Ecological Communication

OPEN ACCESS BBRC Bioscience Biotechnology Research Communications

Biosc.Biotech.Res.Comm Special Issue Vol 12 No (5) Sep 2019 Pages: 285-293

The Application Efficiency of Growth Stimulant Ecopin on Sowing Qualities of Scots Pine Seeds (*Pinus silvestris L.*)

V.Yu. Ostroshenko

ABSTRACT

The influence of the growth stimulator of natural origin Ecopin on the sowing qualities of seeds of coniferous tree species - Scots pine (Pinus silvestris L.), which grows in the forest conditions of the southern part of the Far East, is studied. The use of the biological product activates the germination energy and laboratory germination at concentrations of solutions 1×2×10-3 - 1×5×10-3 ml/l within 71.3 -79.9 % and 83.7-96.4 %, exceeding control, respectively by 5.2-17.8 % and 6.9-23.1 % and, as a result - increasing sowing qualities of seeds on one-two classes: from the third - to the second and the first. The concentration of 1×6×10-3 ml/l had an insignificant effect on the sowing quality of seeds (exceeding the control of 0.6-2.4 %). With the weakening of the concentration of the solution to 1×7×10-3 ml/l, the germination energy and germination of seeds decreased, relative to the control, by 11.4-13.0 %. A higher concentration of the solution (1×10-3 ml/l) had an inhibitory effect on seed germination. The concentration of solutions 1×3×10-3 - 1×4×10-3 ml/l (exceeding the control of 22.2-46.7 %) had the greatest effect on the growth of seedlings along the length. In comparison with the control, the concentration of 1×10-3 ml/l reduced the growth rate of seedlings by 5.9-11.1 %. Further reduction of the solution concentration to 1×7×10-3 ml/l was ineffective. Ecopin also had a positive effect on the formation of the mass of sprouts. At concentrations 1×3×10-3 - 1×5×10-3 ml/l, the excess to the control was -19.8-59.4 %.

KEY WORDS: Ecopin, Growth Stimulator, Seeds, Germination Energy, Germination, Biometrics of Seedlings, Reliability.

INTRODUCTION

The forests of Primorsky Krai lie on the territory of the south-eastern continental part of the Far East. More than 2/3 of the total forest area is represented by coniferous trees (Koryakin, 2010).Scots pine *(Pinus silvestris L.)* – the most common of all the pines growing in Russia. Huge national economic importance, its use in landscape architecture and selection, high biological, sanitary-ecological, soil-protective and medicinal properties (Urusov, Lobanova and Varchenko, 2007; Usenko, 2009), allow considering Scots pine as one of the main forest-forming species of the Far East.

However, in the forest fund of Primorsky Krai, Scots pine is represented less than other coniferous tree species. This contributed to the active development of the region in the past, logging, and forest fires. Currently, the age dynamics of pine forests in the region is diverse. So, 48 % of the area are mature and overmature tree stands; 28.5% are middle-aged and ripening, and only 23.5% are the young trees (Koryakin, 2010). It is necessary to carry out active measures aimed at the preservation and reproduction of Scots pine: protection of forests from fires, preparation and sowing of seeds, cultivation of planting material in forest

ARTICLE INFORMATION:

Corresponding Author Email:

PRINT ISSN: 0974-6455, ONLINE ISSN: 2321-4007 CODEN: BBRCBA
Received: 17th June, 2019 Accepted: 15th Aug, 2019

Online content available: http//www.bbrc.in/

Thomson Reuters ISI ESC / Web of Science Clarivate Analytics USA

NAAS Journal Score 2019 (4.38)

Science Journal Impact Factor 2019 (4.196)

nurseries, laying of forest crops, followed by the restoration of forests on non-forested lands.

