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THE COMPARISON OF PRODUCTIVITY OF THE PURE AND MIXED LARCH STANDS IN LITHUANIA

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The aim of the study was to evaluate the main dendrometric parameters and the status of the pure and mixed larch stands. Our research was performed during 2015-2016 in the pure and mixed larch stands of 30-60 years old. We didn't included younger stands, as on such age the interspecific interactions are still weak, as well as older stands - due to shorter rotation age of larch. The similar comprehensive study performed in Lithuania only more than 60 years ago.

During the research we evaluated 138 stands (207 ha) and established 503 sample plots, measured 21600 trees. Totally the research is performed on the 24.3% of total area of the larch stands in Lithuania. Though in the age of 40-50 years larch stands reach the same volumes as the pine stands reach at the age 100, intense larch stand cultivation is not promoted in Lithuania. The evaluation of the stand volume showed, that the pure larch stands of third - sixth age classes produce the standing volume from 347 m3/ha to 585 m3/ha in average, while the mixed stands – from 278 m3/ha to 527 m3/ha. The average difference between the steam volumes of the larch of 5 and 6 age classes is only 0,036 m3.

Key words: larch stands, productivity, stands volume, pure and mixed stands, tree condition, age classes.

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INTRODUCTION

Significance of mixed stands has increased due to their potential benefits, such as increased production, greater diversity, improved nutrient cycling or reduced risk of biotic and abiotic damage during last decades (Cannell et al. 1992). Aaccording to the forest cadastre (2017) there are 909 pure and mixed larch stands with a total area of 852 ha in Lithuania. The total area of the stands with at least 10% of larch reaches 2358.3 ha. Planted larches were mixed with spruce, pine and lime, so there is the big variety among the larch stands.

The structure of the mixed stands and the character of the species interactions here mostly depend on the light demand of the component species and on the edaphic conditions. Tree species, with similar light demand, form mixed one-layered stands (pine with birch, pine with black alder, pine with larch), where the level interspecific competence mostly related with edaphic conditions. On the fertile soils, there is usually high interspecific competence between

the species growing in the same layer, so the planted secondary species often overshadow and overcompete the main species (Gradeckas & Malinauskas 2005). The species with different light demand creates complex two-layered stands (larch with spruce, larch with lime). The species of the second layer have a complementary function and raise the productivity of the stand. Still, the productivity of such stands depends on the relations between the stand's tree species (Gradeckas & Malinauskas 2005).

The aim of the research was to evaluate the main dendrometric parameters and the status of the pure and mixed larch stands.

MATERIAL AND METHODS

The study performed in the larch stands Lithuanian during the vegetation period of 2015-2016. The study covered the soils with different granulometric composition. After the analysis of the forest cadastre stand database, we decided to perform the research in the stands Ia – II growth class. We refused from the field survey the stands of III and IV growth classes, as mostly these stands consist of Russian and Siberian larches, whose growth is the worst of all larches at Lithuanian climate conditions.

The field survey performed in the stands of relative stocking level between 0.5-1.0. We didn't include the stands with the stocking level of 0.3 – 0.4 due to the small amount of such stands and trees within them, and the stands with the stocking level higher than 1.0 due to the small amount of such stands. Due to these facts, such stands can't be compared neither between themselves, nor with the other stands. To eliminate the edge effect in surveyed stands we selected the stands with the area of 0.5 ha and more, and the centres of the sample plots were planned not closer than 30 m from the edge of the site.

In mixtures to evaluate another tree species impact on larch growth, the studied sites were divided by their species composition, so the sites with three and more species were not involved into the study design. The stands with only 10-20% of larch were also excluded. We didn't included younger stands, as on such age the interspecific interactions are still weak, as well as older stands - due to shorter rotation age of larch. Using above listed criteria, we selected the study objects, distributed all over the territory of Lithuania (Fig.1).

