IJABR

International Journal of Advanced Biotechnology and Research (IJABR)
ISSN 0976-2612, Online ISSN 2278–599X,
Vol-10, Issue-2, 2019, pp173-177
http://www.bipublication.com

Research Article

Variability of Pine Cultures Individual Growth

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[Received: 21/02/2019; Accepted: 12/04/2019; Published: 16/04/2019]

ABSTRACT:
Scots pine is one of the most widespread ligneous species on the territory of Zabaikalsky Krai. Need for pine forest restoration is one of the most priority problems of the regional forestry. Analysis of the current practice of pine man-introduced plantations formation for recent 10 years shows the tendency of great disposal of forest cultures, created on the mechanically treated areas on non-forested lands. To solve this problem the studies on growth of forest species, created on the unprepared soils, have been conducted. The purpose of the work was to study variability of height growth of forest species, created on the prepared and unprepared soil. The studies showed that in man-introduced plantations, irrespective of the variant, in the background of the total increase of the average yearly height growth for the period under study, the period of its decrease was marked in certain years (2013-2015). Value of the tree individual growth variation in variants by years had the maximum values in 2013-2015. Positive correlation has been established between meteorological parameters and the yearly height growth, variability of forest species growth, only on the basis of the average air temperature (r=0.04-0.49). Forest cultures are relatively calm to rainfall in the accounting year. Between years (peaks) of solar activity and indicators of forest species under studies, and quantity of rainfall as well, a significant association has been established (within the range r=0.2-0.6). Taking into account this fact, the site cultivation works shall be performed in great volume in years of solar activity not depending on the variant.

Keywords: forest species, pine, growth, fluctuations

[I] NTRODUCTION

One of the most widespread tree species on the territory of Zabaikalsky Krai is Pínus sylvéstris. It accounts for 7.8 % of the total area of forests and 9.0 % of the Krai area covered with forest (as for 01.01.2018) [1].

Need of pine forests restoration is one of the most priority problems in connection with their intensive exploitation, increase of recreational load, numerous recurrent forest fires, mass destruction by forest pests and diseases, change of species, and climatic changes directed to reduction of the forested area as well.

Analysis of the current practice of laying man-introduced plantations on sandy and sandy clay soils of Zabaikalsky Krai for the latest 10 years testifies of the tendency of a great writing-off the

forest plants formed on the machined areas of the unforested lands.

To solve this problem, taking into account annual significant amounts of forest cultivation works, to decrease material and labor expenses, to accelerate planting on cutover stands and fire-sites, we have conducted studies on growing forest plants created on the untreated soil. More so that positive experience of laying man-introduced plantations by this method has already existed in our country [2-4].

The purpose of this paper was to study rate and fluctuations of height growth in forest plants, formed on the prepared and unprepared soil, that are one of the indicators characterizing state of the trees and plantings on the whole by variants.

[II] MATERIALS AND METHODS

The experimental object (pine forest species formed on the unprepared soil) is situated in the surroundings of the Ingodinsky forest station INREC SB RAS, the undercurrent of the Kakova-river basin (40 km from Chita-city). According to forest vegetation zoning, this area refers to the Zabaikalsky mountain forest area.

Laying of pine plants (experimental variant) was conducted in 2010, at the same time with production planting (check variant) at cutover stands on fire sites of 2000 and 2008 years. These sites were occupied by rhododendron mixed herb pine forest of the III-IV site class.

Soil treatment for production plantings was made with the aid of plough ПКЛ-70, with listering in 3 m. Planting of 3-yeared seedlings, grown in the nursery of the Sivyakovsky forestry (nearby the Ingodinsky forest station INREC SB RAS), was hand worked, under Kolesov planting iron, into the furrow bottom, with the plant spacing – 0.7 m. All production works were made by the Chita forestry workers.

Experimental planting was made on the unprepared soil (virgin soil) between grooves of triple replication (300 items of seedling in each replication) on each of the sites.

Study of the tree growth for comparison and assessment of laying variants was conducted within 2014-2017, i.e. on the 4^{nd}-7^{th} year after planting. For work the common methodology by V.V. Ogievsky, A.A. Khirov [5] was used.

To study fluctuations of individual growth, comparison of growth has been made for each year with growth of the previous year for each tree. Then percent of participation in tree plantation with the increased growth in this year has been defined.

Thus, indicator of the fluctuation value of individual growth in the planting was characterized by percent of trees with the increased growth in the year under study in comparison with the previous year.

For detailed research of man-introduced plants breakdown of trees by fluctuation value of individual height growth was made for the following gradations: from 1 to 25, from 26 to 50, from 51 to 75, from 76 to 100, from 101 to 125, from 126 to 150, from 151 to 175, from 176 to 200 cm in comparison with the previous year.

Study of fluctuation dynamics for the main meteorological parameters (air temperature and humidity) for the period from 2010 till 2017 was made with the use of data from site rp5.ru. Indications for the period from April till September were subject to consideration for each accounting year.

