород Приморского края. Выполняет значимую роль в лесопотреблении. Однако лесные пожары и рубка леса приводят к сокращению ареала данного вида. Благодаря применению стимуляторов роста возможно ускоренное восстановление дальневосточной пихты. Целью исследований являлось изучение влияния стимуляторов роста Рибав-Экстра и Эпин-Экстра на энергию прорастания, лабораторную всхожесть семян и морфометрические показатели проростков (длину и массу) пихты почкочешуйной (белокорой). Опыты проводили в соответствии с ГОСТ в четырех повторностях в семи различных концентрациях растворов (1×10^{-3} – $1\times7\times10^{-3}$ мл/л). Контроль – семена, замоченные в дистиллированной воде. Электронным штангенциркулем замеряли длину проростков, их массу определяли на электронных весах.

Проведенные исследования показали, что на посевные качества семян (энергию прорастания и лабораторную всхожесть) наибольший эффект оказал Рибав-Экстра при концентрациях растворов $1\times2\times10^{-3}$-$1\times7\times10^{-3}$ мл/л,

составив 4-16% (превышение к контролю – 21,2-384,8%). На лабораторную всхожесть (21,4-33,1%) – при концентрациях $1 \cdot 3 \cdot 10^{-3}$-$1 \cdot 6 \cdot 10^{-3}$ мл/л (превышение к контролю – 127,7-252,1%). Эпин-Экстра более активное влияние на показатели энергии прорастания семян показал при растворах концентрациями $1 \times 2 \times 10^{-3}$-$1 \times 6 \times 10^{-3}$ мл/л, составив 4-16%. Превышение к контролю – 21,2-384,8%. На лабораторную всхожесть семян (13-33%) положительный эффект оказали концентрации растворов $1 \times 3 \times 10^{-3}$ – $1 \times 5 \times 10^{-3}$ мл/л, превышая контроль на 38,3-251,1%. Отмечено повышение классов качества семян: с третьего – до второго и первого. Указанные стимуляторы также оказались эффективны для нарастания биометрических показателей проростков (длины и массы). Так, на нарастание длины проростков существенное влияние Рибава-Экстра отмечалось при концентрациях 1×10^{-3}-$1 \times 6 \times 10^{-3}$ мл/л (превышение к контролю 7,7-50%); у Эпина-Экстра – при растворах $1 \times 4 \times 10^{-3}$-$1 \times 7 \times 10^{-3}$ мл/л, превышая контроль на 7,7-40%. На нарастание массы проростков Рибав-Экстра положительно повлиял во всех концентрациях растворов, превысив контроль на 5,1-79,5%. Эпин-Экстра менее эффективен.

Ключевые слова: *пихта почкочешуйная (белокорая); стимуляторы роста; Рибав-Экстра; Эпин-Экстра; энергия прорастания; лабораторная всхожесть; длина проростков; масса проростков*

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Introduction

Khinghan fir (*Abies nephrolepis* (Trautv.) Maxim.) is the most common species among conifers of the forest fund of Primorsky Krai. It grows mainly on mountain slopes, which gives it the importance of a mountain-reinforcing and water-regulating tree species. It rises to the mountains up to 1200 m. Fir wood is less valuable among the conifers of the Far East, but in the presence of its reserves it plays a significant role in forest consumption. It is widely used as sawing and construction logs, poles, box containers, plaster shingles. It is used in medicine, landscape construction. However, emerging forest fires and deforestation lead to a reduction in the range of this species [31]. Currently, fir occupies 427.4 thousand ha [24].

In this regard, it is necessary to take measures for its conservation and reproduction. One of the methods of restoring Khinghan fir is the creation of forest

plantations, for the laying of which high-quality planting material is needed, grown in forest nurseries. It can be obtained through the use of growth stimulants. Recently, growth stimulants have been actively used in agriculture of Russia and abroad. In the forest industry, their use is carried out on an experimental basis [10, 29, 34, 36-38, 40-41].

Scientific novelty of the study – the effect of growth stimulants of natural (Ribav-Extra) and synthetic (Epin-Extra) origin on the germination of Khinghan fir seeds has been studied for the first time.