At the same time, seed years in the pine forests of the region are observed in three to four low-yielding ones (Grozdov, 1952; Urusov, Lobanova and Varchenko, 2007; Usenko, 2009). For the annual sowing of seeds, it is necessary to store them so that it will be possible to reduce the sowing qualities. Treatment with physiologically active substances positively proven in agriculture - growth stimulators - can increase the germination energy and seed germination (Vakulenko, 2004; Nickell, 1984).

Growth stimulants are substances that stimulate or inhibit growth and development in plants. However, manufacturers' instructions on the use of growth stimulants were compiled for crops.In the forest industry, work on the use of growth promoters is carried out in the experimental procedure. Studies were conducted abroad (Borno and Taylor, 1975; Huang and Bachelard, 1993; Kabar, 1990,

Table 1. The effect of growth stimulant Ecopin on the germination energy and laboratory germination of Scots pine seeds (*Pinus silvestris L.*)

Date of the counting of sprouts, days	Concentration of solutions, ml /l							
	Control (distilled water)	1×10^{-3}	$1 \times 2 \times 10^{-3}$	$1 \times 3 \times 10^{-3}$	$1 \times 4 \times 10^{-3}$	$1 \times 5 \times 10^{-3}$	$1 \times 6 \times 10^{-3}$	$1 \times 7 \times 10^{-3}$
1	2	3	4	5	6	7	8	9
5th	52,3±2,1	41,4±2,0	48,4±2,0	53,1±1,8	54,0±2,0	51,7±2,4	48,9±2,3	41,8±2,0
% to control		-20,8	-7,5	+1,5	+3,3	-1,1	-6,5	-20,1
Reliability, t_m	25,4	20,3	23,7	29,5	26,5	21,2	21,7	20,5
The experience accuracy (P), %	3,0	4,9	4,2	3,4	3,8	4,7	4,6	4,9
7th	15,5±0,7	16,1±0,5	22,9±0,7	24,5±1,4	25,9±1,8	23,9±1,8	19,3±0,8	17,2±1,4
% to control		+3,9	+47,7	+58,1	+67,1	+54,2	+24,5	+11,0
Reliability, t_m	23,8	32,9	32,3	18,1	14,1	13,3	25,7	12,7
The experience accuracy (P), %	8,5	3,0	3,1	5,5	7,1	7,5	3,9	7,8
10th	6,5±1,6	7,4±0,3	8,1±0,4	7,8±0,2	10,2±0,6	9,2±0,6	7,6±0,5	5,6±0,6
% to control		+13,8	+24,6	+20,0	+56,9	+41,5	+16,9	-13,8
Reliability, t_m	4,2	21,8	23,1	32,5	16,5	14,8	16,5	10,0
The experience accuracy (P), %	11,4	4,6	4,3	3,1	6,1	6,7	6,1	10,0
15th	4,0±0,4	3,8±0,2	4,3±0,4	5,8±0,9	6,3±0,4	7,1±0,5	4,4±0,2	4,8±0,4
% to control		-5,0	+7,5	+45,0	+57,5	+77,5	+10,0	+20,0
Reliability, t_m	9,8	15,8	10,2	6,4	16,2	14,5	18,3	13,7
The experience accuracy (P), %	20,5	6,3	9,8	15,5	6,2	6,9	5,5	7,3
Germination energy, %	67,8	57,5	71,3	77,6	79,9	75,6	68,2	59,0
Germination, %	78,3	68,7*	83,7	91,2*	96,4**	91,9**	80,2	69,4
The number of non-germinated, PCs	22	32	17	9	4	9	20	31
healthy	4	13	5	3	2	1	5	8
rotted	1	6	3	-	-	-	-	7
steamed	1	1	1	1	-	1	2	2
empty	5	5	3	3	2	4	4	3
sprouted abnormally	11	7	5	2	-	3	9	11

Note: solution concentrations: 1×10^{-3} - 1ml/1l, $1 \times 2 \times 10^{-3}$-1ml/2l, $1 \times 3 \times 10^{-3}$ -1ml/3l ...

