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THE EXPERIENCE OF GROWING PLANTING MATERIAL WITH CLOSED ROOT SYSTEM IN THE BELARUSIAN FORESTRIES

Studies on the cultivation of planting material with closed root system were carried out in connection with large-scale plans of the Ministry of Forestry to introduce it in reforestation and afforestation according to the developed document "Sectoral program for growing seedlings with closed root system in the organizations of the Ministry of Forestry of the Republic of Belarus for the period up to 2020 year".

To study the experience of growing seedlings with closed root system, studies were carried out annual seedlings age of Scots pine, Norway spruce and European larch in different forest enterprises in Belarus. Measured their biometric parameters, made comparisons between different rotations and calculates statistics.

Perform chemical analysis of substrate for growing seedlings. Revealed differences in the properties of the substrate on receipt of standard seedlings and seedlings have not reached the standard parameters, due to the fact that the differentiation by size of seedlings observed indicators intact containers. In containers with seedlings standard parameters marked higher acidity, lower content of exchangeable bases and higher security nutrients.

Significant differences in biometrics seedlings among the forestry enterprises is also confirmed by the properties of the substrate. This leads to the the need to prepare an optimal substrate for the cultivation of planting material with closed root system.

Key words: substrate, seedling root system is closed, pine, spruce, larch, height, diameter, age, acidity, nutrients.

Introduction. The use of planting material with closed root system is a modern, high-tech and the most effective possibility of reforestation and afforestation, which can extend the time limits of the plantation. In addition, the use of this technology allows the economical use of seeds with good hereditary qualities to give a very high yield of planting material close to 100%. The use of planting material with closed root system is increasingly being used in forestry practice, reforestation and afforestation.

According to the plan of the Forestry Ministry 54.4 million of pieces of planting material with closed root system will be grown in the forestry sector up to 2020. The share of forest crop created by using such planting material will grow from 0.5 to 16.9% [1]. The corresponded sectoral program is approved by the Minister of Forestry. By 2017 the share of forest cultures created planting material with closed root system, will have been grown to 10.8%.

According to the program [1], in order to achieve the declared 54.4 million of saplings and seedlings to 2020 with closed root system it is planned:

– to realize the construction (upgrade) of greenhouses with the area of 21,918 m^2;

– to put into operation 6 modern production facilities for growing planting material with closed root system: in Ivatsevichi, Glubokoye, Mozyr, Shchuchyn, Mogilev and in Republican forestries and Forest breeding and seed production center. By the end of 2016, each of them should have grown at least 1 million plants per year.

Main part. The aim of the study was to investigate the possibility of obtaining a standard planting material with closed root system in the forestry enterprises of the republic, as RFBSC has the ability to crop in the drawer of large volumes of seed materials, however, it is limited by the size of hothouse and the surrounding area for rearing. To study the success rates biometric characteristics of planting material with closed root system were measured. It was referred to RFBSC for growing in forest enterprises of the Republic: Vetka, Ivie, Kobrin, Osipovichi, Zhlobin, Orsha, Ivatsevichi, Novogrudok.

The root collar diameter was measured with electronic caliper with an accuracy of 0.01 mm. Moreover, the height of the aerial part from the root collar to the terminal bud was measured too with an accuracy of up to 1 mm using 200 seedlings. These average results were compared with values given in standards of bare-root plant material. A strong differentiation in the dimensional parameters of planting material was noticed in many forestries. That's why it was decided to distinguish all seedlings into 3 groups: large, medium and small ones. In some cases, one of the groups could not be investigated

In parallel with the measurement of seedlings with closed root system, substrate samples for analysis of acidity and security elements of plant nutrition were taken from the cassettes. Chemical

analyzes of the substrate: pH amount in KCl by potentiometric method, the exchange of calcium and magnesium in a saline base drawing using trilon B, exchangeable potassium content on the flame photometer, content of mobile forms of phosphorus and ammonia nitrogen in hydrochloric acid extract colorimetric method were carried out under laboratory conditions.

The planting material with closed root system of common pine (Pinus sylvestris) and common spruce (Picea excelsa) was being grown in Ivatsevichi forestry (Table 1). At the time of registration of the results, the planting material age was one less than a year.

It should be noted that the planting material of the common pine in embodiment 1 is well suited for use in silvicultural area when creating forest crops and their addition manually, and embodiment 2 still needs little rearing up to require seedlings yearling standards ($D > 1$ mm, $H > 5$ cm).

Both the first and the second variants have not reached the required size for planting material biennial age yet. But embodiment 1 has much deviation from the standard only by the diameter of the root collar (–39%). The growth retardation is not so high (–23%).

In silvicultural practice European Spruce grown in open ground in the annual age does not reach the required size for use in the silviculture production. However, in the first variant of the experiment the required size of planting material $D = 1.44$ mm (must be 2 mm), $H = 11.5$ cm (must be 12 cm) has almost been reached. The second embodiment with later rotation has not reached the required size in the first year.

These biometric parameters of planting material are shown in Table 2.

Analyzing the data in the Table, it should be noted that the common pine, both in height and diameter reached the required standard sizes for one year seedlings, but not for two-year-old seedlings. It is not sufficiently high (only 5.7 cm (–52%) instead of required 12 cm). However, the diameter size is sufficient for the biennial age.

The common spruce meets the required standard for the size of biennial seedlings and in one year reached the indicators that are the standard for two-year-old seedlings (GOST 3317-90 $D > 2$ mm, $H > 12$ cm).

These biometric parameters of growth of larch seedlings with closed root system are presented in Table 3.