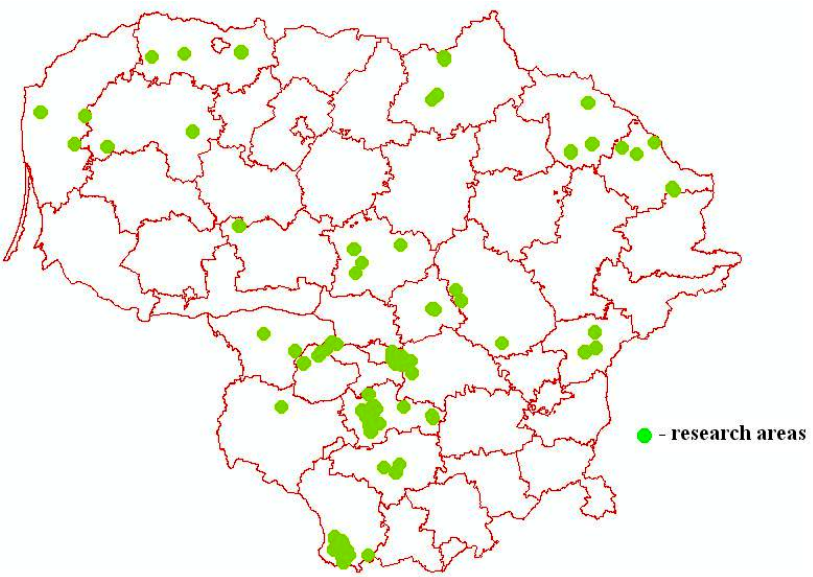

Fig. 1. The distribution of the research areas.

The sample plots were established in a systematic way in all studied stands. The amount of sample plots was calculated according to National forest inventory (Kuliešis et al. 2010). The area of the sample plot was 500 m^2, radius – 12.62 m. The sample plots were distributed within the equal distances every 50-100 m, depending on the stand size and shape. The net of the sample plots before field survey was created by ArcMap 10.1 software. The initial point was random, and the others – using the net, orientated by the north-south and east-west directions. Using the ArcMap software were marked and numbered all the sample plots, were identified their coordinates. On the 0.5-1.0 ha sites we established 3 sample plots, 1.1-2.0 ha - 4 sample plots, 2.1-3.0 ha - 5 sample plots, in the stands bigger than 3 ha - 7 sample plots. On every site the amount of the established plots was adjusted depending on the site configuration and dendrometric characteristics. During the field works the sample plots location were detected by the portable GPS equipment Mobile Mapper 6.

In every sample plot the dendrologic and dendrometric aspects were measured. All trees thicker than 8 cm (both living and dead) were measured and identified species. If the prevailing species in the stand were Siberian larch (*Larix sibirica* Ledebour), Russian larch (*Larix archangelica* Lawson) or their admixture, such stands were not studied further.

For every tree in the sample plot were determined the following parameters:
- height – with the accuracy of 0.1 m, measured by Vertex VL5 combined ultrasound and laser height meter;
- diameter – with the accuracy of 1.0 cm, at the breast height, in two directions, using Haglof calliper;
- tree status (1-3 points, where 1- good, 3 – bad) and its reasons, estimated visually;

For the larch trees, additionally were determined:
- Kraft tree development class – (I-V) - visually;
- crookedness (1-3 points, where 1- straight tree, 3 – crooked) - visually;
- type of crookedness (close to stump curvature, bow, zigzag, crookedness in the crown) – visually;
- branch thickness (1-3 points, where 1 – thin branches, 3 – thick) - visually;

Totally the research was performed on the 24.3% of the total area of larch stands in Lithuania and 50.5% of the areas, potentially suitable for this study. All collected data was processed using MS Excel, Statistica and Canoco software.

RESULTS

We evaluated the average number of trees in the pure and mixed larch stands (Fig. 2) as well as the main dendrological and dendrometric characteristics of larch trees.

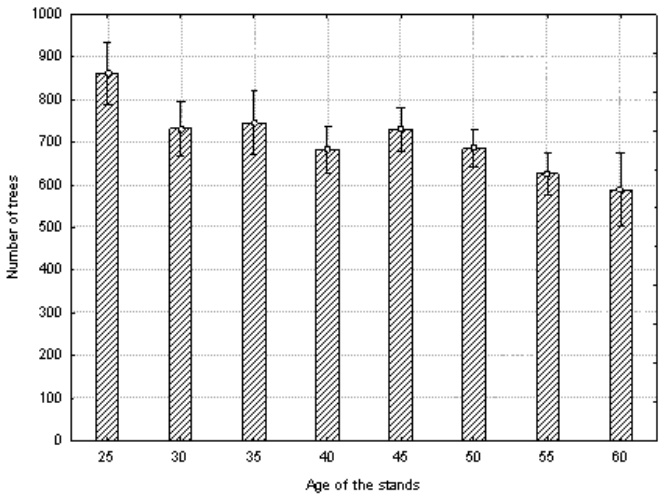

Fig. 2. The average number of trees per ha in the larch stands in Lithuania.

In the studied larch stands the highest stand density can was observed in the larch stands of the 3rd age class. Here the average tree‘s nutrition area was 12.5 m^2. In the stands of 4th and 5th age classes the average tree‘s nutrition area was 29% bigger as well as 6th age class the average tree‘s nutrition plot increases only

up to 19.6 m^2 (with the natural tree elimination, i.e. without any management operations).

Pure larch stands had smaller density, compared to the mixed ones - in average in the stands of the 3rd age class there were 690 trees/ha (in the mixed stands 768 trees/ha), and in the stands of the 6th age class – 518 trees/ha (in the mixed stands 596 trees/ha).