* - reliability of differences in the values of seed germination parameters between the studied concentration of the sample solution and control (Student's t- test, at P = 0.05)

**- reliability of differences in the values of seed germination parameters between the studied solution concentration and control (Student's t- test, at P = 0.01);

1998; Kralfk, Psota and Kluovi, 1992; Krawczynska, Kolwzan and Rybak, 2012; Kuneš, Baláš, Linda, Gallo and Nováková, 2016; Magyar, Barancsi, Dickmann and Hrotko, 2008; Salas, Saskova, Mokrickova and Litschmann, 2012; Tredici, 2005; Wort, Severson and Peirson, 1973; Young, 1987), in Ukraine (Belelya, 2014), in Belarus (Ivanova, 2009; Lebedev and Schestibratov, 2013) and in various regions of Russia: the European part (Borisov and Matvienko, 2014; Galdina and Shevchenko, 2012; Ostroborodova and Ulanova, 2014; Pentelkina, 2002; Pentelkin, 2003; Trots, 2016; Ustinova and Chentsov, 2013; Chilimov, 1995; Chukarina, 2014), Siberia (Kirienko and Goncharova, 2016), the Far East (Ostroshenko, Ostroshenko, Klyuchnikov, Ostroshenko and Chekushkina, 2015; Ostroshenko and Poleshchuk, 2016; Usov and Popkov, 2010) with both coniferous and deciduous tree species: Scots pine (*Pinus silvestris L.*), Japanese pine (Pinus densiflora Siebold et Zucc.), Jack pine (Pinus Banksiana Lamb.), Red pine (Pinus resinosa Sol. ex Aiton) and Monterey pine (Pinus radiata D. Don); Siberian larch (*Larix sibirica Ldb.*), Amur larch (Larix amurensis and B. Kolesn and Dahurian larch (Larix cajanderi Mayr.); Thuja occidentalis (*Thuja occidentalis L.*), Chinese thuja (Thuja orientalis L.), Pacific redcedar (Thuja plicata Donn ex D. Donn); European spruce (Picea abies (L.) H. Karst.) and Siberian spruce (Picea obovata Ldb.); Khingan fir (Abies nephrolepis Maxim.), Manchurian fir (Abies holophylla Maxim.) and Douglas fir (*Pseudotsuga menziesii*); European oak (Quercus robur L. = Q. pedunculata Ehrh.); European ash (Fraxinus excelsior L.); Brittle Gum mannifera Mudie); Rowan (Sorbus aucuparia L.); Apple tree “Idared” (Malus domestica 'Idared'), Chosenia arbutifolia (Chosenia arbutifolia Nacai), etc.

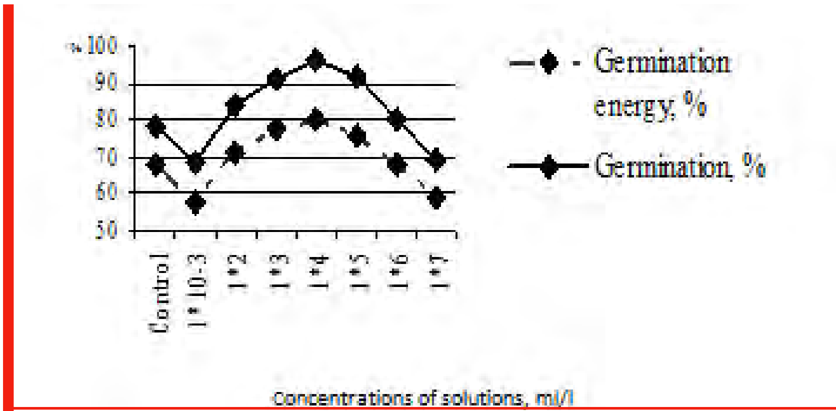

Fig. 1: The effect of growth stimulant Ecopin on the germination energy and laboratory germination of Scots pine seeds (*Pinus silvestris L.*)