European Larch did not reach the required standard sizes in the two given embodiments. However, the root diameter neck meets indicator ($D > 3$ mm), and is far behind in height (–35% when necessary $H > 20$ cm) during the second rotation. Later seeds sowing for repeated rotations and therefore short-lived growing season may explain it.

Table 1

Indicators of seedlings growth with closed root system in Ivatsevichi forestry

Embodiment		Mean, cm	Median	Minimum	Maximum	Variance	Standard deviation	Asymmetry	Excess
Pine 1	*D*, mm	1.22 ± 0.04	1.25	0.45	1.82	0.11	0.33	–0.58	–0.18
	H, cm	9.22 ± 0.28	9.70	3.40	13.30	5.23	2.29	–0.43	–0.27
Pine 2	*D*, mm	0.76 ± 0.02	0.78	0.30	1.11	0.03	0.18	–0.42	0.09
	H, cm	4.43 ± 0.09	4.60	2.00	6.00	0.67	0.82	–0.61	0.29
Spruce 1	*D*, mm	1.40 ± 0.04	1.43	0.83	1.79	0.05	0.22	–0.51	0.49
	H, cm	11.00 ± 0.40	11.00	5.30	15.50	5.64	2.38	–0.29	0.41
Spruce 2	*D*, mm	0.62 ± 0.03	0.66	0.10	0.82	0.03	0.16	–1.23	1.97
	H, cm	4.64 ± 0.25	4.80	1.50	8.70	2.25	1.50	0.08	0.60

Table 2

Indicators of seedlings growth with closed root system grownin RFBSC

Embodiment		Mean, cm	Median	Minimum	Maximum	Variance	Standard deviation	Asymmetry	Excess
Spruce	*D*	0.210 ± 0.004	0.20	0.15	0.30	0.001	0.038	0.721	0.365
	H	12.650 ± 0.31	12.90	6.50	20.30	7.900	2.811	0.100	–0.221
Pine	*D*	0.200 ± 0.004	0.20	0.10	0.30	0.002	0.040	–0.466	0.797
	H	5.690 ± 0.126	5.70	1.70	10.30	1.881	1.371	0.085	0.630

Table 3

Biometric parameters of growth of larch seedlings with closed root system

Embodiment		Mean, cm	Median	Minimum	Maximum	Variance	Standard deviation	Asymmetry	Excess
2 rotation	*D*	0.300 ± 0.009	0.300	0.100	0.500	0.007	0.085	0.288	–0.066
	H	13.160 ± 0.288	12.90	6.500	18.600	6.735	2.595	–0.150	–0.261
4 rotation	*D*	0.090 ± 0.004	0.100	0.050	0.200	0.002	0.040	1.127	1.185
	H	2.920 ± 0.093	2.700	1.100	5.200	0.858	0.926	0.457	–0.239

Thus, the question of the timing of the European larch seeds sowing should be considered in order to maximize the quality characteristics. The biological potential of this breed growth is very high. It confirms the growing experience of the breed in the open field. Therefore, it is possible to get large seedlings for growing seedlings with closed root system in one year. The volume of the used containers should be also be considered. Researching the of larch seedlings with closed root system grown in Novogrudok forestry it was noted that the maximum biometrics seedlings were observed in the cases when the cassettes have been placed on fertile soil. The size of their root system was much greater than the amount of P64 container where the seeds were sown.

Analysis of the chemical properties of substrates showed that the pH value in the analysis of forestry enterprises has significant differences. However all the containers were filled with substrate in RFBSC and similar agrochemical properties would be expected. Norway spruce seedlings have reached the standard parameters in the substrate having pH below 5.0. Seedlings having significantly lower average standard parameters reach pH more than 6.0 having been put into substrate. It is confirmed by the referenced data on the optimal pH soil for growing seedlings of Norway spruce. The substrate on which the seedlings were grown Scots pine, had an average pH of about 5.5 and a significant differentiation was not observed (pH from 5.44 to 5.71). Substrate for growing seedlings of larch has an average pH of 5.5 (from 5.05 to 5.63). The content analysis of calcium and magnesium exchange bases showed that the higher the content the higher pH value.

High height differentiation of seedlings of Scots pine and Norway spruce is well correlated with the content of exchangeable bases: the highest performance is achieved when the seedlings have calcium and magnesium content from 25 to 45 meq per 100 g of soil. While calcium and magnesium content is from 45 to 80 meq per 100 g of soil seedlings biometrics is significantly lower. These differences point to the fact that not all forest enterprises have identical approach to the introduction of fertilizing and stimulants for growing seedlings with closed root system, as well as the differences in the initial part of the individual batches of the substrate obtained in the breeding center.

Exchangeable potassium content in all samples is quite high and ranges from 15 to 82 mg per 100 g of soil. The content of mobile forms of phosphorus and nitrogen is low, especially in the substrate for growing seedlings of Scots pine.

Conclusion. Growing seedlings with closed root system makes it possible to get a standard planting material for silvicultural production in one year, as evidenced by the results obtained in the RFBSC.

However, researches conducted in forestry enterprises of the republic have shown that the required size is reached only by a number of seedlings. It can be explained by the difference in the approaches to the cultivation of planting material in terms of fertilizing. It leads to significant differentiation of biometric parameters of seedlings, as well as agro-chemical properties of substrate. State forest enterprises must keep a unified system of intensive cultivation technology of planting material using complex necessary fertilizers and growth stimulants. Any help of experts and researchers of RFBSC specialized institutions is required in the initial stage of implementation of this technology.

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