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THE STIMULATING PROPERTIES OF SPRUCE WOOD GREENERY EXTRACT OBTAINED IN ACCORDANCE WITH THE PRINCIPLES OF "GREEN TECHNOLOGY"

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The article is devoted to the study of the composition and biological activity of an extract obtained from spruce wood greenery using an environmentally safe "green technology" method of extraction with an aqueous-alkaline solution. The content of neutral compounds (sesquiterpenoids, diterpenoids, polyprenols, and sitosterols) and acidic components (fatty and phenolic acids) in the extract was determined.

The biological activity of spruce extract as a growth stimulant when growing planting material of *Pinus sylvestris* seedlings in forest nurseries of the Ural region was assessed. Soaking pine seeds in an aqueous solution of the spruce extract is performed for 6 hours at room temperature. The stimulating effect of the extract is shown when growing pine seedlings in forest nurseries, with different granulometric and agrochemical compositions of the soil. An increase in the growth parameters and phytomass of seedlings was established when growing on medium-loamy soil and light loam.

The use of a biostimulant made of wood greenery for growing seedlings will reduce the chemical load on the arable soil of forest agrocenosis and will significantly contribute to the development and application of "green" technologies in forestry.

Keywords: *Picea abies*, extraction, plant biostimulants, forest nurseries, seedlings, *Pinus sylvestris*.

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Introduction

Biotechnological developments related to preparing new products from natural raw materials are increasing both due to the accumulation of knowledge about the useful properties of extractive compounds that have a wide range of applications in many areas of industrial activity and to the improvement of techniques for their extraction. Extracts from logging waste have become the basis for the development of new growth promoters used in the plant protection system [1, 2].

Due to the transition from traditional agrarian production to more intensive methods of producing plant products, the number of plant stimulants is constantly updated. So, if in 2002 in Russia about 40 growth-stimulating preparations were officially registered, over the past two decades this list more than doubled. In the world economy, the main consumer of biostimulants is European countries – the average annual growth in the volume of stimulants is about 12%. It is emphasized that the main factor in the expansion of the market of biostimulants is the widespread introduction of sustainable agricultural methods and an increase in demand for organic products [3–8].

European spruce *Picea Abies* (L.) Karst. is distributed in the temperate regions of the Northern hemisphere and is the most important of the forest-forming species of the taiga zone. This tree plays an important economic role, as its wood is widely used for the production of sawnwood and pulp. The use of spruce wood greenery (WG) for the production of biologically active extracts is of particular interest since this raw material is a logging waste [9].

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Products of spruce WG processing are used in folk medicine and as raw materials for the chemical, perfumery, cosmetic, and pharmaceutical industries. Essential oils are known for their anti-inflammatory, bactericidal, fungicidal, virucidal, antioxidant, adaptogenic, choleretic, and wound-healing effects [10, 11]. Spruce WG is most rich in phenolic compounds which are the most common and numerous classes of natural compounds with biological activity. Phenolic extractive compounds of spruce are known for their antioxidant action, antifungal and antibacterial activity effects [12]. The main component of tree greens of spruce hydroxyacetophenone has virucidal and fungicidal activity.

The chemical composition and properties of plant extracts depend on the isolation conditions and extraction methods [13]. There are various known methods that are used to recover extractive substances from spruce and produce medical products [14, 15]. To isolate biologically active products, the use of environmentally friendly, non-toxic solvents is desirable. Traditional methods such as maceration and Soxhlet extraction have been used for extraction for a long time. These traditional techniques have now been refined using microwave radiation and ultrasound to reduce time, energy, and solvent consumption Carbon dioxide is used to extract oils and lipophilic compounds, but natural phenolic compounds do not dissolve in this solvent. The use of co-solvents facilitates the sequential extraction of polar compounds [16–18].

The Institute of Chemistry of the Federal Research Center of Komi Science Center of the Ural Branch of the Russian Academy of Sciences has developed an emulsion method for processing vegetable raw materials using an aqueous-alkaline solution as an extractant. This method is not inferior to traditional technologies for the extraction of solids, but at the same time allows the simultaneous extraction of a complex of lipophilic and hydrophilic compounds of different polarities without the use of organic solvents [19]. By the method of emulsion extraction from spruce WG, extractive substances were isolated, the chemical composition was studied and the biological activity of the extract was evaluated as a growth stimulant when growing seedlings of Scots pine. Seedlings intended for artificial reforestation should have a number of indicators that ensure their accelerated survival in the forest area, namely, good morphometric parameters of the above-ground part, growth indicators, and a developed root system. The optimal solution for levelling negative soil effects expressed in a decrease in growth parameters when growing forest seedlings, is to stimulate cultivated plants with environmentally safe biopreparations.

