XV WORLD FORESTRY CONGRESS
Building a Green, Healthy and Resilient Future with Forests
2–6 May 2022 | Coex, Seoul, Republic of Korea

Forest plantations for wood growing in the European North of Russia

N.A. Demidova, T.M. Durkina, L.G. Gogoleva

Federal Budgetary Institution "Northern Research Institute of Forestry", Arkhangelsk, Russian Federation. E-mail: forestry@sevniilh-arh.ru

Abstract

The Russian Federation has accumulated quite a lot of experience in plantation forestry. An urgent issue of returning unused agricultural land to economic circulation can be solved by creating plantation crops on these lands, which contributes to the achievement of the Sustainable Development Goals on rational forest management, restoration, afforestation and reforestation (SDGs 2, 12, 15 and GFGs 1 and 2). Research on the creation of targeted forest plantations in the European North of Russia was carried out within the framework of a state assignment. Well-grounded conclusions on the choice of species for targeted plantation cultivation were made. Preference should be given to aboriginal species (Scots pine, European spruce). However, one of the promising fast-growing species suitable for the pulp and paper industry in temperate countries is Lodgepole pine (*Pinus contorta* Loud. var. *latifolia* S. Wats.), naturally growing in North America. Based on long-term research, the most suitable origins of Lodgepole pine were selected – located in regions of the most northern Canadian origin (Yukon), where it grows at the northern limit of the distribution of forest species. The advantage of Lodgepole pine over local coniferous species was revealed while growing on industrial forest plantations, where, by the age of 40-50 years, it forms 250-300 m3/ha of low-resinous wood, suitable for both sulfate and sulfite pulping and is 70% more productive than local spruce and pine. In the research process, the basic requirements for plantation crops in the European North of Russia were developed, under which plantations justify their purpose. One of the main innovative areas of research is the development of technology for creating forest plantations on lands that have come out of agricultural use.

Keywords: Lodgepole pine, boreal forests, plantation.

Introduction, scope and main objectives

Lodgepole pine (*Pinus contorta* Loud. var. *latifolia* S. Wats) naturally growing in western North America, is one of the promising fast-growing species on plantations. Its wood is suitable for the pulp and paper industry in countries with temperate climates. Numerous studies, mainly in Sweden and Finland, confirm that Lodgepole pine is superior to native pine in growth and biomass production (Ericsson 1993,1994; Ruotsalainen 1993, Varmola 2000; Elfving 2001).

The Lodgepole pine cultures in the Russian Federation have been created since the 1920s, mainly in the Karelia Republic, the Leningrad Region and the Baltic Republics (Drozdov 2005). Subsequently, Lodgepole pine has been spread south to the forest-steppe and north to the Arkhangelsk Region. However, its cultivation was rather spontaneous, almost without regard to the origin of the raw material. Research and creation of experimental trials were carried out by industry and academic research institutions without any coordination, based on their capabilities.

Northern Research Institute of Forestry, which is situated in the European North of the Russian Federation, provides research on Lodgepole pine introduction and cultivation for more than 40 years (1979-2021). Experimental plantations of Lodgepole pine on a total area of 53 hectares were created in various regions of the European North of the Russian Federation (Arkhangelsk, Vologda Regions, Komi Republic). It was determined that Lodgepole pine of the most northern Canadian origin (Yukon), where it grows in permafrost

on the northern limit of forest distribution, is of great interest for introduction into the European North of Russia (Demidova et al. 2020).

An urgent issue of returning unused agricultural land to economic circulation can be solved by creating on these lands plantations of fast-growing coniferous species, such as Lodgepole pine, that would lead to rural development initiatives to reduce pressure on forests. The creation of fast-growing forest plantations supports the reverse of the loss of forest cover through sustainable forest management, including protection of natural forests and afforestation of unused agricultural land.

The aim of the work is the feasibility of the Lodgepole pine (Pinus contorta Loud. Var. latifolia S.Wats.) use for plantation cultivation in the boreal forests. The overall measurements of the diameters at breast height, the Lodgepole pine trees height measurements and model tree cutting were carried out on the coniferous plantations.

Methodology/approach

The European North of the Russian Federation is located in the north of the East European Plain. Most of the territory is of the Far North regions, it is a vast plain with a weak slope towards the White and Barents Seas, where the plain is somewhere disturbed by terminal moraine hills formed as a result of the activity of an ancient glacier.

The climate of the region is transitional between marine and continental. Winter is usually long (up to 250 days) and cold, with a low average temperature of -26 degrees Celsius and strong winds. Spring comes to the southern regions in April, to the northern ones in May. The average summer temperature is about +15 degrees C. The duration of the period with average daily negative temperatures in the south is 160 days, in the north - about 200.

