

Original Scientific paper
10.7251/AGREN2401093R
UDC 630*232:582.474(571)

THE INFLUENCE OF THE PLANTING SCHEME OF FOREST CROPS ON THE GROWTH OF LARCH IN THE CONDITIONS OF THE SOUTHERN TAIGA

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ABSTRACT

The genus Larch (*Larix*) is one of the most common in Russian forest plantations. Larch wood is a high-quality building material. In the past, Sukachev larch (*Larix sukaczewii* Ledeb.) naturally grew on the territory of the Perm Region. But this species, as well as the Siberian larch (*Larix sibirica* Ledeb.) that replaced it, turned out to be incapable of self-renewal in the conditions of the Perm Region. All forest plantations with the participation of larch have to be created artificially. In the scientific community, there is no unambiguous vision of the competitiveness of larch in relation to other conifers. There is also no consensus on the schemes for creating larch forest crops. The planting of larch on the territory of the current urban forests was carried out from 1943 to 1989. Cultures were created not only pure, but also mixed with pine and spruce. Forest crops aged 57-76 years were studied. The purpose of the study is to identify the dependence of the growth and development of larch on the planting scheme and the scheme of mixing conifers. To do this, we had to conduct a retrospective analysis of planting schemes. The study showed the absence of the influence of the width of the aisle on the safety of larch, on the diameter of the trunk and the formation of the stock of larch wood. A strong influence of the in-the-row spacing was found both on the preservation of forest crops and on the formation of a wood stock.

Key words: *larch, forest crops, planting scheme.*

INTRODUCTION

In the Russian Federation, larch plantations are predominant in terms of their distribution area. This is primarily due to the high adaptability of this breed to various habitat conditions. In the Perm Region, the areas of plantings with the participation of larch are extremely small and amount to less than 0.3% (Lesnoi plan (2018)). At the same time, the natural renewal of larch in the plantings of the Perm region is not observed. This fact encourages the cultivation of larch in the

form of artificial plantings. Many authors note the high productivity of artificial larch plantations (Koreshkov N.V., Tsareva E.A. (2021, Merzlenko M.D. at all (2019)). These authors also note the influence of planting density (standing of the stand) on the accumulation of wood stock per unit area.

As noted by M.D. Merzlenko and N.A. Babich, such an indicator as "planting density" during research should still be accompanied by the calculation of the "uniformity index" (Merzlenko M.D., Babich N.A. (2002)). This index is directly related to the planting scheme, since the "optimal" density can be achieved using different values of row spacing and in-the-row spacing. According to the forestry regulations of the MKU "Perm City Forestry" (FR (2012)), larch crops should be created with a row spacing width of 5 m.

MATERIALS AND METHODS

Research conditions. The research was conducted on the territory of the MKU "Perm Urban Forestry" of the Perm Region in 2022. The forest compartments were selected in three precinct forest districts: Verkhne-Kuryinskoye (forest compartment 12), Levshinskoye (forest compartments 1, 3, 4 and 68) Motovilikhinskoye (44). The numbering of forest compartments and mensurational description of stratum in compartments were used from forest management data in 2010. This territory belongs to the Southern Taiga forest region of the European part of the Russian Federation in terms of forest-growing zoning (FR (2012), Lesnoi plan (2018). According to the botanical and geographical zoning of the Perm Krai, this territory belongs to the area of broad-leaved spruce-fir forests (Ovesnov S.A. et al (2007).

Methods. The criteria for the selection of stratum in compartments of district forestry were the participation of larch in the composition of the stand, a small difference in the age of larch. Table 1 shows some values of the mensurational description of the surveyed plantings.

Table 1. Characteristics of the studied forest crops with the participation of larch

District forestry	Planning quarter/stratum	Stand composition* (at 2010)	Age of larch, years	Forest site type**
Levshinskoe	1/6	6P4L+B+S	58	2
	1/18	8P2L+S+B	57	2
	3/18	4P1L1S4B	62	2
	3/25	8L2P+S	62	2
	4/8	4L3P1S2B	59	2
	68/9	9L1P	76	2
Verkhne-Kurinskoe	12/5	10L+B	60	2
Motovilikhinskoe	44/13	8P1S1L	60	2
	44/23	10L	60	2

Notes: * - P – Scots pine, L – Siberian larch, S – spruce, B – birch,

** - B2 – C2 –

The temporary sample plot during the survey had a length of 50 m, in width it captured at least 4 rows (in clean plantings) or a complete scheme of mixing trees in cultures. On the temporary sample plot, a tree-by-tree accounting of all growing trees was carried out, the location of each tree and stump was noted in each row with the measurement of diameters (for a tree at a height of 1.3 m, for a stump - at a height of 20 cm from the ground surface). The sanitary condition was also determined for growing trees.