The study and selection of parameters for the application of spruce extract for seedlings of the main coniferous species of the Ural region were carried out over several years. The aim of the work is to present the results of the study of the reaction of Scots pine to the inclusion of spruce extract in the agricultural technique of planting material in forest nurseries, under conditions of different physical and chemical soil compositions, as well as under the influence of weather conditions during the growth of seedlings.

The first stage of the studies was to study the effectiveness of the extract on pine seedlings at doses of 0.1 and 0.25 mg/kg of seeds. The second stage of the studies was to study the effectiveness of the extract at doses of 0.01 and 0.5 mg/kg of pine seeds.

Materials and methods

Obtaining spruce extract. Spruce woody greens were collected in the suburban forests of Syktyvkar, Komi Republic, Russia.

Plant materials were ground to a 20-80 mm fraction on a cutting drum, further – to a 2–5 mm fraction on a screw chopper. Moisture content of raw materials was evaluated by the Dean-Stark method prior to the experiments.

Extraction of spruce WG was carried out in an extraction apparatus with mechanical stirring for 4 hours, 1/10 duty of water, temperature 50 °C, and a 3% concentration of the aqueous-alkaline solution. After cooling, the mixture was filtered on a Büchner funnel.

For analysing the produced extract, neutral and acidic components were isolated, and fractionated by column chromatography; the component composition was identified by spectral methods as described in paper [19]. The volatile components of the neutral fraction were analysed by gas liquid chromatography – mass spectrometry.

Soil conditions of the experiment. Field studies of the extract were carried out in two permanent forest nurseries of the Berezovsky forestry (Sverdlovsk Region, subzone of the south-taiga forests of the Middle Urals) – Berezovsky (coordinates 56°57.7' N, 60°46.6' E) and Baltimsky (coordinates 57°05.7' N, 60°0′ E). In both nurseries, mixed soil samples were taken to perform agrochemical and granulometric analysis of indicators necessary for assessing soil fertility, and samples were collected for analysis of pesticides (herbicides) in the arable soil layer. Samples were analysed at the Ecoanalytical Laboratory of the Institute of Biology of the Komi Scientific Centre of the Ural Branch of the Russian Academy of Sciences according to standard methods (Table 1).

Table 2 shows the degree of cultivation of the soil. As follows from the tables, only the content of organic matter in the arable layer meets the requirements of a well-cultivated soil. For the remaining elements, there is insufficient provision to maintain the necessary soil nutrition.

Data of granulometric analysis showed that in the Berezovsky nursery, where the soil is medium sandy-dusty loam, the mass fraction of sand fractions was 57%, clay fraction – 43%; in the Baltimsky (soil type is light coarse-dusty loam), the sand fraction was 73.5%, clay – 26.5%, respectively.

Soil analysis for pesticide contamination revealed residual glyphosate. It was found that in the Berezovsky nursery, its number was twice as high as in the Baltymsky nursery: 0.34±0.07 and 0.17±0.03 ppm, respectively. The content of pesticides in two nurseries probably depends on the granulometric composition of the soil – it is known that glyphosate is better sorbed by clay soils than by sandy soils [20]. The accumulation of residual amounts of pesticides in nurseries is the reason for a decrease in the quality of seedlings, which is expressed in morphological deviations of stems and a decrease in growth parameters [21].

Climatic and weather factors. The climate of the Middle Urals is continental and is characterized by cold long winters and moderately warm summers. The growing season, when the seedlings grow and form, takes five months – from May to September.

In the first stage of the research, the average long-term values of the main indicators determining plant growth conditions for the five-month season were: average air temperature +14.7 °C; rainfall rate – 333 mm; relative humidity – 67.4%. Experiments of the first stage of the research were carried out in the Berezovsky nursery in 2016–2017 and in the Baltymsky nursery in 2018–2019. Lack of precipitation (164 mm) and an excess of average temperature over long-term values (+17.1 °C) and relative humidity of 57% were noted in the first year of seedlings' growth. In the following three years of the experiment, weather conditions remained even and close to the average climatic values.

In the second stage of the research in 2020 and 2021, the average air temperature in the growing season was higher than long-term indicators by 2 °C, relative humidity did not exceed 59%, and the amount of precipitation ranged from 278 mm in the first year to 248 mm in the second year of growth (http://www.pogodaiklimat.ru/climate/28440.htm).

