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ANALYSIS OF SCOTS PINE'S (*PINUS SYLVESTRIS* L.) WOLF TREES' PARAMETERS, GROWTH AND HABITAT

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Our study focused on Scots pine's (*Pinus sylvestris* L.) wolf trees. The main objectives of the research were to distinguish existing wolf trees' morphotypes and compare their growth with regular trees and between themselves. During the study we identified two wolf trees' morphotypes and it was proven by the tree-ring analysis. It showed that the trees of both morphotypes grow faster than regular trees in the early age. The analysis of the growth trends showed future growth diminishment for the both wolf trees' morphotypes. For both morphotypes we analyzed d/h ratio and its' dependence on the growth conditions. Hypothetical reason for the growth differences between two morphotypes could be different growth conditions and genetic origin

Key words: Scots pine, wolf trees, b-type trees, tree classes, morphotypes, growth patterns, growth trends.

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INTRODUCTION

The management of Scots pine (*Pinus sylvestris* L.) stands has a long tradition and history (Cotta 1821, Schwartz 1991). During this time forest specialists developed many scenarios of thinning practices, aiming for the different tree parameters: diameter, height, wood density. Nevertheless, in all times special attention was paid to the timber quality, and nowadays quality of timber is the main aim of stand thinning (Cameron 2002, Liziniewicz 2014).

Wolf trees are super-dominant trees with wide crowns and thick branches (Beck 2004). Such trees are undesired by foresters due to their low timber quality. Moreover, such trees exploit space not effectively, occupy large gaps and overdominate perspective trees of the stand. In most thinning guidelines is especially accented wolf trees removal on the early stages of the stand development.

Though usually wolf trees are regarded as one tree class, the reasons of their appearance in the stand, growth patterns and reactions to different factors could differ. In this study we focused on two wolf trees' morphotypes and tried to distinguish their growth patterns, reaction to the habitat factors and differences from the regular trees.

MATERIAL AND METHODS

The study was carried out in Lithuania, Kaunas region. It consisted of 37 stands, 23 of them were situated in Kazlu Ruda and 14 – in Vaisvydava (Fig.1). All chosen stands were cultural and even-aged, in order to eliminate uneven-age effect within the stand. Age of the stands ranged from 14 to 35 years. All stands were unthinned since the growth initiation.

For the study we chose sample plots with constant amount of trees. Every wolf tree was considered as a center of such plot. After that we spotted 10 neighboring trees, and from them chose 4 most competitive trees, oriented by different cardinal directions (Fig.2). If the wolf trees situated close to each other, sample plots could be unified, looking at the exact situation.

For every tree, selected for the study, we recorded following data: diameter, height, site type, microrelief and mezorelief. For the microrelief we chose the following gradation: plain ground (lv), micropit (md), microhill (mk). Mezorelef gradation also consisted of 3 categories: flat place (L), slope bottom (Sa), slope center (S), slope top (Sv) and pit (D). Wolf trees were divided into two morphotypes according to the visual parameters, such as branch thickness and branching angle.

Also we cored every chosen tree from the northern side with the increment borer. All taken samples were taken to the laboratory, where were moistened by putting them for 20 minutes into the container with water in order to get an equal moisture level for every sample. Prepared in such way, samples were put into the metal fixator, and with a sharp boxcutter the upper layer of wood was cut off. This action let us get an equal surface and enhance visibility of tree-rings for every sample. In case of blank or unclear tree-rings we used a chalk to enhance the contrast. Prepared tree-ring samples were processed with “Lintab 6” tree-ring measurement station and TsapWin software. Samples of wolf trees’ and regular trees’ tree-rings were processed in separate data stacks. Measurement accuracy was set to

Fig. 1. Map of the experiment places.

1/100 mm, and measurements were made from bark to pith. To reach maximum data accuracy, after measurements we performed cross-dating procedure for all data stacks.

Measured data was analyzed using Statistica software. To process our data we used ANOVA analysis type (analysis of variance). In order to eliminate uneven-age effect, we didn't pay attention to the calendar growth years. For every tree growth years were numbered seriatim (1, 2, e.t.c). Then the growth patterns of both morphotypes and regular trees were compared.