Ribav-Extra is a product of the vital activity of mycorrhizal fungi isolated from ginseng roots by biotechnological means and contains a unique natural complex (amino acids, phytohormones, vitamins), which, in negligibly small doses, activates all processes of plant life. Ribav-Extra is an analogue of the drug "Symbiont". The active substance of the drug Ribav-Extra: 0.00125 g/l L-alanine + 0.00196 g/l L-glutamic acid [30].

It has been established, that Ribav-Extra has a positive effect on seed germination, growth and development of plants [5], their productivity [27]; contributes to the activation of rooting and growth parameters in green cuttings [19, 25]; increases the heat resistance of sprouts [15]; affects the number and size of leaves [18]; increases the yield of planting material per unit area [25], etc.

The growth stimulator **Epin-Extra** – is a synthetic analogue of natural phytohormone. The active substance of the drug is epibrassinolide; belongs to the class of brassinosteroids, natural plant hormones. Its mechanism of action is to activate its own phytohormones in plants. It is epibrassinolide that causes the activation of biological processes in plants, literally saving them from illness, old age and at the time of stress [30].

The active influence of this drug on germinative energy, laboratory germination of seeds, as well as an increase in the morphometric parameters of seedlings was revealed [11]; increase in antibacterial action [1], stress resistance and productivity of plants [4], safety and survival [12], their productivity [35]; acceleration of the terms of vegetative reproduction [13]; plant resistance to a complex of phytopathogens [16], etc.

Objective

The object of the work was to study the effect of these growth stimulants on sowing qualities of seeds and morphometric parameters of sprouts of Khinghan fir.

The following tasks are set in the article:

– to study the effect of the growth stimulants Ribav-Extra and Epin-Extra on germinative energy and laboratory germination of Khinghan fir seeds;

– to study the influence of these stimulants on length and weight of Khinghan fir seed sprouts.

Materials and methods

The object of research was the seeds of Khinghan fir, harvested in the southern part of Primorsky Krai in October 2019. Before the start of the experiment, cold stratification of seeds was not carried out. Identification of the stimulating effect of growth stimulants Ribav-Extra and Epin-Extra was carried out in accordance with the requirements of GOSTS [7, 8].

For germination, externally undamaged seeds were selected, which were soaked for 20 hours in solutions of growth stimulants. The experiments consisted of 7 variants (the concentrations of the drug and water solutions were: 1×10^{-3}; $1\times2\times10^{-3}$; $1\times3\times10^{-3}$; $1\times4\times10^{-3}$; $1\times5\times10^{-3}$; $1\times6\times10^{-3}$; $1\times7\times10^{-3}$ ml/l and the control group – seeds soaked in distilled water). The ratio of the volume of seeds and solution is 1:5. All experiments were performed in four repetitions. Germination of seeds was carried out in a thermostat TS-80 "KZMA" - electric, dry-air, manufactured at the Kazan plant of medical equipment. Seeds prepared for the experiments, 100 pieces each, were laid out in Petri dishes on a wet bed consisting of 4 layers of filter paper. The bed for seed germination was kept humid, periodically moistening the filter paper with distilled water. Seed germination temperature – 20-30 ° C. Seeds were counted on the 7^{th}, 10^{th}, 15^{th}, 20^{th}, and 25^{th} days. On the days of recording, for each variant of the experiment, seeds that were not normally germinated, healthy, empty, decayed, steamed, pest-infested were selected [22].

The main information about indicators of Khinghan fir seeds feed by growth stimulants in different solution concentrations and on the control (soaked in distilled water) is presented (Table 1).

Germinative energy was determined as the percentage of fully germinated seeds on the 10^{th} day after the start of the experiment. Laboratory seed germination was established as the percentage of seeds, that germinated during the experiment, i.e. in 25 days. It was calculated as the sum of the germination of four repetitions, divided by 4.