Summarizing the description of the climatic features of the experimental work, it should be noted that some deviations in weather characteristics, although occurred, were not critical for the cultivation of pine seedlings.

Table 1. Indicators characterizing soil fertility of forest nurseries

Indicators	Berezovsky nursery	Baltymsky nursery
Humus, %	4.8–5.5	4.5–5.3
pH (water)	5.40–5.50	5.73–6.09
pH (sal.)	3.89–3.91	4.48–4.63
P_2O_5, mg/100 g	0.9–1.3	2.4–6.9
K_2O, mg/100 g	6.8–9.8	9.4–12.4
Total nitrogen, mg/100 g	0.6–1.5	0.5–3.2
Sum of absorbed bases (S), mmol/100 g	10.8–12.6	15.0–18.8
Hydrolytic acidity (Hr), mmol/100 g	9.2–11.0	5.5–6.7
Capacity of exchangeable cations (S+Hr), mmol/100 g	20.4–23.1	22.9–25.5

Note. The table shows the extreme values of the indicators obtained from the set of samples.

Table 2. Characteristics of soil fertility of forest nurseries by the degree of cultivation

Characteristics	Berezovsky nursery		Baltymsky nursery	
	Degree of provision with nutrients	Degree of culturalted of arable layer	Degree of provision with nutrients	Degree of culturalted of arable layer
Humus, %	heightened	well cultivated soil	heightened	well cultivated soil
pH (sal.)	very strongly acidic soil	weakly cultivated soil	strongly acidic soil	weakly cultivated soil
P_2O_5, mg/100 g	very low provision	weakly cultivated soil	medium provision	weakly cultivated soil
K_2O, mg/100 g	low provision	weakly cultivated soil	medium provision	weakly cultivated soil
Total nitrogen, mg/100 g	very low provision	–	very low provision	–

Preparation of seeds and the organization of experimental sites. Pre-sowing treatment consisted in etching the seeds in a 0.5% $KMnO_4$ solution, washing with water, and, subsequently, soaking the seeds in an aqueous solution of the spruce extract for 6 hours at doses of 0.01, 0.05, 0.1, 0.25 and 0.5 ml/kg of seeds. In the control, the seeds were soaked in distilled water. Before sowing, the seeds were dried to a loose condition.

The size of the test and control sites in the nurseries was 1 × 1 m; the repetition of each option was threefold. The seeding rate met the requirements for forest nurseries of the Ural region. Agrotechnical care for crops was carried out in accordance with the recommendations adopted when growing planting material in production nurseries.

The statistical processing of results. Plant samples were taken in each stage of the experiment at the end of the second growing season. Pine seedlings with obvious signs of developmental disorders (abnormal) were excluded from the analysed total population [21]. To assess the results of the experiments, seedlings were studied for growth indicators: stem height (cm) and diameter at the level of the root neck (mm), the length of the main root (cm). Plant weight was determined in an absolutely dry state (g) after drying at 105 °C. When studying the effect of the spruce extract on seedlings, multifactorial analysis of variance was used. The statistical significance of differences in seedlings was assessed by the Tukey test; comparisons were carried out separately for each of the nurseries and experimental stages. Statistica 10.0 (Statsoft inc.) was used for the statistical analysis of the data.

Results and discussion

The obtainment and composition of the spruce extract

The method of extracting vegetable raw materials in an aqueous alkaline medium used in this work, developed at the Institute of Chemistry of the Federal Research Centre of the Komi Science Centre of the Ural Branch of the Russian Academy, consists of treating the ground vegetable raw materials with an aqueous base solution. During the processing of the raw material, the lipid part passes into an aqueous medium together with water-soluble components.

To assess the effectiveness of the water-alkaline extraction method, the yield of extractive substances was determined by isolating the fractions of neutral and acidic components from the resulting emulsion solution. The total yield of extractive substances was 5.4% of the weight of dry raw materials, including neutral components 0.8%, acidic – 4.6% of the weight of dry raw materials.

To determine the component composition of the extract, the fractions of acidic and neutral components were separated by column chromatography (Tables 3–5).

An analysis of the results presented in Tables 3–5 shows that the spruce extract contains a wide range of biologically active compounds. Monoterpenoids and sesquiterpenoids with bactericidal action, polyprenols - natural immunostimulants — have been identified as part of the extract [22, 23]. The main components of the spruce extract are phenolic compounds, which are consistent with the literature [9, 12].