The annual amount of precipitation in the forest zone varies from 400 to 700 mm with the number of days with precipitation up to 200. Relative air humidity in winter and autumn is 85-95% and in summer and spring 7% -90%. This is due to low temperatures and a large number of cloudy days. In winter, a 60-70-cm-thick snow cover is formed on the territory of the region.

In terms of vegetation, the European North of Russia is entirely part of the natural zone of the taiga, which is subdivided into subzones: the subzone of the northern taiga (north of the 64-65th parallel), middle (the main part of the region) and south taiga.

The objects of research were Lodgepole pine plantations located in the European North of Russia (Arkhangelsk, Vologda regions and the Komi Republic) on a total area of 53 hectares.

Plantations were created by seedlings with an open root system. Lodgepole pine seeds were obtained from its natural range, as well from the most northern Canadian (Yukon) origin.

The study of the growth and productivity of Lodgepole pine was carried out according to the generally accepted method: complete counting of trees with measurement of height and diameter at a height of 1.3 m with an accuracy of ± 1 mm. The measuring plug "Mantax Precision 11–100–1032" was used for diameter measurement; the measuring pole "MODEL – 202 12 m" and the laser range finder "Vertex Laser VL 400" were used for height measurement. The growth progress in diameter was studied by selecting 5 cores at a height of 1.3 m (d1,3) using an incremental drill on each thickness level. Studying growth progress in height (h) on three medium-tall trees by whorl counting, the age was determined at ¼; ½ and ¾ heights.

Methods of mathematical analysis and applied computer programs were used to determine the average growth indicators (average value, coefficient of variability, experimental accuracy, reliability of the average value). The stands stocks were determined using standard formulas and tables. Due to the lack of standard materials for Lodgepole pine for the European North of Russia, tables for Scots pine were used. Growth graphs

were done for height, diameter and stem volume at the final stage of the analysis of a tree trunk (Vojnov et al. 2012). Periodic surveys and analyses of these plantations' states were carried out.

Results

Particular attention is paid to the growth of Lodgepole pine (*Pinus contorta* Loud. var. *latifolia* S.Wats) compared to Scots pine (*Pinus sylvestris* L.) in the same growing conditions. The average taxation indicators of Lodgepole pine in height and stem diameter, obtained from the results of continuous counting, are presented in table 1.

Table 1: Average Lodgepole pine taxation indices

Plantation number	Forest type	Area, ha	Species	Age at year of surveys	Stem volume, m^3/ha	Average diameter, cm	Average height, m
P-83	Sphagnetosum ameliorated swamp	1,12	Lodgepole pine	37	85,5	12,6±0,5	12,1±0,3
			Scots pine	36	48,0	10,4±0,3	10,3±0,4
P- 82-84	Fresh spruce myrtillosum	0,48	Lodgepole pine	36	220,7	18,3±0,4	15,1±0,3
			Scots pine	35	190,0	10,4±0,8	10,3±0,4
P-85	Floodplain	0,05	Lodgepole pine	33	240,9	20,3±1,2	11,5±0,3
P-1-88	Former nursery	2,7	Lodgepole pine	30	104,2	14,9±0,2	12,1±0,3
P-2-85	Pine lichenosum	1,24	Lodgepole pine	34	109,0	9,4±0,1	9,2±0,2
			Scots pine	34	93,0	11,2±0,5	8,7±0,6
P-3-93	Pine vaccinosum, former nursery	2,9	Lodgepole pine	25	163,0	14,7±0,2	12,9±0,4
P-4-93	Pine lichenosum	2,4	Lodgepole pine	26	113,0	10,8±0,2	8,0±0,3
P-1-90	Fresh spruce myrtillosum	1,8	Lodgepole pine	29	226,0	15,1±0,1	14,9±0,3
			Scots pine	29	163,0	10,7±0,4	11,9±0,4
P-1-93	Spruce oxalisum	9,9	Lodgepole pine	26	226,0	14,2±0,2	14,9±0,3
			Scots pine	26	182,0	12,7±0,7	13,3±0,5
P-2-88	Fresh spruce myrtillosum	0,9	Lodgepole pine	31	42,5	12,3±0,3	10,8±0,4
P-88	Fresh spruce myrtillosum	3,0	Lodgepole pine	32	196,0	16,0±0,2	12,1±0,4
P-2-93	Fresh spruce myrtillosum	11.0	Lodgepole pine	27	167,0	12,9±0,3	10,8±0,5
P-1-97	Pine vaccinosum	7,0	Lodgepole pine	23	98,0	9,7±0,1	9,1±0,1
P-1-87	Pine lichenosum	1,0	Lodgepole pine	32	138,5	12,7±0,4	12,0±0,4

The data indicate the successful growth of Lodgepole pine, which, even in conditions of an ameliorated swamp (P-83), continues to grow intensively and exceeds Scots pine in terms of taxation indices (twice in stem volume). The presented results on the average growth indicators of Lodgepole pine of Yukon origin (P-1-88, P-2-88, P-88) show that this pine responds well to improved soil conditions and, undoubtedly, to pre-plant soil preparation.