Fig. 2: The sprouted seeds of Scots pine (*Pinus silvestris L.*) treated with growth stimulant Ecopin on the 5th day of germination (the author’s photo)and laboratory germination of Scots pine seeds *(*Pinus silvestris L.*)*

The experiments showed the effectiveness of the research. Seeds have increased germination energy and germination; root formation; growth of seedlings in the nursery and the output of standard planting material per unit area activate. The safety of seedlings is high; the terms of their cultivation are reduced. We consider it is expedient to conduct further studies to identify drugs that stimulate the improvement of seed sowing qualities and reforestation of one of the main tree species of the far eastern Primorye – Scots pine *(Pinus silvestris L.*).

The Goal of Research

Study of the stimulatory effect of aqueous solutions of growth stimulant Ecopin were done on the seeds of Scots pine (*Pinus silvestris L.*) and identification of doses that activate the germination energy. Laboratory germination of seeds and growth of seedlings in length and weight based was the goal. The following tasks were carried :- soaking of Scots pine seeds in aqueous solutions of growth stimulant Ecopin of different concentrations;- germination of seeds in laboratory conditions;- analysis of the effect of the drug Ecopin on germination energy, laboratory germination of seeds and the dynamics of growth of seedlings in length and weight.

MATERIAL AND METHODS

The object of the study is the seeds of Scots pine (*Pinus silvestris L.*) harvested in the southern part of Primorsky Krai, on the territory of the MTS - Federal Scientific Center of the East Asia Terrestrial Biodiversity FEB RAS. Weather conditions were within the average longstanding ones (Poleshchuk, 1993). Identification of the stimulating effect of growth stimulant Ecopin on sowing qualities of seeds was carried out in laboratory conditions, according to applicable State Standards (GOST 14161-86, 1986; GOST 13056.6-97, 1997), by the developed technique. For germination, externally intact seeds were selected, which were soaked in aqueous solutions of the drug for 12 hours. In the experiments, 7 variants were studied (concentrations of drug solutions and distilled water were: 1×10-3, 1×2×10-3, 1×3×10-3, 1×4×10-3, 1×5×10-3, 1×6×10-3, 1×7×10-3 ml/l) and control – seeds soaked in distilled water. The accepted ratio of the volume of seeds and solution is 1:5. All experiments were performed in fourfold repetition. 100 PCs of seeds prepared for the experiences were placed

Table 2: The effect of growth stimulant Ecopin on the growth of seedling in length at germination of Scots pine seeds (Pinus silvestris L.)

Date of the counting of sprouts, days	Concentration of solutions, ml /l							
	Control (distilled water)	1×10^{-3}	$1\times2\times10^{-3}$	$1\times3\times10^{-3}$	$1\times4\times10^{-3}$	$1\times5\times10^{-3}$	$1\times6\times10^{-3}$	$1\times7\times10^{-3}$
	Average length of the seedling, cm							
1	2	3	4	5	6	7	8	9
5th	1,6±0,1	1,5±0,3	1,9±0,1*	2,2±0,1**	2,1±0,2*	2,3±0,1**	2,1±0,1*	1,7±0,1
% to control		-6,2	+18,8	+37,5	+31,3	+43,8	+31,3	+6,3
Reliability, t_m	17,8	6,0	23,8	27,5	12,4	19,2	23,8	18,9
The experience accuracy (P), %	7,5	16,7	4,2	3,6	8,1	52,4	4,2	5,3
7th	1,8±0,1	1,6±0,1	1,9±0,1	2,2±0,1*	2,3±1,0**	2,2±0,1*	2,1±0,1*	1,6±0,1
% to control		-11,1	+5,6	+22,2	+27,8	+22,2	+16,7	-11,1
Reliability, t_m	36,0	20,0	14,6	16,9	28,8	16,9	17,5	12,3
The experience accuracy (P), %	4,4	5,0	6,8	5,9	3,5	5,9	5,7	8,1
10th	1,7±0,1	1,6±0,1	2,1±0,1*	2,3±0,1**	2,4±0,2**	2,1±0,1*	1,9±0,1	1,5±0,1
% to control		-5,9	+23,5	+35,3	+41,2	+23,5	+11,8	-11,8
Reliability, t_m	24,3	20,0	30,0	28,8	14,1	30,0	21,1	8,0
The experience accuracy (P), %	7,1	5,0	3,3	3,5	7,1	3,3	4,7	12,5
15th	1,5±0,1	1,4±0,2	1,7±0,2	2,1±0,1**	2,2±0,1**	1,8±0,2	1,7±0,2	1,5±0,1
% to control		-6,7	+13,3	+40,0	+46,7	+20,0	+13,3	-
Reliability, t_m	37,5	8,2	8,1	16,2	31,4	8,6	10,0	11,5
The experience accuracy (P), %	5,3	12,1	12,4	6,2	3,2	11,7	10,0	8,7