The seed quality classes were determined. Due to the absence of requirements in GOSTs for determining the quality classes of Khinghan fir seeds, the indicators adopted for a tree species that grows in a region similar in biological features and similar in terms of growing conditions − Sakhalin fir (*Abies sachalinensis* Fr. Schmidt) (OST 56-27-77) were used [20]. The length of sprouts was measured with the use of an electronic caliper. The mass of sprouts

was weighed on an electronic balance. Statistical processing of the obtained data was carried out using Microsoft Excel 2007 [22]. To calculate the significance of differences between the experimental and control variants, the Student's t-test formula was used for a disconnected sample [9, 22].

Table 1.

The influence of growth stimulants on the indicators of Khinghan fir seeds

Experiment variants	Indicators of seeds					
	Abnormally germinated	Healthy	Empty	Decayed	Steamed	Pest-infested
Control (seeds, soaked in distilled water)	Number of seeds, %					
	28,0	28,0	30,0	2,0	2,0	1,0
Ribav-Extra (1×10^{-3} ml/l)	30,0	30,0	29,0	1,0	2,0	-
Ribav-Extra ($1\times2\times10^{-3}$ ml/l)	26,0	27,0	36,0	1,0	1,0	-
Ribav-Extra ($1\times3\times10^{-3}$ ml/l)	24,0	26,0	26,0	1,0	1,0	-
Ribav-Extra ($1\times4\times10^{-3}$ ml/l)	25,0	24,0	24,0	1,0	-	-
Ribav-Extra ($1\times5\times10^{-3}$ ml/l)	23,0	21,0	22,0	1,0	-	-
Ribav-Extra ($1\times6\times10^{-3}$ ml/l)	29,0	26,0	24,0	-	-	-
Ribav-Extra ($1\times7\times10^{-3}$ ml/l)	36,0	31,0	24,0	-	-	-
Epin-Extra (1×10^{-3} ml/l)	32,0	23,0	30,0	4,0	3,0	1,0
Epin-Extra ($1\times2\times10^{-3}$ ml/l)	31,0	23,0	27,0	6,0	4,0	-
Epin-Extra ($1\times3\times10^{-3}$ ml/l)	25,0	29,0	25,0	4,0	3,0	1,0
Epin-Extra ($1\times4\times10^{-3}$ ml/l)	12,0	21,0	29,0	2,0	2,0	1,0
Epin-Extra ($1\times5\times10^{-3}$ ml/l)	22,0	24,0	31,0	1,0	2,0	1,0
Epin-Extra ($1\times6\times10^{-3}$ ml/l)	31,0	25,0	28,0	4,0	3,0	-
Epin-Extra ($1\times7\times10^{-3}$ ml/l)	28,0	26,0	30,0	5,0	2,0	1,0

Results

Ribav-Extra

Ribav-Extra had a positive influence on germinative energy of Khinghan fir when using the solution concentrations of $1\times2\times10^{-3}$ - $1\times7\times10^{-3}$ ml/l, at which it comprised 4-16% (excess to the control – 21.2-384.8%). The concentration of 1×10^{-3} ml/l produced a weak influence on seed germination, reducing the percentage of control by 6.1%.

The solution concentrations of $1\times3\times10^{-3}$ - $1\times6\times10^{-3}$ ml/l had a positive effect on laboratory germination (21.4-33.1%) (excess to the control – 127.7-252.1%). The differences with the control group are significant: $t_{fact} \geq t_{table}$ at P = 0.01%.

The solution concentrations of 1×10^{-3} - $1\times2\times10^{-3}$ and $1\times7\times10^{-3}$ ml/l produced an inhibitory effect on laboratory germination, reducing the indicators of germinating compared to the control by 1.1-12.8%.

The growth stimulator Ribav-Extra had a positive effect on the growth of sprouts along the length at the solution concentrations of 1×10^{-3} - $1\times6\times10^{-3}$ ml/l, at which the excess to the control was 7.7-50%. Significant differences with the control were observed: $t_{fact} \geq t_{table}$ at P = 0.05% and P = 0.01%. The solution concentration of $1\times7\times10^{-3}$ ml/l is less effective (Fig. 1).