[III] RESULTS

Results of the conducted studies have shown that culmination of the average yearly height growth in variants has not come yet. In **[Table-1].**

For the whole period under consideration the maximum values were marked in the latest accounting year (52.8 and 57.0 cm are accordingly experimental and check variants).

[Table-1]. below

Year	Average growth and error of the average (M ±m)	Average standard deviation (±σ)	Variation factor (V)	Indicator of accuracy (p), %	Validation criterion for the growth difference (t)
Experimental variant					
2010	11.56±0.57	6.10	53.1	4.9	0.8
2011	11.35±0.59	7.30	64.3	5.1	1.1
2012	17.32±0.82	10.34	59.6	4.7	5.8
2013	23.7±1.10	14.37	60.6	4.6	1.3
2014	31.76±1.44	18.48	59.1	4.5	0.1
2015	35.43±1.81	22.34	63.0	5.1	0.1
2016	43.17±2.25	27.40	63.4	5.2	0.1
2017	52.86±2.73	33.20	62.8	5.1	
Check variant					
2010	8.34±0.61	5.63	67.5	7.3	0.1
2011	9.53±0.67	7.86	82.4	8.0	1.3
2012	16.45±1.06	12.90	78.4	6.4	9.6
2013	24.47±1.85	17.20	70.2	5.8	6.8
2014	37.30±2.08	25.60	68.6	5.5	0.5
2015	39.20±2.30	28.70	73.2	5.8	0.1
2016	46.90±3.00	36.60	78.0	6.3	0.1
2017	57.05±3.63	44.40	77.8	6.3	

Table: 1. Statistic Data of the Average Annual Height Growth for the period from 2010 till 2017.

In variant of forest species formed on the unprepared soil, the average annual height growth changed by years in the following way: after planting, in the first two years, it was insignificant and practically the same. Then in 2012 the height growth increased by 52.5% and for 2 years it was gradually decreasing. In 2015 it fell up to 11.5% in comparison with the previous year, and then, in the following accounting years it increased again by 21.8% in 2016, and 22.4% - in 2017 (in comparison with the previous year). The similar situation was observed in the forest species formed on the prepared soil. Here, insignificant growth increase was marked on the second year after planting, that subsequently significantly increased in 2012 (by 72.6%) and for 2 years it started to decrease with slight fluctuations.

Here, a slight increase of the growth was marked on the second year after planting, which afterwards increased significantly (by 72.6%) in 2012 and for two years it was decreasing with slight fluctuations. In 2015 the annual growth of species sharply decreased to 5.0%, and then it began to change towards increase by 19.6% in 2016 and by 21.6% - in 2017, but nevertheless it remained to be slight on the background of the general trend of height growth increase.

On the year of forest species planting, regardless of the variant, fluctuations of individual growth were negative (less than 50%). In **[Figure-1].** Since 2011 fluctuations in the variant of forest species, formed on the unprepared soil, have significantly increased (by 37.1%). Experimental variant exceeded the check one by 18.2%.

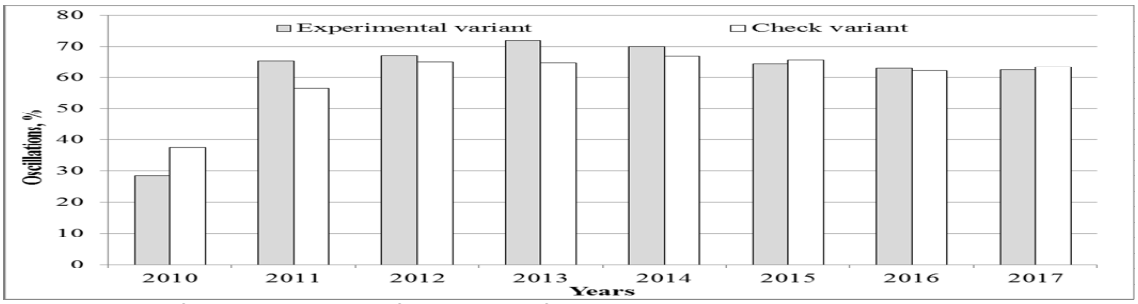
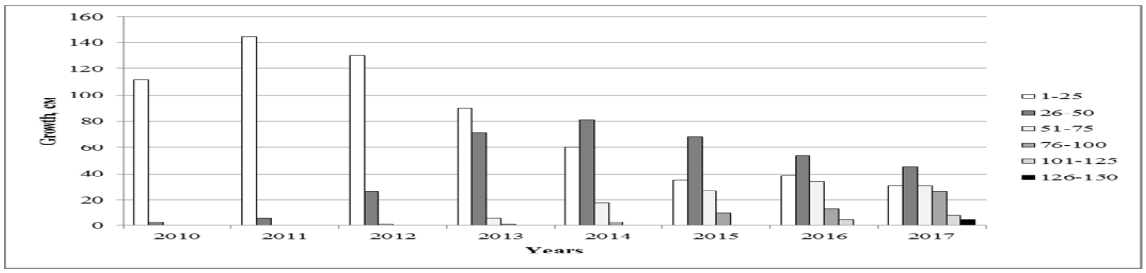