The heights of the trees prevailing in the thickness of the trunk were taken as the height of the plantings. The distances between the rows were fixed. The in-the-row spacing is determined primarily by the minimum distance between trees (stumps). In the event that the trees grew at a great distance, the planting step was set by the selection method. At first, a calculation was made about the location of trees in a row at different distances (0.5-0.6-0.7-0.8-0.9-1.0-1.1 m). Then the resulting models were compared with reality. The volume of trees was calculated using single-tree assortment table. The influence of the planting scheme on the growth and development of larch was established using the approximation confidence value.

RESULTS AND DISCUSSION

According to the forestry regulations (LHR) of the Perm City Forestry, there are 63.1 hectares under larch crops in total (FR (2012)). Such an area concerns only forest crops, where larch prevails in stock over all other tree species in the stand. Analysis of mensurational descriptions from forest management materials for 2010 shows that forest crops with the participation of larch occupy about 341.2 hectares (Table. 2 and 3).

The data in Table 2 show that the largest areas of forest crops with the participation of larch were created in the 60s of the twentieth century. Since the 90s of the last century, the planting of crops with the participation of larch has not been carried out. From 1943 to 1989, pure larch plantations were created on an area of 19.5 hectares (Table 3). Mixed crops of larch and pine were the most popular – 279.3 hectares.

Table 2. Distribution of areas for the creation of forest crops with larch by the periods of their creation on the territory of the MKU "Perm City Forestry", ha

District forestry	The period of creation of forest crops with larch				
	1943-1946	1950-1959	1960-1969	1970-1979	1980-1989
Verkhne-Kurinskoe	0.0	11.0	14.6	0.0	9.8
Nizhne-Kuryinskoe	0.0	0.0	0.6	0.0	0.0
Levshinskoe	9.9	10.0	203.9	2.4	0.0
Motovilikhinskoe	0.0	38.0	30.3	0.0	10.6
Chernyaevskoe	0.0	0.0	0.0	0.1	0.0
The amount	9.9	59.0	249.4	2.5	20.4

Table 3. Distribution of areas of forest crops with larch by the nature of the mixing of tree species, ha

District forestry	Plantings with a predominance of larch	Total forest crops with larch	Areas of mixed stands *			
			L	LP	LS	LPS
Verkhne-Kurinskoe	7.6	35.4	2.4	27.3	4.2	1.5
Nizhne-Kuryinskoe	0.0	0.6	0.0	0.6	0.0	0.0
Levshinskoe	38.3	226.2	10.5	185.8	0.9	29.0
Motovilikhinskoe	17.1	78.9	6.5	65.6	4.3	2.5
Chernyaevskoe	0.1	0.1	0.1	0.0	0.0	0.0
The amount	63.1	341.2	19.5	279.3	9.4	33.0

Notes: * - P – Scots pine, L – Siberian larch, S – spruce

Studies conducted during 2022 in some stratum of district forestry allowed us to determine the scheme of planting forest crops. As the data in Table 4 show, the row spacing in the surveyed forest crops was in a wide range: from 1.7 to 8 m. The in-the-row spacing, with the exception of the stratum of the 23rd planning quarter of the 44 Motovilikhinsky forestry (actual for 2021), was in a fairly narrow range: 0.5... 0.8 m. In terms of forest crops, the method of mixing crops was quite simple – mixing in rows. On two sites, the mixing of pine and larch occurred in the row itself.

The intensity of tree death in forest crops over the entire growing period is inversely proportional to such an indicator as "capacity for survival, %". The data in Table 4 show that the greatest natural death of larch trees is observed with a row spacing of 1.7 m (uniformity index – 0.5). While with a row spacing from 2.7 to 8 m with a planting step of 0.5-0.8 m (uniformity indices – 0.09 ... 0.26), the indicators of capacity for survival of crop do not differ much from each other.

On the other hand, with an increase in the in-the-row spacing to 2 m with a row spacing width of 3 m (uniformity index – 0.67), the safety of trees was 58%. This indicates that a rarer planting density of pure larch crops with an optimal planting scheme (from the point of view of the uniformity index) affects the better capacity for survival of trees, instead of increasing the row spacing to 5...8 m.

Table 4. Probable schemes for the creation of forest crops with the participation of larch in the study sites

District forestry	Planning quarter/ stratum	Year of planting	Planting scheme, m	Scheme of mixed stands	Capacity for survival L (total),%
Levshinskoe	1/6	1964	4.9 0.7	2 rows – L	21 (20)
	1/18	1965	3.5 0.6	2 rows - P a complex type of tree mixing*	- (18)
	3/18	1960	3.0 0.8	1 row – P	18 (19)
	3/25	1960	5.0 0.5	3 rows – L 1 row – L	15 (14)
	4/8	1963	3.0 0.8	1 row - P	10 (9)
	68/9	1946	2.7 0.7	1 row – L 2 rows - P 1 row – P	29 (23)
Verkhne-Kurinskoe	12/5	1962	1.7 0.8	pure stand – L	8 (8)
Motovilikhinskoe	44/13	1962	row spacing: 8.0 and 5.0 and in-the-row spacing: 0.5 and 0.7	a complex type of tree mixing**	- (13)
	44/23	1962	3.0 2.0	pure stand – L	58 (58)