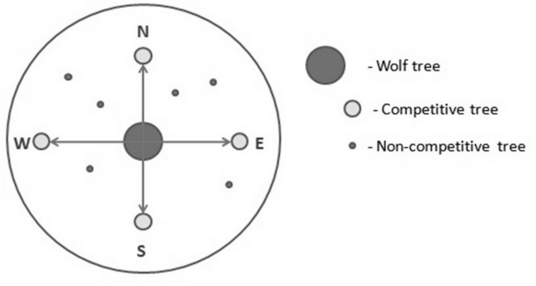

Fig. 2. Scheme of the sample plot.

RESULTS

During this study we distinguished two different morphotypes of wolf trees, which can be visually discerned from each other and regular trees. 48% of all studied wolf trees belonged to the first morphotype, which can be characterized by tree parameters close to regular trees. The only high difference, which can be spotted visually, is higher branch length and longer crown, what results in lower crown ratio, higher space occupation and slight overdominance in the stand (Fig.3).

Second morphotype also can be characterized by longer branches and smaller crown ratio, but the trees of this morphotype also have thicker branches and bigger branching angle, which causes almost horizontal branching and results in even wider crown, than of the first morphotype (Fig.4). Such trees occupy large spaces in the stand, suppress other trees and due to that can be called superdominant.

Fig. 3 First wolf trees' morphotype.

Fig. 4 Second wolf trees' morphotype trees.

The tree-ring analysis showed existing difference between growth patterns of wolf trees and regular trees. Moreover, such difference also exists between growth patterns of both wolf trees' morphotypes (Fig.5).

The biggest difference between first wolf trees' morphotype and regular trees growth can be observed on the 6-10 growth years and counts 0.7 mm. By the 11-15 growth years the difference starts to diminish and almost disappears by the year 30.

The difference between regular trees and second wolf trees' morphotype is almost twice bigger. Maximal difference at the 6-10 growth years counts 1.3 mm. This difference also tends to diminish by 11-15 growth years and disappear by the 30th growth year.

Growth speed difference between two wolf trees' morphotypes tend to stay equal up to 6-10 growth years and counts 6 mm. However, later the trees of second morphotype show bigger growth speed loss, then the trees of the first morphotype, and by the 35th growth year start growing even slower.

The d/h relation distributed in the expected way (Fig.6). For the regular trees it was the smallest – 1.33; for the first morphotype – 1.46 and for the second morphotype – 1.53.

The reaction to the soil fertility was slightly different for the different tree types (Fig.7). On the more fertile "c" type habitats h/d ratio for all tree types was almost equal. Bigger difference showed h/d ratios of the trees, growing on "b" type habitats. For the regular trees h/d ratio on the "b" soil fertility was even higher, than on "c". However, both wolf trees' morphotypes showed the opposite results, and their h/d ratio on the "b" habitat was smaller. The biggest difference, which counted 0.13, showed second wolf trees' morphotype.

Another important factor, affecting wolf trees' growth, seems to be mezorelief (Fig.8). The most sensitive to mezorelief appeared to be second wolf trees' morphotype. Biggest h/d relation, which counted 0.75, showed trees of second wolf trees' morphotype, growing on the slope bottom (Sa) and slope middle (S). Smallest h/d relation, which counted 0.45, showed the trees, growing in the pit (D).

Analyzing the first morphotype, we see smaller mezorelief effect. The h/d ratio varies from 0.45 for the trees, growing on the bottom of the slope till 0.57 for the trees on the top of the slope.

Though we performed the analysis of both morphotypes' and regular trees' reaction to the microrelief (Fig.9) and soil humidity (Fig.10), for these factors we got p-values higher, than 0.05, what makes us think, that microrelief and soil humidity level have less effect for the wolf trees' growth.

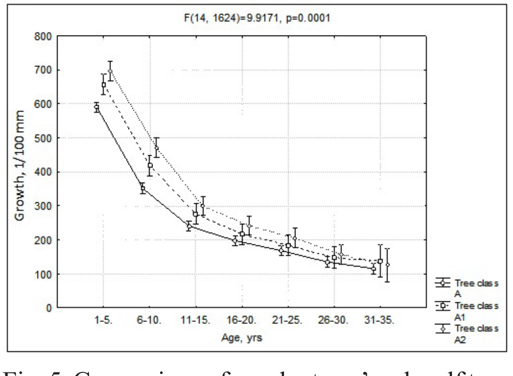

Fig. 5. Comparison of regular trees' and wolf trees' growth patterns.