The evaluation of the stand volume showed, that the pure larch stands are more productive, than the mixed ones (Fig. 3).

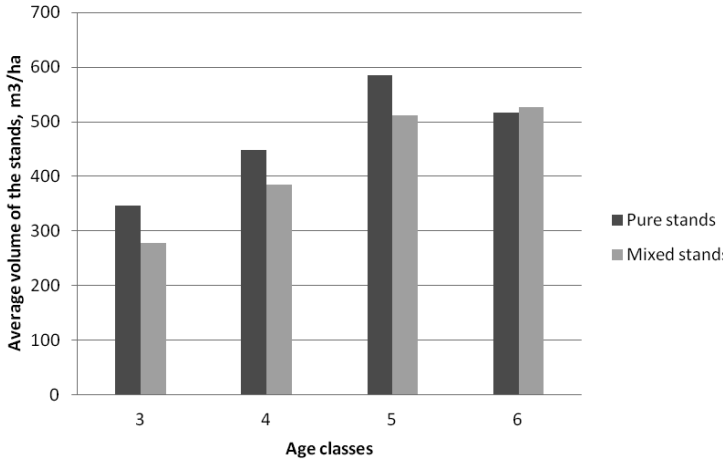

Fig. 3. The average volume of the studied stands of different age classes.

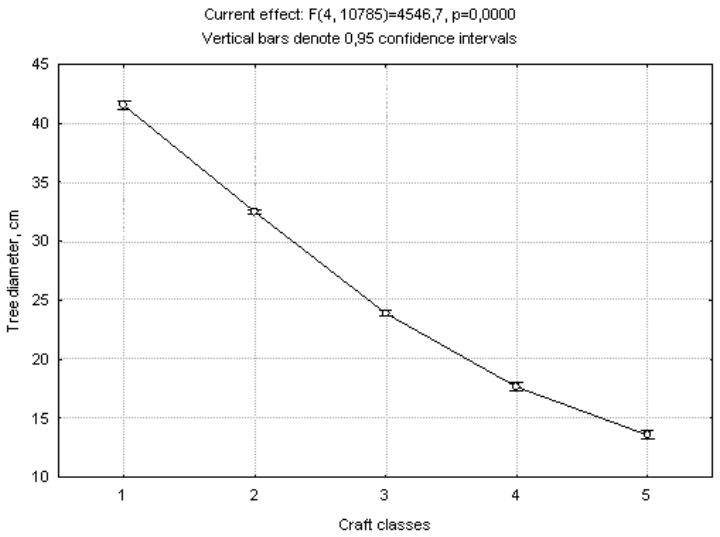

Fig.4. The distribution of larch trees by the Kraft classes.

Stand density affected the average volume of the stem. In the stands of the 3rd age class the average volume of the stem reached 0.477 m^3, fourth – 0.627 m^3, fifth – 0.938 m^3, sixth – 0,974 m^3. In the dense stands (both pure and mixed) takes place the intensive tree differentiation, so the trees of the different Kraft classes can be characterized by the diverse diameters (Fig. 4).

The trees of the II Kraft class (with well-developed crowns) were dominating in such stands – their share was 34.8%. There were 31.1% of the trees of the III Kraft class (with slightly suppressed crowns), and the shares of the larches of IV and V classes (with poor crowns and shaded) were 11.6% and 13.3% respectively. Finally, the share of the trees of the I Kraft class (with strongly developed crowns) in the larch stands was only 9.2%.

The study showed, that in the studied larch stands of the 3 – 6 age classes only 43.4% of larch trees were in good condition. The share of the trees in the satisfactory condition was 41.8%, bad - 6.8%, and dry – even 10.7% from all studied larch trees.

The impairment of the larch trees‘ status can be caused by many factors, however, the most frequent of them was shading. Totally in the studied larch stands the shaded trees were 82.2% from all trees in satisfactory and bad condition. 7.7% of such trees were wounded, 5.3% - rotten, 4.8% - suppressed, with the broken and dry tops.

Though the studied larch stands were very productive and dense, the share of the

straight trees was only 68.6%. The most frequent crookedness (along the whole stem length) was of a zigzag character. The share of the trees with such crookedness was 65.5% from all crooked larches.

The economic value of the stand depended not only on the stem straightness, but also on the amount and size of the branches. In the studied larch stands in 62.5% of cases dominated the larches with the thin branches, and the share of the larches with thick branches was only 14.3%.

The average volume of the larch branches was 0.05 m^3, what was 0.9% from the volume of the whole tree. During the data analysis, we evaluated the correlations between the larch parameters (Fig.5).