Note: solution concentrations: 1×10^{-3} - 1ml/1l, $1\times2\times10^{-3}$-1ml/2l, $1\times3\times10^{-3}$ -1ml/3l ...
* - reliability of differences in the values of the length of the roots of seed seedlings between the studied concentration of the solution and control (Student's t-test, P = 0.05);
** - reliability of differences in the values of the length of the roots of seed seedlings between the studied concentration of the solution and control (Student's t-test, P = 0.01);

in Petri dishes on the wet bed, made of filter paper which was cut according to the size of Petri dishes.

Germination of seeds was carried out in the thermostat TS-80 – "KZMA" (electric, dry air, made at the Kazan plant of medical equipment). Petri dishes were placed in the working chamber of the thermostat. The bed for seeds germination was kept wet, periodically wetting the filter paper with distilled water.Germination temperature was within 22±2oC. Accounting of seedlings was carried out, according to the current GOST on the 5th, 7th, 10th, 15th day of germination (GOST 13056.6-97, 1997).

On the day of each counting of seedlings from the bed normally sprouted and rotted seeds were removed and in the analysis card, separately for each sample, the number of seeds was noted: normally sprouted, rotted and left on the bed not sprouted seeds. Germination energy was

Table 3: The effect of growth stimulant Ecopin on the increase in seedling weight during germination of Scots pine seeds (*Pinus silvestris L.*)and laboratory germination of Scots pine seeds (*Pinus silvestris L.*)

Date of the counting of sprouts, days	Control (distilled water)	Concentration of solutions, ml /l 1×10^{-3}	$1\times2\times10^{-3}$	$1\times3\times10^{-3}$	$1\times4\times10^{-3}$	$1\times5\times10^{-3}$	$1\times6\times10^{-3}$	$1\times7\times10^{-3}$
	Average seedling weight, mg							
1	2	3	4	5	6	7	8	9
5th	8,1±0,2	6,5±0,2**	7,7±0,3	10,3±0,3*	9,7±0,9	9,8±0,5*	8,4±0,8	7,1±0,2*
% to control		-19,8	-4,9	+27,2	+19,8	+21,0	+3,7	-12,3
Reliability, t_m	36,8	31,0	26,6	16,9	11,3	20,0	10,2	33,8
The experience accuracy (P), %	3,3	3,2	3,8	5,9	8,9	5,0	9,8	3,0
7th	6,9±0,3	6,4±0,9	8,1±0,9	10,1±0,9*	11,0±0,8**	10,0±1,2*	9,0±0,8*	7,1±0,7
% to control		-7,2	+17,4	+46,4	+59,4	+44,9	+30,4	+2,9
Reliability, t_m	28,8	7,1	9,0	10,7	13,4	8,1	11,0	10,8
The experience accuracy (P), %	3,8	14,1	11,1	9,3	7,5	12,3	9,1	9,3
10th	6,9±0,3	6,7±0,9	8,1±1,0	8,5±0,9	10,0±0,5**	9,1±0,3*	7,9±1,3	6,5±0,9
% to control		-2,9	+17,4	+23,2	+44,9	+31,9	+14,5	-5,8
Reliability, t_m	24,6	7,4	8,1	9,0	20,4	18,6	6,0	7,2
The experience accuracy (P), %	3,3	13,4	12,3	11,1	4,9	5,4	16,6	13,8
15th	6,4±0,3	5,2±0,6	7,5±0,9	8,2±0,5*	9,0±1,2*	7,8±0,9*	7,0±0,8	6,1±1,4
% to control		-18,7	+17,2	+28,1	+40,6	+21,9	+9,4	-4,7
Reliability, t_m	24,6	9,1	8,3	16,7	7,3	8,7	8,5	4,5
The experience accuracy (P), %	3,5	11,0	12,0	6,0	13,7	11,5	11,7	22,1