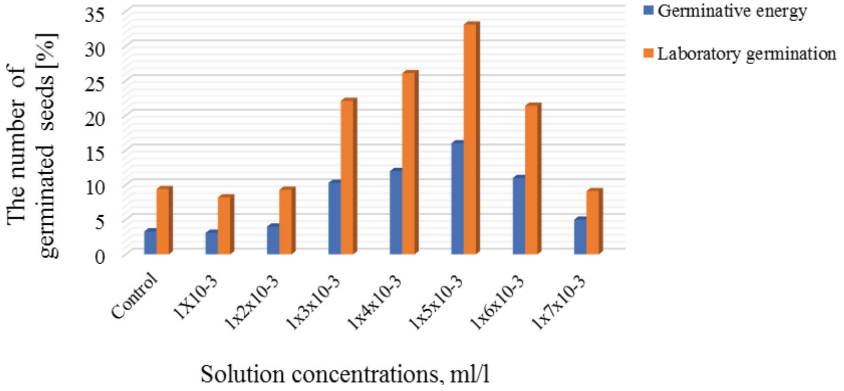

Fig. 1. Influence of the growth stimulator Ribav-Extra on germinative energy and laboratory germination of Khinghan fir seeds

On the 25th day of accounting, a decrease in the rate of germination in relation to the control by 15.4% was noted. All concentrations of solutions had a positive effect on the growth of the mass of sprouts.

The excess in relation to the control was 5.1-79.5%. Significant differences with the control were noted: $t_{fact} \geq t_{table}$ at P = 0.05% and P = 0.01%.

Epin-Extra

The stimulator Epin-Extra had a positive effect on the sowing qualities of Khinghan fir seeds.

Active influence on the energy of seed germination (4-16%) was exerted by the concentrations of solutions $1\times2\times10^{-3}$ – $1\times6\times10^{-3}$ ml/l (excess to the control − 21.2-384.8%). Higher and lower concentrations of solutions are not effective (decrease to the control − 9.1%).

The concentrations of solutions $1\times3\times10^{-3}$ – $1\times5\times10^{-3}$ ml/l had a positive effect on laboratory germination of seeds (13-33%), exceeding the control by

38.3-251.1%. The differences with the control are significant: $t_{0.05} = 3.2 > t_{st} = 2.45$, $t_{0.01} = 9.2 > t_{st} = 3.71$ and $t_{0.05} = 3.5 > tst = 2.45$ (Fig. 2).

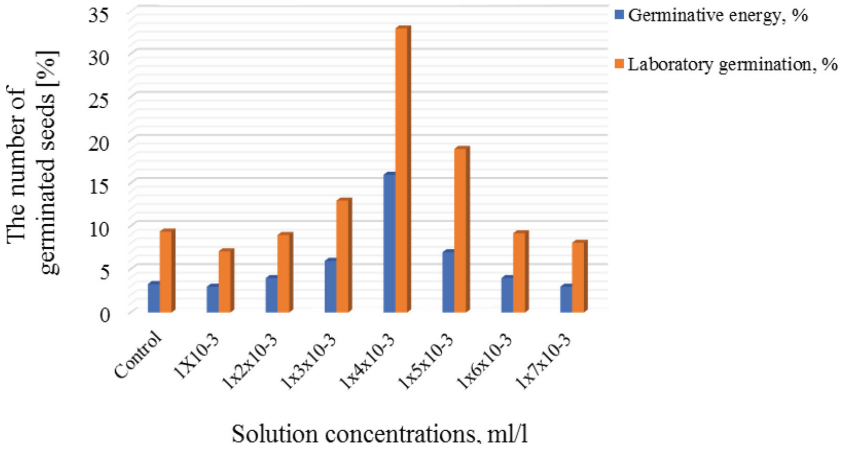

Fig. 2. Influence of the growth stimulator Epin-Extra on germinative energy and laboratory germination of Khinghan fir seeds

The concentrations of solutions 1×10^{-3} - $1\times2\times10^{-3}$ and $1\times6\times10^{-3}$ - $1\times7\times10^{-3}$ ml/l had an inhibitory effect on laboratory seed germination, amounting to 7.1-9.2 % (reduction to the control − 2.1-24.5%).

When using the growth stimulator Epin-Extra, a more effective influence of the drug on the increase in the length of sprouts was observed at the concentrations of solutions $1\times4\times10^{-3}$ - $1\times7\times10^{-3}$ ml/l. Excess to the control – 7,7-40%.