Both dependent and independent regression parameters for the tree height dependence on the diameter were statistically significant ($p<0,05$). The strongest correlation (from all measured parameters) noticed between the larch tree volume and diameter ($r=0,945$, $p<0,05$) (Fig. 6). Larch stem volume had the strongest correlations with all parameters, however site type had the weakest correlations.

DISCUSSION

Larch stands occupy 0.04% of all forest area in Lithuania as well as small proportion of larches documented in 0.12% of all stands. Though at the age of 40-50 years the larch stands reach the same volume as the scots pine stands reach only by the age of 100 years, cultivation of larch stands is not widely promoted in Lithuania.

The thinnings of the main tree species in Lithuania are conducted using the approved thinning regulations. Such document for larch doesn't created yet. During this research, we evaluated 138 stands, and none of them were thinned recently, what can be identified as the major problem of larch stand management in Lithuania.

Due to fast growth of this species and high accumulated standing volume, larch trees need larger nutrition plots than the trees of the other species. We determined that in the stands of the 6th age class in average there are still more than 620 trees/ha, what probably reduce the average volume of the stem.

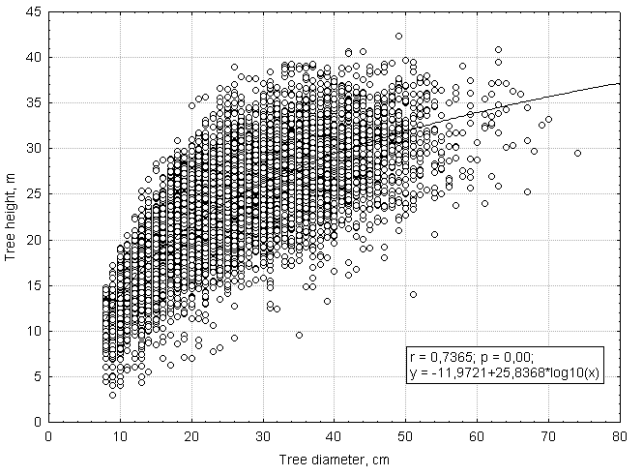

Fig. 5. The dependences between the heights and diameters of larch trees.

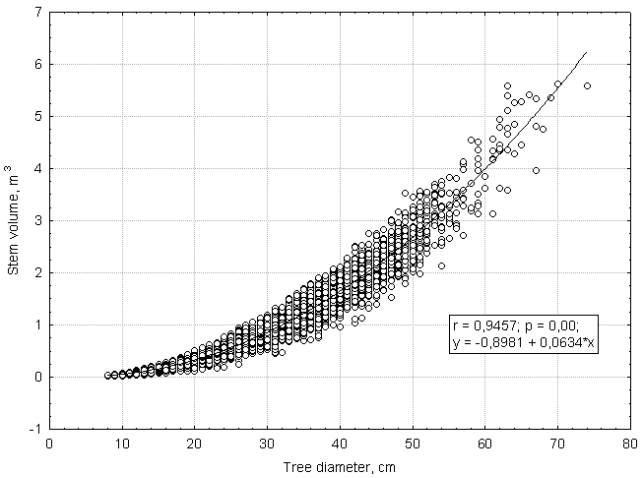

Fig. 6. The dependence between larch stem volume and diameter.

The comparison of the larch stands of the 5th and 6th age classes showed, that their average volume is almost the same (in the stands of the 6th age class it's even in average 5 m^3 smaller). We can assume, that the volume decrease can be caused by the absence of the necessary management operations.

The stands of the 6th age class contained almost one third of the trees of the IV and V Kraft classes (not perspective), what causes the decrease of the volume increment. Moreover, in such stands there are a comparatively hight number of dry trees, whose volume is in average 10 m^3/ha. Such stand structure and growth conditions in larch stands cause bigger volume loss than production.

Mixed larch stands of 30 - 50 years old the height and volume are smaller than in the pure stands of the same age, what confirms the results of the research by A. Gradeckas ir A. Malinauskas (2005). M. Jankauskas (1954) got the opposite results and stated, that in the mixed stands larch reaches bigger height and diameter, than in the pure stands of the same age.

CONCLUSIONS

1. The average standing volume in the larch stands of the third age class is in average 298 m^3/ha, fourth - 411 m^3/ha, fifth – 539 m^3/ha, sixth - 524 m^3/ha.
2. The average difference between the stem volume in the stands of 5th and 6th age classes is not significant, what means that if the stand was not thinned in time, there is a big volume loss.
3. In the stands of the 6th age class, where the nutrition plot for every tree is 20 m^2 and more, the average stem volume reaches up to 1,311 m^3. At the same time in the stands with higher density the average stem volume is 48% smaller.
4. The strongest correlation (from all measured parameters) is noticed between the larch tree volume and diameter ($r=0.945$, $p<0.05$).

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