Thus, it was established that a complex of valuable biologically active compounds was isolated by the method of emulsion extraction from spruce WG. The use of spruce extracts as plant growth regulators is known from the literature [1]. Using the example of forest nurseries in the Ural region, the authors assessed the biological activity of spruce extract as a growth stimulant in the cultivation of planting material of Scots pine seedlings.

Results of experiments in forest nurseries

Variance analysis of the obtained data array. According to the results of the variance analysis, the main indicators of two-year pine seedlings (height and stem diameter) are statistically significantly influenced by all the factors studied (Table 6).

Under the "nursery" factor, the determining factors are primarily the soil conditions of the nurseries where the studies were carried out. It is known that sandy loam and loamy soils are best suited for the growth of seedlings of Scots pine in terms of mechanical composition, so the soil conditions of the Baltymsky nursery are more consistent with the requirements of successful seedlings growth. Since the interaction of the factors "nursery" and "year" was significant, it can be concluded that in nurseries with different soil conditions, weather conditions have a different effect on the growth of pine seedlings. Thus, in the Berezovsky nursery, the height and diameter of the stem were higher in the first stage of the experiment than in the second. In the Baltymsky nursery, the diameter of the stem of seedlings, on the contrary, was larger in the second stage of the experiment, and the height of the stem did not differ significantly over the years (Tables 7, 8).

Table 3. Composition of volatile components of the spruce extract

Compounds	Quantity in the extract, mg/l
Limonene	1.75
Borneol	7.73
α-longipinen	2.62
β-elemene	2.07
Longifolene	5.85
Caryophyllene	4.19
1-dodecanol	6.54
Germacrene	3.00
Δ-cadinol	1.38
α-amorphene	3.73
β-bisabolene	2.16
γ-cadinene	5.62
β-cadinene	7.98
Nerolidol	1.41
Germacrene-4-ol	14.14
Spathulenol	1.84
T-cadinol	5.44
α-cadinol	8.31
α-bisabolol	3.12
Isocembrol	15.86
13-epimanool	21.24
1-docosanol	1.68
Phytol	4.91
Isopimara-7,15-diene-3-one	3.18
Total	132.57

Table 4. Components identified in the neutral components fraction of the spruce extract

Compounds	Quantity in the extract, mg/l
Carotenoids	33.34
Polyprenols	215.86
Dehydroabietinol	85.86
β-sitosterol	31.51
Epitorulosol	34.38
Epimanool	21.21
Total	422.16

Table 5. Components identified in the fraction of acidic components of the spruce extract

Compounds	Quantity in the extract, g/l
Saturated fatty acids	1.3
Unsaturated fatty acids,	24.1
including linoleic	15.0
Phenolic compounds, including:	28.3
2-hydroxyacetophenone	10.5
3,4- dihydroxyacetophenone	2.5
Para-coumaric acid	4.8
Vanillic acid	0.5
Caffeic acid	3.7
Ferulic acid	5.8
Flavonoids	0.23
Total	96.73

Table 6. Results of the three-factor analysis of the diameter and height of the stem of two-year-old pine seedlings

Factor	Stem diameter			Stem height		
	F	d.f.	p	F	d.f.	p
Nursery	248.5	1	<0.001	11.34	1	0.001
Year	0.004	1	0.948	87.95	1	<0.001
Nursery*year	41.3	1	<0.001	76.31	1	<0.001
Extract dose	5.5	9	<0.001	9.36	9	<0.001

Table 7. Biometrics and mass of biennial pine seedlings

Parameters	Berezovsky nursery			Baltymsky nursery		
	Control	Dose, mg/kg seed		Control	Dose, mg/kg seed	
		0.1	0.25		0.1	0.25
Stem diameter, mm	1.8±0.06	2.0±0.06	2.1±0.07	2.2±0.08	2.5±0.07	2.2±0.07
Stem height, cm	9.0±0.30	13.2±0.46	11.6±0.42	8.7±0.30	10.2±0.36	8.3±0.30
Needle length, cm	7.6±0.22	5.5±0.22	6.8±0.26	9.3±0.28	10.4±0.21	9.6±0.23
Length of a primary root, cm	21.9±0.31	17.8±0.46	19.8±0.31	17.6±0.44	21.2±0.35	19.6±0.50
Mass of root, g	0.18±0.016	0.13±0.010	0.15±0.011	0.23±0.02	0.31±0.02	0.25±0.02
Mass of stem, g	0.19±0.020	0.29±0.022	0.31±0.027	0.19±0.02	0.29±0.02	0.18±0.01
Mass of needles, g	0.46±0.052	0.50±0.042	0.57±0.050	0.68±0.06	0.91±0.06	0.65±0.05
Above-ground mass, g	0.63±0.071	0.79±0.063	0.88±0.077	0.87±0.07	1.20±0.08	0.83±0.06
The ratio of above-ground mass to underground mass	3.59±0.123	6.10±0.226	5.86±0.168	3.88±0.15	3.97±0.10	3.34±0.12