In the first days of accounting, significant differences with the control were noted at P = 0.05% and P = 0.01%. The concentrations of 1×10^{-3} - $1\times3\times10^{-3}$ are not effective. The decrease to the control was 7.7-23.1%. On some days of accounting, significant differences with the control are observed: $t_{fact} \geq t_{table}$ at P = 0.05%.

A positive effect on the increase in the mass of sprouts was noted: at the solution concentration of $1\times2\times10^{-3}$ ml/l – on the 7th and 20th days of accounting; at the concentrations of $1\times3\times10^{-3}$ - $1\times7\times10^{-3}$ ml/l – on the 7th day. Excess to the control - 7.7-17.9%.

At the concentration of $1\times4\times10^{-3}$ ml/l, the differences with the control are significant: $t_{0.05} = 3.0 > tst = 2.45$. A decrease to the control by 2.3-68.2% was noted. Differences with the control are significant at the concentrations of solutions $1\times4\times10^{-3}$ - $1\times5\times10^{-3}$ and $1\times7\times10^{-3}$ ml/l on the 15$_{th}$ day, and at the concentration of $1\times6\times10^{-3}$ ml/l on the 15th and 25th days: $t_{fact} \geq t_{table}$ at P = 0.05% and P = 0.01%.

Discussion

We have analyzed the effect of growth stimulants of natural (Ribav-Extra) and synthetic origin (Epin-Extra) on sowing qualities of seeds (germinative energy and laboratory germination) and morphometric parameters (length and weight) of sprouts of Khinghan fir – a local tree species, common on the territory of Primorsky Krai. Seeds soaked in distilled water were tested as a control.

The positive effect of these growth stimulants on the germination of seeds of various agricultural crops is highlighted in the literature. So Kurkina Yu.N. claimed that the treatment of seeds of beans with the stimulant Epin-Extra enhances their germination and has a significant impact on germinative energy and laboratory germination [14]. The treatment of tomato (*Solanum lycopersicum* L.) seeds with this preparation also contributed to the improvement of their sowing qualities [6]. The stimulating effect of Epin-Extra on the physiological parameters of winter wheat (*Triticum aestivum*) is also described by Reshetnik G.V. [26]. It has been proven that the use of stimulants Ribav-Extra and Epin-Extra has a positive effect on the germination of seeds of victorious onion (*Allium victorialis* L.) and bear onion (*Allium ursinum* L.) [28]. The positive effect of these stimulants on the development of watercress (*Lepidium sativum* L.) plants has been documented by Brovchenko K.R. [3]. An active effect of these preparations on improving the quality of seedlings of *Rhodiola rosea* L. has been established: height, length of the underground part, number of shoots, total wet and dry mass of plants [2].

The effect of these growth stimulants on the seeds of coniferous tree species has been studied experimentally. Thus, Usov V.N. et al. studied the effect of stimulants Ribav-Extra and Epin-Extra on the growth energy and germination of seeds of omatsu (*Pinus densiflora* Siebold et Zucc.). It was found that Ribav-Extra had the greatest effect compared to Epin-Extra [32]. It was noted that these preparations increase seed germination and rooting of juniper (*Juniperus* L.) cuttings [17]. The effect of Epin-Extra on the growth of roots of Scots pine seedlings (*Pinus sylvestris* L.) was studied by Ustinova T.S. [33].

In this study, we analyzed the effect of stimulants Ribav-Extra and Epin-Extra in seven different concentrations of solutions on the germination of Khinghan fir seeds. The results of the experiments depended on the stimulant used and the concentration of its solution. The greatest positive effect of the stimulator Ribav-Extra was revealed in comparison with Epin-Extra. The stimulator Ribav-Extra demonstrated a positive effect on the energy of seed germination at the concentrations of $1 \cdot 2 \cdot 10^{-3}$-$1 \cdot 7 \cdot 10^{-3}$ ml/l, on laboratory germination at the concentrations of $1 \cdot 3 \cdot 10^{-3}$-$1 \cdot 6 \cdot 10^{-3}$ ml/l. Epin-Extra showed a more active effect