Notes: * - the mixing of trees was probably carried out by alternating in a row of 30 pieces of larches and pines; ** - the mixing of trees was more likely to be carried out in a row under the tree method (L-P-L-P)

The features of the radial growth of the stand of crops, as well as the volume of wood by the age of 60, are shown in Table 5. It should be noted that larch had the minimum thickness of the trunk when planting according to the scheme 3.5 x 0.6 m, and the minimum volume of wood when planting 3.0 x 0.8 m. At the same time, the planting scheme 3 x 2 m provided the largest volume of wood larches.

Table 5. Values of trunk diameter and stock for forest crops of the studied sites

District forestry	Planning quarter/ stratum	Stem diameter, cm		Cubic capacity on 1 ha, m ³	
		L	P	L	P
Levshinskoe	1/6	22.5	24.5	211	238
	1/18	16.5	24.6	148	202
	3/18	20.1	25.8	180	253
	3/25	20.9	27.7	186	223
	4/8	23.3	23.1	92	167
	68/9	28.0	20.5	443	224
Verkhne-Kurinskoe	12/5	18.5	-	217	-
Motovilikhinskoe	44/13	36.9	32.0	181	238
	44/23	28.8	-	469	-

Notes: L – Siberian larch, P – Scots pine

The identification of the dependencies of the growth and development indicators of larch crops on the values of the planting scheme showed a number of interesting dependencies. Thus, the inverse dependence of the volume of wood on the row spacing was established (Figure 1). As well as the parabolic dependence of the capacity for survival of larch plants on the row spacing (Figure 2). A direct linear relationship was revealed between the planting step and such indicators as: the safety of larch trees and the volume of wood per 1 hectare.

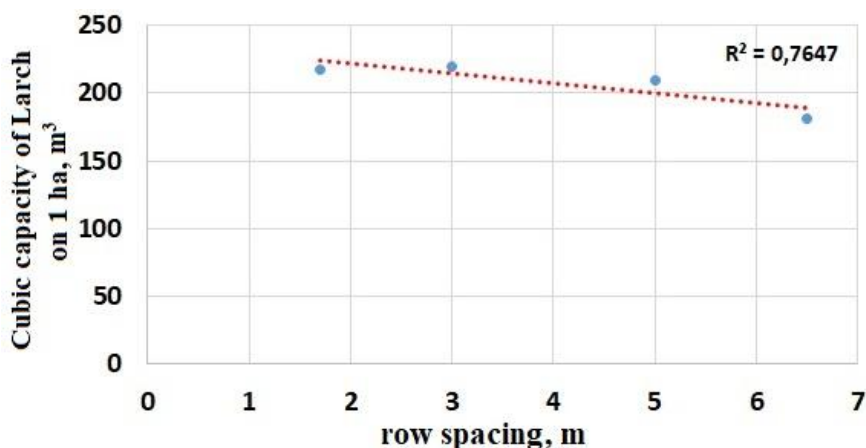


Figure 1. The dependence of the cubic capacity of larch on the row spacing

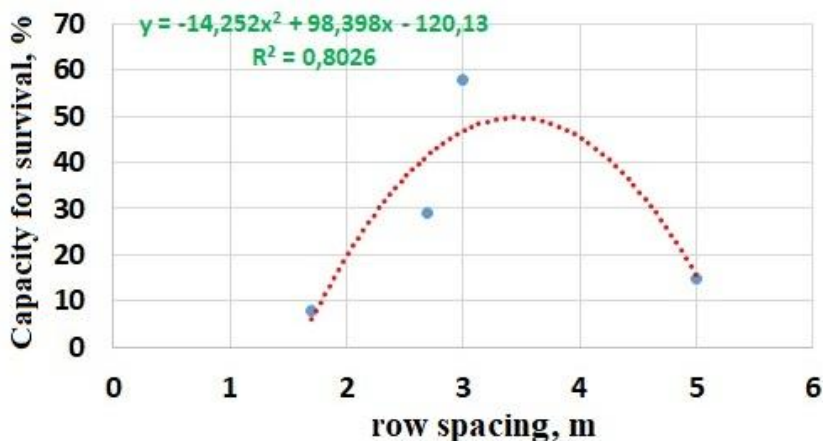


Figure 2. The dependence of the capacity for survival of crops on the row spacing

CONCLUSIONS

The creation of forest crops with larch in the forest plantations of the city of Perm was carried out from 1943 to 1989, mainly mixed with pine. The most common way of mixing is in rows. The greatest loss of larch by the age of 60 was recorded with a planting scheme of 1.7 x 0.8 m (pure larch crops). The greatest preservation of larch trunks and the volume of wood was formed with a planting scheme of 3 x 2 m .

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