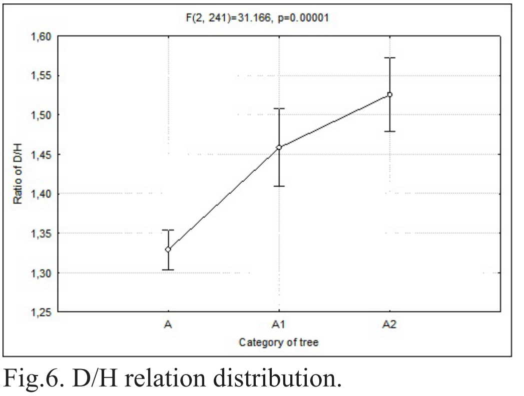

Fig.6. D/H relation distribution.

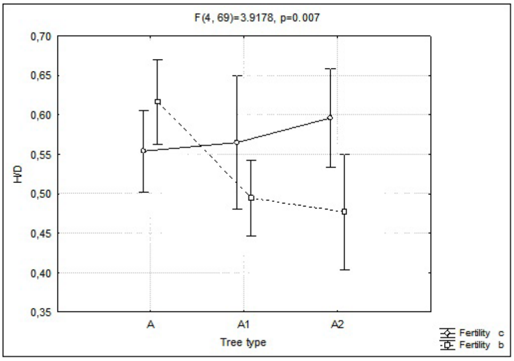

Fig. 7. Regular trees' and wolf trees' reaction to the soil fertility.

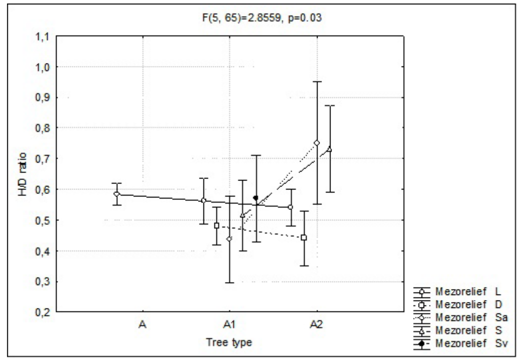

Fig. 8. Regular trees' and wolf trees' reaction to the mezorelief.

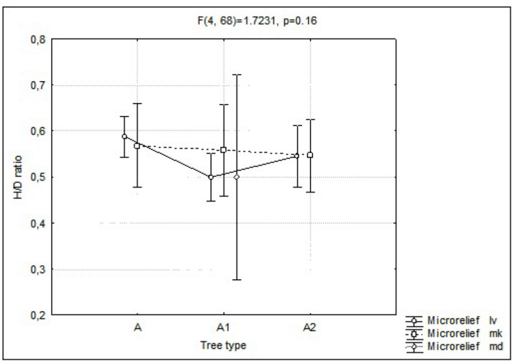

Fig. 9. Regular trees' and wolf trees' reaction to the microrelief.

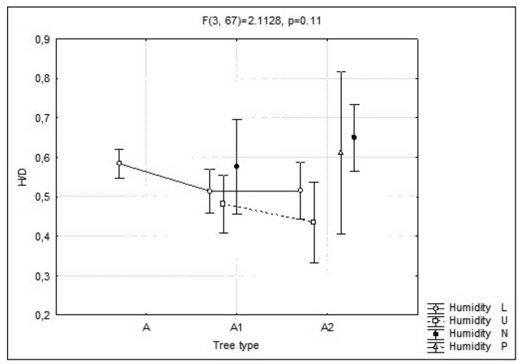

Fig. 10. Regular trees' and wolf trees' reaction to the soil humidity.

DISCUSSION

Though usually wolf trees are considered as a one tree class, their division into several morphotypes isn't a novelty. Such division was especially popular in the beginning of 20th century. For example, Lönnroth (1925) also defines two types of wolf trees. First of them, "better wolf", is described as extensively grown trees with larger branches. Second type, "worse wolf", is described as especially bended, branchy, sometimes crooked trees, or trees with other low-quality traits. The similar classification is given by Lakari (1920), who also identified two wolf trees' types. To the first type belong branchy, bended badly-shaped wolf trees. Second type includes other super-dominant, but better shaped wolf trees.