on the energy of seed germination with the solution concentrations of $1 \cdot 2 \cdot 10^{-3}$-$1 \cdot 6 \cdot 10^{-3}$ ml/l. Laboratory germination increased at the solutions of $1 \cdot 3 \cdot 10^{-3}$-$1 \cdot 5 \cdot 10^{-3}$ ml/l. It has been established, that the treatment with these preparations leads to an increase in seed quality classes: from the third to the second and first. A significant effect of Ribav-Extra on the growth of sprout length was noted at the concentrations of $1 \cdot 10^{-3}$-$1 \cdot 6 \cdot 10^{-3}$ ml/l; in Epin-Extra – with the solutions of $1 \cdot 4 \cdot 10^{-3}$-$1 \cdot 7 \cdot 10^{-3}$ ml/l. Ribav-Extra had a positive effect on the increase in the mass of seedlings in all concentrations of solutions. Epin-Extra is less effective.

Previously, we also conducted experiments to test these preparations at the same solution concentrations for germinative energy, laboratory seed germination and biometric indicators of sprouts of other economically valuable Far Eastern coniferous species: Scots pine, omatsu and Manchurian fir (*Abies holophylla* Maxim.). A high positive effect of these stimulants has been proven.

Thus, during the germination of Scots pine seeds, the greatest positive effect of the growth stimulator Ribav-Extra on the seed germinative energy was observed at the solution concentrations of $1 \cdot 3 \cdot 10^{-3}$ and $1 \cdot 5 \cdot 10^{-3}$ ml/l, amounting to 76-78% and on indicators of laboratory germination when using the concentrations of $1 \cdot 4 \cdot 10^{-3}$ and $1 \cdot 5 \cdot 10^{-3}$ ml/l, where it was 90.1-93%. Excesses to the control, respectively: 11.8-14.7 and 15.1-18.8% [22]. The growth stimulator Epin-Extra was less effective. Thus, at the concentrations of $1 \cdot 3 \cdot 10^{-3}$ and $1 \cdot 5 \cdot 10^{-3}$ ml/l, the seed germinative energy was 69-71% [21]. Excess to the control - by 1.5-4.4%. Seed germination reached 81-83%, which exceeded the control by 3.4-6%.

In omatsu, the stimulator Ribav-Extra did not have a significant positive effect on the energy of seed germination. However, its active effect on laboratory germination was noted at the solution concentrations of $1 \cdot 4 \cdot 10^{-3}$ - $1 \cdot 6 \cdot 10^{-3}$ ml/l, at which it amounted to 92.3-95.3%, exceeding the control by 6.1-9.5% [23]. When using the drug Epin-Extra with the concentration of $1 \cdot 4 \cdot 10^{-3}$ ml/l, germinative energy and laboratory germination were 84 and 96%. Excesses to the control - 12 and 10.3%.

In Manchurian fir, Ribav-Extra had a positive influence on germinative energy at all tested solution concentrations; on laboratory germination – at the solution concentrations of $1 \cdot 3 \cdot 10^{-3}$ - $1 \cdot 6 \cdot 10^{-3}$ ml/l, comprising at germinative energy: 13.3-21.3% (excess to control – 33-113%) and laboratory germination – 43.1-53%, exceeding the control by 12.2-38% [39]. Epin-Extra is less effective. The concentrations of $1 \cdot 3 \cdot 10^{-3}$ - $1 \cdot 7 \cdot 10^{-3}$ ml/l had the greatest effect on germinative energy, comprising 12-15%, exceeding the control by 20-50%; on laboratory germination – the solutions $1 \cdot 4 \cdot 10^{-3}$ - $1 \cdot 5 \cdot 10^{-3}$ ml/l, comprising 41.2-44%, which

exceeded the control by 7.3-14.6%. The concentrations of $1 \cdot 3 \cdot 10^{-3}$ - $1 \cdot 7 \cdot 10^{-3}$ ml/l had the greatest effect on germinative energy, comprising 12-15%, exceeding the control by 20-50%; on laboratory germination – the solutions of $1 \cdot 4 \cdot 10^{-3}$ - $1 \cdot 5 \cdot 10^{-3}$ ml/l, comprising 41,2-44%, which exceeded the control by 7,3-14,6%.