The Lodgepole pine on plantation P-2-88, created on a site without soil preparation, is significantly behind in growth. As calculations show, the wood stock of 26-year-old Lodgepole pine per hectare has been determined between 113 and 163 m3 / ha in different growing conditions. Lodgepole pine significantly exceeds Scots pine in growth in stem volume under similar growing conditions. The best growth both in diameter and height was noted at the Lodgepole pine plantations P-82-84, P-85, P-1-88, P-88, P-1-90, P-1-93, p-2-93 and P-3-93.

Discussion

An urgent issue of returning unused agricultural land to economic circulation can be solved by creating plantations of fast-growing coniferous species that lead to rural development. As noted, Lodgepole pine responds well to improving soil conditions, which allows us to conclude that the creation of its plantations on lands that have come out of agricultural use will be successful. The creation of fast-growing forest plantations supports the reverse of the loss of forest cover through sustainable forest management, including protection of natural forests and afforestation of unused agricultural land.

The study of experimental Lodgepole pine cultures has demonstrated their high safety and good condition, indicating the proper selection of ecotypes of this species for planting. It was assigned that the Lodgepole pine exceeds the Scotch pine in current increment in diameter, volume and in range of mean volume increment. The most northern Canadian origin (Yukon) of Lodgepole pine appeared to be the most suitable origin for the European North of Russia. The advantage of Lodgepole pine over local coniferous species was revealed while growing on industrial forest plantations, where, by the age of 40-50 years old, it forms 250-300 m3/ha of low-resinous wood, suitable for both sulfate and sulfite pulping and is 70% more productive than local spruce and pine. In the research process, the basic requirements for plantation crops in the European North of Russia were developed, under which plantations justify their purpose.

Conclusions/ wider implications of findings

As a result of the study, it can be concluded that the planting of this species is recommended to be carried out in productive forest types of the hylocomiosa group (oxalidosum and fresh myrtillosum). At the same time, soil preparation and mineral fertilizing before planting are of great importance in increasing the productivity of the Lodgepole pine plantations.

Based on the research results, it can be concluded that the European North of Russia is a promising area for the Lodgepole pine cultivation.

The research contributes to the achievement of the Sustainable Development Goals through sustainable forest management, including protection, restoration, afforestation and reforestation (SDGs 2, 12, 15 and GFGs 1, 2 and 4). It enhances forest-based economic, social and environmental benefits, including by improving the livelihoods of forest-dependent people.

Acknowledgements

The studies were carried out as part of the state task "Conducting Applied Scientific Research" in the field of Federal Forest Agency of the Russian Federation activity, state registration number is AAAA-A20-120021190023-9.

The views expressed in this information product are those of the authors and do not necessarily reflect the views or policies of FAO.

References

Demidova N.A., Durkina T.M., Gogoleva L.G., Paramonov A.A. 2020. Lodgepole pine of Yukon origin in the European North of Russia. IOP Conference Series: Earth and Environmental Science. 574 012022 doi:10.1088/1755-1315/574/1/012022

Drozdov I. I. and Drozdov Yu. I. 2005 Lodgepole pine forest cultures in solving the raw problem of pulp wood. Forestry bulletin. 5: 83-84

Elfving B, Ericsson T., Rosvall O. 2001. The introduction of Lodgepole pine for wood production in Sweden. A review. Forest Ecology and Management. 14: 15-20.

Ericsson T. 1993. Provenance qualities of the *Pinus contorta* breeding base in Sweden, Uppsala: Forestry Research Institute of Sweden. 4: 33 pp.

Ruotsalainen S., Velling P. 1993. *Pinus contorta* provenances in northern Finland. In: Pinus contorta: From untamed forest to domesticated crop. Umea: Swedish University of Agricultural Sciences. 122−136.

Varmola M., Salminen H., Rikala R., Kerkela M. 2000. Survival and early development of Lodgepole pine. Scandinavian Journal of Forest Research. 15: 410−423.

Vojnov G. S, Chuprov N. P., Yaroslavcev S. V., Torhov S. V. and Shusharin A. P. 2012. Forest taxing guide to the North-East of the European part of the Russian Federation. Arkhangelsk: Pravda Severa, 672 pp.