Table 8. Biometrics and weight of two-year-old pine seedlings in the extended dose range

Parameters	Berezovsky nursery			Baltymsky nursery			
	Control	Dose, mg/kg seed		Control	Dose, mg/kg seed		
		0.05	0.5		0.01	0.05	0.5
Stem diameter, mm	1.4±0.03	1.6±0.03	1.9±0.06	2.5±0.06	2.6±0.07	2.5±0.06	2.7±0.07
Stem height, cm	7.6±0.71	7.8±0.21	7.7±0.28	8.5±0.22	9.4±0.29	8.7±0.22	9.0±0.27
Needle length, cm	6.0±0.15	7.7±0.18	8.6±0.26	9.0±0.13	10.1±0.13	9.5±0.17	10.2±0.17
Length of a primary root, cm	19.2±0.59	19.7±0.45	18.1±0.48	20.8±0.33	18.6±0.27	20.4±0.31	21.3±2.02
Mass of root, g	0.13±0.01	0.17±0.01	0.22±0.01	0.49±0.03	0.45±0.03	0.44±0.02	0.53±0.03
Mass of stem, g	0.09±0.00	0.11±0.00	0.13±0.01	0.31±0.02	0.39±0.03	0.30±0.02	0.36±0.02
Mass of needles, g	0.27±0.02	0.39±0.02	0.49±0.03	1.16±0.07	1.33±0.08	1.13±0.06	1.39±0.08
Above-ground mass, g	0.35±0.02	0.51±0.03	0.62±0.04	1.46±0.09	1.72±0.10	1.44±0.07	1.75±0.10
The ratio of above-ground mass to underground mass	2.84±0.10	3.00±0.10	2.85±0.09	3.03±0.08	3.97±0.10	3.29±0.07	3.46±0.11

The "extract dose" factor according to the results of the analysis of variance has a statistically significant effect on both the height and diameter of the stem of pine seedlings (Table 6). Positive effects from the use of spruce extract were noted on the territory of each of the nurseries and in each stage of the tests. However, the degree of manifestation of the stimulating effect depended on the nature of the growing season and soil features of forest agrocenosis.

Seed treatment experiments with extract at doses of 0.1 and 0.25 ml/kg. The experimental sites are located in industrial forest nurseries, which are territories with a long-term service life (30–40 years). Assessing the agrochemical indicators of the soil and the accumulation of residual amounts of pesticides, one can conclude that the soil of nurseries has signs of "soil fatigue", which negatively affects the cultivated crop.

It was found that when treating seeds with spruce extract at doses of 0.1 and 0.25 ml/kg in the Berezovsky nursery, experimental seedlings had larger dimensions in diameter ($p<0.1$) and height ($p<0.001$) than in the control (Table 7). There was an increase in the diameter of the stem by 10%, and the height of the stem – by 30–54% compared to the control. The accumulation of phytomass in experimental seedlings significantly exceeded this value in control plants.

In the Baltymsky nursery, an increase in the diameter (by 13%) and height (by 17%) of the stem, as well as the length of needles (by 12%, significantly with $p=0.006$) of seedlings compared to the control was noted only in the version using an extract at a dose of 0.1 ml/kg of seeds. In the 0.25 ml/kg dose variant, the seedlings did not differ in morphometric parameters from the control. In terms of weight, an increase in the above-ground part of the seedling was also noted at a dose of 0.1 ml/kg of seeds.

It is worth noting that in both nurseries, despite different growing periods, two-year-old seedlings of the control variant did not reach the standard size in height (10 cm), and in diameter – only in the Berezovsky nursery.

Experiments on the treatment of seeds with the extract in doses from 0.05 to 0.5 ml/kg

In the next stage of the studies, the range of applied doses of the spruce extract was expanded and the impact of low doses – 0.05, 0.1 and high dose – 0.5 mg/kg of seeds was tested. The study of reduced doses by one and two orders is necessary to detect the threshold values of the stimulating effect of the extract when growing pine seedlings on different types of soils.