In modern literature wolf trees are mostly united into one tree class, also often called the trees of b-type. In this case regular trees are taken for a-type. In German literature can also be found the intermediate a/b type (Beck, 2000). Such typology is quite similar to our study results, and first wolf tree morphotype can be taken for a/b tree type, and second morphotype – for b-type.
Analyzing the growth trends of wolf trees and regular trees, we see future growth speed and productivity loss for both morphotypes (Fig.11). Thus, the speed of growth diminishment for both morphotypes is slightly different. The first morphotype's growth speed was closer to the regular trees' growth speed from the first growth year, and though in the beginning the trees of the second morphotype were growing faster, by the growth years 26-30 they reach the same growth speed as the trees of the first morphotype, and by the growth years 41-45 the growth speed of both morphotypes diminishes until the same numbers as the growth speed of the regular trees.

In the study of Uusvara (1991) was regarded the effect of soil fertilty on Scots pine's trees' branchiness, branch thickness and branch angle. This research confirmed, that increased site productivity strongly increased these parameters. Also there was found a positive corellation between branch thickness and annual ring width, what corresponds to the lower h/d ratio of wolf trees, growing on richer sites, in our research. These results also correspond to the the studies by Kräuter (1965), who recommended early removal of wolf trees on fertile sites to promote regular trees with smaller amount of branches and higher wood quality.

Hertel and Kohlstock (1994) made a genetic study of a and b Scots pine tree types. It showed the existing difference on the genetic level: type b showed low genotype variation; and there was higher level of heterozygosity based on a high number of rare alleles in a-type. However, the difference between these two types was only in a minor polymorphism. Genetic base of the second morphotype's appearance in the stands also corresponds to the study of Hannrup, Ekberg and Persson (2000). Their research showed high heritability estimates for the wood traits, moderate for the growth capacity traits and low for the stem traits, with the exception of branch angle which showed a higher value.

Kuuvulainen and Rouvinen (1997) indicate, that competition tends to make tree crowns narrower and crown base higher. At the same time, availability of space makes crowns wider and crown ratio lower. Less competition in the young age could be the explanation for appearance of first wolf trees' morphotype, or intermediate a/b type.

Though most studies and thinning guides distinguish wolf trees as a separate class, there are no quantitative criteria for distinguishing them from regular trees in the stand. Both morphotypes, regarded in this article, are relative, and can be distinguished in the exact stand visually in a comparison with other regular trees.

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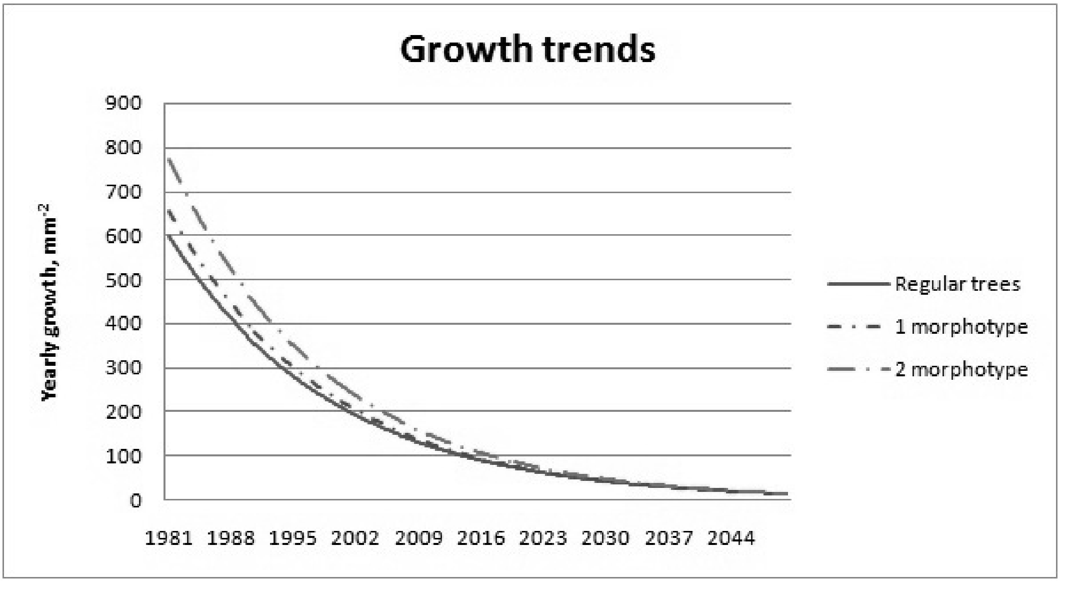

Fig. 11.Comparison of regular trees' and wolf trees' growth trends.

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