Fig: 1. Fluctuations of growth by variants for the period from 2010 till 2017, %

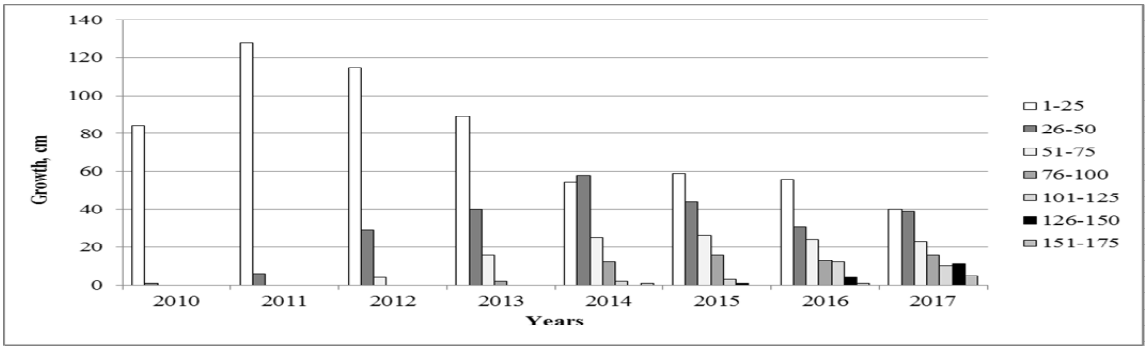
For the period under study, in the variant of forest species, formed on the unprepared soil, fluctuations of individual growth were maximum in 2013 (71.7%), after that gradual decrease of the indication was marked, and in 2017 it decreased by 9.4%. In the check variant of forest species the maximum value was in 2014 (66.9%). Fluctuations of individual growth for the whole period under study did not exceed 70%, they were within 62.1-66.9%. Since 2014 fluctuations have decreased by 3.5%.

Distribution of the individual growth by year gradations showed transition to the second group with the height growth 26-50 cm in 2014 in the experimental variant. In **[Figure-2].**

Here, predominance of this group growth preserved up to 2017. In the check variant transition to the second group was going on for only one year in 2014, from 2015 and up to nowadays the tendency of decreasing, transition to the first group of trees with height growth 1-25 cm was outlined.



a



b

Fig: 2. Distribution of trees by individual growth by years and variants: a – experimental variant; b – check variant

[IV] DISCUSSION

Statistical treatment of meteorological parameters showed that in the course of years under consideration the data were not constant, their slight variability was marked. So, in the first two years after planting, the average air temperature had a slight variability towards increase, and since 2012 it has started to decrease gradually (by 6,0% in comparison with the previous year). In 2013 this tendency continued to decrease by 3,6%, therefore the year was cool. Since 2014 the average air temperature increased by 11% and in the following two years it slightly fluctuated within 0,9 and -4,7%. In 2017 it increased again by 6,1%. Variability of the rainfall amount by years was more significant. So, starting from

2010 and up to 2012, the gradual increase of rainfall amount was marked. Since 2013 a considerable decrease (by 79,3%) of this indicator has been marked, that still continued in the next accounting year by 38,6%. A slight increase of the rainfall amount in 2015 and 2016 changed again to decrease of this indicator by 7,4 %. Revealing of dependence between meteorological parameters and the yearly height growth, fluctuation of forest species growth, has shown that positive correlation can be seen in both variants, but only taking into account the average air temperature (r=0,04-0,49). Correlation between all indicators of forest species under study and amount of the rainfall could not be set. Evidently that forest species relatively calmly respond to jumping of the rainfall amount in the accounting year.

It is interesting to mark the fact that significant decrease of the yearly growth in variants (compared to the previous years after planting) was marked in the period from 2013 till 2015, when the greatest fluctuations of the increased growth occurred in the variants, and when transition to the next growth group with height growth 26-50 cm is going on. Study of dependence between solar activities and indicators of forest species under consideration, and meteorological parameters as well have shown the presence of significant correlation between years of solar activities and growth fluctuations (within the range r=0,5-0,6) and between years of solar activities and amount of the rainfall (r=0,2).

In the man-introduced plantings, regardless of the variant, at the background of total growth of the average yearly height growth for the period under study, the period of its decrease was marked in certain years (2013-2015).

[V] CONCLUSION

1. Fluctuation value of the individual growth of trees in variants by years was the greatest in 2013-2015.
2. Distribution of the yearly height growth by grades by years showed to transition to the following age group (with height growth 1-25 cm) in 2014.
3. Positive correlation between meteorological parameters and yearly height growth, fluctuation of forest species growth has been determined but only taking into account the average air temperature (r=0,04-0,49). Forest species relatively calmly respond to jumping of rainfall amount in the accounting year.
4. Between years (peaks) of solar activities and indicators of forest species under study, and rainfall amount as well, a considerable association has been determined (within the range r=0,2-0,6). Taking into account this fact, plantation works shall be conducted in great amount in peaks of solar activities irrespective of the variant. In our case these are 2013-2015 years. From the economic point of view, it is profitable to create forest cultures formed on the unprepared soil, since they decrease expenses for performance of labor-consuming and high-priced works.

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