In the Berezovsky nursery, seedlings from seeds treated with doses of 0.05 and 0.5 ml/kg did not differ significantly in stem height from control samples, but had a significantly higher stem diameter (by 14 and 36%, respectively) and needle length (by 28.3 and 42.3%). In the Baltymsky nursery, in the experimental variants, seedlings had equal or slightly higher values of morphometric indicators. The height of stems exceeded reference values by 2–10.5%, stem diameter – by 0–10.5%, and needle length – by 5.5–13.3% (Table 8).

The phytomass of seedlings and morphometric indicators in the Berezovsky nursery were inferior to the seedlings of the Baltymsky nursery.

Thus, the stimulating effect of the spruce extract was established at doses of 0.05 and 0.5 mg/kg of seeds, but was only aimed at increasing the stem diameter and needle size.

Assessment of the degree of manifestation of the stimulating effect of the dosage of spruce extract at different stages of growing pine seedlings. The first stage of the pine growing experiment using spruce extract (doses of 0.1 and 0.25 mg/kg of seeds) showed a positive effect on most morphometric and weight indicators. Despite the fact that the soil of the Berezovsky nursery is poorer in terms of nutrient levels compared to the soil of the Baltymsky nursery, seedlings grown with the use of a stimulator were higher and had higher phytomass indicators; most likely, influenced by climatic conditions of the growing season. The initial stages of growth (the first growing season) of seedlings in the Berezovsky nursery were characterized by warm and dry weather. Under such conditions, the mobility of soil chemicals and their accessibility to plants may be reduced. It is known that glyphosate is well soluble in water and with increasing humidity of the medium can migrate into the surrounding space [24]. Accordingly, the negative impact of this herbicide in the Berezovsky nursery in the first year of seedling growth was reduced, and the lag in the growth rate of seedlings in the control is probably associated with a weak nutritional regime of the arable horizon.

When conducting experiments to grow pine seedlings using extended doses of spruce extract, the second year was characterized by abnormally hot and dry summers. Such weather conditions in the absence of artificial irrigation had a significant negative impact on the growth of seedlings; this was most strongly manifested in the Berezovsky nursery. Hot and dry weather at the beginning of the growing season significantly influenced the linear growth of the stem. The height of the stems of pine seedlings did not differ significantly from the control seedlings. With a slight softening of weather conditions in late summer, higher values in the experimental variants – indicators of stem growth in thickness and length of needles were noted. This indicates that under the conditions of the Berezovsky nursery, the stimulating effect of the spruce extract at doses of 0.01, 0.05, and 0.5 mg/kg of seeds is not manifested in very dry and hot conditions.

At the same time, in the Baltymsky nursery, the growth of pine seedlings was less dependent on weather conditions. It should be noted that in seedlings in the nursery on loamy soils, the distribution of nutrients goes not to the upper part, but to the lower part, so seedlings always don’t grow very high, but have a thick stem. In addition, according to Table 8, experimental seedlings grown in the Baltymsky nursery (doses of 0.01, 0.05, and 0.5 mg/kg of seeds) under abnormally hot summer conditions had a significantly higher stem and needle biomass than seedlings on the soils of the Berezovsky nursery.

As a result of experiments on the cultivation of pine seedlings in the nurseries of the Middle Urals, it was found that the stimulating effect of the spruce extract was manifested in poorer soil fertility for the cultivation of pine seedlings in medium-loam soil conditions. The use of stimulating drugs in the cultivation of planting material should be carried out taking into account the soil conditions of the nurseries in which it is carried out.

Conclusions

Thus, it was established that an extract was obtained from the spruce WG according to an environmentally safe resource-saving technology by the method of emulsion extraction; its composition and biological activity were studied. The extract contains valuable biologically active compounds and can be used in growing planting material of Scots pine seedlings. The use of a spruce biostimulant will reduce the chemical load on the arable soil of forest agrocenosis (the use of xenobiotic substances) and will make a significant contribution to the development and application of "green" technologies in forestry.

The study materials on the cultivation of Scots pine seedlings, and the use of the spruce extract in forest nurseries with different granulometric and agrochemical soil compositions, while taking into account weather conditions, made it possible to establish a positive effect of its use in doses of 0.1 and 0.25 mg/kg of seeds.

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Conflict of Interest
The authors of this work declare that they have no conflicts of interest.

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