Note: solution concentrations: 1×10^{-3} - 1ml/1l, $1\times2\times10^{-3}$-1ml/2l, $1\times3\times10^{-3}$ -1ml/3l ...

* - reliability of differences in the values of the weight of the roots of seed seedlings between the studied concentration of the solution and control (Student's t-test, P = 0.05);

** - reliability of differences in the values of the weight of the roots of seed seedlings between the studied concentration of the solution and control (Student's t-test, P = 0.01);

determined on the 7th day of germination, germination – on the 15th day. On the day of final accounting of germination, the remaining seeds on the bed for each sample the number of healthy, not normally sprouted, rotted, steamed, germless and empty, infected with pests of seeds were determined (GOST 13056.6-97, 1997). The obtained data were recorded in the analysis card.

The length of seedlings was measured with an electronic caliper. Their mass was determined by weighing on electronic scales. The materials of the experiments were subjected to statistical analysis in the application program Microsoft Excel. The significance of differences in average values was calculated by Student's t –test (Doev, 2011).

RESULTS

Biological preparation Ecopin is the growth stimulant of natural origin. It consists of 6.2 g/kg of poly-beta-hydroxybutyric acid + terpenic acids + a set of nutrients and represents a concentrated product of biosynthesis of beneficial soil bacteria + a starter set of nutrients. It is a universal biological growth stimulant of plant growth and development with anti-stress effect. The basis of this biological product contains a concentrated product of the biosynthesis of beneficial soil bacteria and a starter set of nutrients. It is available in the form of viscous paste. The manufacturer of the drug is "NPF Albite". The manufacturer of packing is "Gardener's Green Pharmacy" firm. It has a wide range of actions. It is used for growing plants at all stages of growth: from seed to harvest (URL: http: // grepharm.ru/products/159/390).

Soaking the seeds in the preparation awakens them and reduces the germination time by a few days. Ecopin stimulates the growth of the root system, improving its mineral and water nutrition; promotes the growth and development of young plants, protects them from adverse weather conditions, various diseases. It activates the vitality and the revival of the weakened plants. Preventive treatment with Ecopin helps plants to resist diseases (powdery mildew, scab, vascular bacteriosis, etc.), increases yield, accelerates maturation and improves the quality of the fruit (color, vitamin content). It does not have harmful effects on animals and humans, does not irritate the skin and mucous membranes of the eyes, does not accumulate in the soil. It is not dangerous for bees, other insects and fish (URL: http: //www.shebek.ru/ishop/product/252).

The drug is included in the List of pesticides and agrochemicals allowed for use in the Russian Federation, easily soluble in water and alcohol. It is freely sold by the trading network. However, instructions for the use of a growth stimulant are made up for crops. In the forest industry, these works have been started in the experimental procedure (List of pesticides and agrochemicals…, 2016).