These stimulants also proved to be effective for the growth of sprouts in length and mass.

Thus, in Scots pine, biometric indicators of sprouts along the length the growth stimulator Ribav-Extra showed high activity at the solution concentrations of $1 \cdot 2 \cdot 10^{-3}$ - $1 \cdot 5 \cdot 10^{-3}$ ml/l, exceeding the control by 5,6-53,3%. The drug had the low effect on the growth of sprout mass. The concentrations of $1 \cdot 3 \cdot 10^{-3}$ - $1 \cdot 5 \cdot 10^{-3}$ ml/l had more active influence, exceeding the control group by 6,3-14,5% [22]. Epin-Extra is less effective.

Ribav-Extra showed high activity on the growth of Khinghan fir sprouts along the length and mass at the solution concentrations of $1 \cdot 2 \cdot 10^{-3}$ - $1 \cdot 6 \cdot 10^{-3}$ ml/l (excesses to the control − 5,9-93,8 и 1,4-31,2%, respectively). Epin-Extra had a weak effect on sprouts along the length. The drug concentrations of $1 \cdot 3 \cdot 10^{-3}$ - $1 \cdot 4 \cdot 10^{-3}$ ml/l had a more positive influence on the increase of mass of sprouts (excesses to the control − 1,5-20,8%).

In Manchurian fir, Ribav-Extra had a positive influence on the growth of sprouts along the length at all solution concentrations, exceeding the control by 7,1-33,3%. The concentrations of $1 \cdot 3 \cdot 10^{-3}$ - $1 \cdot 5 \cdot 10^{-3}$ ml/l increased the mass of sprouts on 2,7-28,8% [39]. Epin-Extra had a weak effect on the growth of sprouts along the length. The concentrations of $1 \cdot 3 \cdot 10^{-3}$ - $1 \cdot 5 \cdot 10^{-3}$ ml/l also produced a positive influence on the mass of sprouts. Excesses to the control - 1,3-39%.

The positive effect of the growth stimulator Ribav-Extra in our experiments on the sowing qualities of seeds and the increase in the morphometric parameters of sprouts of Khinghan fir is probably connected with the influence of glutamic acid, which is part of the stimulant, which provided stimulation of seed germination. The drug Epin-Extra has the content of epibrassinolide, which had a stimulating effect on seed germination.

In our opinion, the stratification of Khinghan fir seeds together with the use of stimulants would increase the rate of seed germination.

Conclusion

Thus, the growth stimulants Ribav-Extra and Epin-Extra had a positive influence on the germination of Khinghan fir seeds. So, there was an increase of sowing qualities of seeds (germinative energy and laboratory germination) and the growth of biometric indicators of sprouts (length and mass).

1. It has been established, that Ribav-Extra showed a positive effect on the energy of seed germination at the concentrations of $1 \cdot 2 \cdot 10^{-3}$-$1 \cdot 7 \cdot 10^{-3}$ ml/l, on laboratory germination at the concentrations of $1 \cdot 3 \cdot 10^{-3}$-$1 \cdot 6 \cdot 10^{-3}$ ml/l. Epin-Extra showed a more active effect on the energy of seed germination with the solution concentrations of $1 \cdot 2 \cdot 10^{-3}$-$1 \cdot 6 \cdot 10^{-3}$ ml/l. Laboratory germination increased at the solutions of $1 \cdot 3 \cdot 10^{-3}$-$1 \cdot 5 \cdot 10^{-3}$ ml/l.

2. It has been found out that the treatment with these preparations leads to an increase in seed quality classes: from the third to the second and first.

3. A significant effect of Ribav-Extra on the growth of sprout length was noted at the concentrations of $1 \cdot 10^{-3}$-$1 \cdot 6 \cdot 10^{-3}$ ml/l; in Epin-Extra - with the solutions of $1 \cdot 4 \cdot 10^{-3}$-$1 \cdot 7 \cdot 10^{-3}$ ml/l. Ribav-Extra had a positive effect on the increase in the mass of sprouts in all concentrations of solutions. Epin-Extra is less effective.

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