The results of the experiments show that the concentration of the drug solutions 1×2×10-3 - 1×5×10-3 ml/l activate the seed germination energy within 71.3-79.9%, exceeding the control, respectively: by 5.2-17.8 % (table 1, fig. 1, 2).

When seeds were soaked in a solution with a concentration of 1×6×10-3 ml/l, no significant effect on their germination energy was observed (exceeding 0.6% to the control), and the concentration of the solution of 1×10-3 ml/l had an inhibitory effect on seed germination.

Soaking of seeds in solutions with concentration 1×2×10-3 - 1×5×10-3 ml/l activated their germination, the value of which, depending on the concentration of the solution,

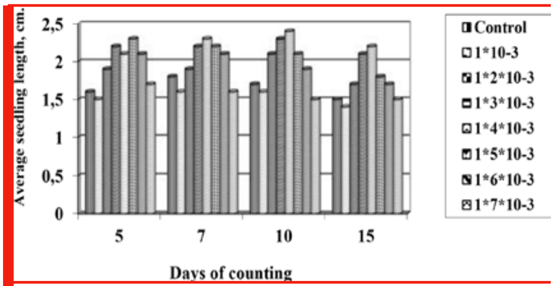

Fig. 3: The effect of growth stimulant Ecopin on the growth of seedlings in the length at the germination of Scots pine seeds (*Pinus silvestris L.*)

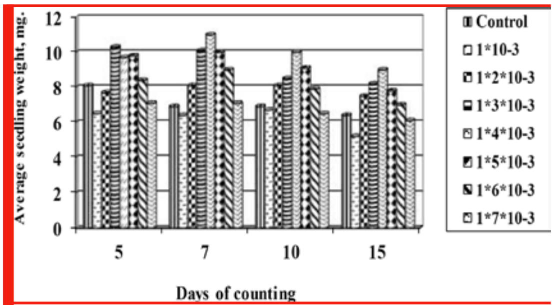

Fig. 4: The effect of growth stimulant Ecopin on the increase of the mass of the seedlings at germination of Scots pine seeds (*Pinus silvestris L.*) and laboratory germination of Scots pine seeds (*Pinus silvestris L.*)

increased significantly to 83.7-96.4 % (excess to the control of 6.9-23.1 %), causing an increase in their sowing qualities by one or two classes: from the third to the second and the first. With the weakening of the concentration of the solution to 1×7×10-3 ml/l, the germination energy and germination of seeds decreased, relative to the control, by an average of 11.4-13.0%. A higher concentration of the solution (1×10-3 ml/l) had an inhibitory effect on seed germination (table 1).

Indicators of seed germination in variants with concentrations of solutions 1×3×10-3 - 1×5×10-3 ml/l differ significantly from control: t fact > t table at significance level (P = 0.05 % and P = 0.01 %). A significant difference in the average value with the control was observed at a high concentration of solution 1×10-3 ml/l (t fact > t table at P = 0.05 %), in which the drug had an inhibitory effect. Stimulation of seed germination was also observed at concentrations of solutions of 1×2×10-3 ml/l (6.9 %) and 1×6×10-3 ml/l (2.4 %). However, the difference between the average values is not reliable: t fact < t table at P = 0.05 %.

The general dynamics of growth of seedlings in the length at a solution concentration of 1×10-3 ml/l shows a decrease in their growth rates in comparison with the control by 5.9-11.1 %. Activation of growth of seedlings in the length was observed at concentrations of solutions 1×2×10-3 - 1×6×10-3 ml/l; excess to control 5.6 – 46.7 %. At a solution concentration of 1×2×10-3 ml/l, the maximum growth rates of seedlings were observed on the 5th and 10th day of seed germination. The excess to the control was 18.8-23.5 %: t fact > t table at P = 0.05 %. The most effective concentration of solutions were 1×3×10-3 - 1×4×10-3 ml/l. Indicators of growth of the seedling in length differed significantly from the control for all days of the registration of seeds (exceeding the control to 22.2-46.7 %): t fact > t table at P = 0.05 % and P = 0.01 %. Solutions of concentrations of 1×5×10-3 and 1×6×10-3 ml/l also had a positive effect on the growth of seedlings, but to a lesser extent (11.8 - 43.8 %). The significance of differences with the control was observed on the 5th -10th days of accounting (1×5×10-3 ml/l) and the 5th-7th days (1×6×10-3 ml/l). Further reduction of the concentration to 1×7×10-3 ml/l was ineffective (table 2, fig. 3).

Drug Ecopin had a positive impact on the growth of roots of seedlings by mass. The highest activity of solution concentration was observed at 1×3×10-3 - 1×5×10-3 ml/l (exceeding 19.8-59.4 %); significance of differences with control: t fact > t table at P = 0.05 % and P = 0.01 %. Concentrations of solutions of 1×2×10-3 and 1×6×10-3 ml/l were less effective: the difference between the average values with the control is not significant: t fact < t table. The concentration of 1×10-3 ml/l had an inhibitory effect on the growth of the mass of seedlings, which was more significant on the 5th day of seed germination and amounted to (-19.8 %): t fact > t table at P = 0.01 %. The concentration of the solution of 1×7×10-3 ml/l was also ineffective (table 3, fig. 4).

DISCUSSION

The obtained results of the studies are in good agreement with the data of the similar experience obtained by us a year earlier during the germination of Scots pine seeds harvested in the neighboring forest area, located 5.6 km southwest from the experimental object [14]. The germination energy of seeds soaked in a solution of a growth stimulant Ecopin the same solution concentration amounted to 71.3-75.3 %, laboratory germination – 85.1-94.6 %.

Similar indicators of sowing qualities of seeds in this study range from 71.3-79.9 % and 83.7-96.4 %. A comparative analysis of the sowing qualities of seeds harvested at the same time at two different sites shows no significant differences.

The experiments in this study were expanded by identifying the efficiency effects of a growth stimulant Ecopin on the biometrics of seeds: the growth of roots of seedlings in length and weight.

CONCLUSION

The experiments allowed identifying the effects of growth stimulant (regulator) Ecopin on sowing qualities of seeds and to make the following conclusions:

1. Growth stimulant Ecopin shows high activity during germination of seeds and the growth of biometric parameters of Scots pine seedlings and can be recommended for use in nurseries in the forest industry.

2. The most effective concentrations of the drug 1×2×10-3 - 1×5×10-3 ml/l, in comparison with control, increasing significantly the germination energy and laboratory germination of seeds to 71.3-79.9% and 83.7-96.4% (excess to control by 5.2-17.8% and 6.9-23.1%) and as a consequence – quality classes: from the third to the second and first. The concentration of 1×6×10-3ml/l had an insignificant effect on the sowing quality of seeds, exceeding the control by 0.6-2.4 %. The lower concentration of

solution 1×7×10-3 ml/l reduced germination and seed germination energy by 11.4-13.0 %. A higher concentration of 1×10-3 ml/l was ineffective.

3. The concentration of solutions had the greatest effect on the growth of seedlings in length and weight 1×3×10-3 - 1×4×10-3 ml/l and 1×3×10-3-1×5×10-3 ml/l (excess to control 22.2-46.7 % and 19.8-59.4 %). The concentration of 1×10-3 ml/l had an inhibitory effect, reducing the growth rate of seedlings in length, compared with the control by 5.9-11.1 % and by weight by 2.9-19.8 %. Reducing the concentration to 1×7×10-3 ml/l was ineffective.

4. The observed increase in quality classes causes a decrease in the seeding rate in the forest nursery per unit area, increasing the economic efficiency of growing planting material.

5. The main part of the seeds, in most of the used options, germinates in the first half of the germination period, reducing their activity by the end of its term.

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