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WOOD PROPERTIES OF NINE *PINUS SYLVESTRIS* OPEN-POLLINATED FAMILIES ORIGINATING FROM DIFFERENT LITHUANIAN POPULATIONS

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Trees originating from nine open-pollinated families of different Lithuanian *Pinus sylvestris* L. populations were studied with respect to wood properties at age 30. The average width of Scots pine wood ring mostly depended on site productivity and stocking level. Mean value of pine families for Pilodyn pin penetration was 19.3 mm, for annual wood ring – 2.7 mm, for wood density – 431 kg/m3. Wood density was slightly higher in less fertile sites. The average difference between family mean estimates for wood hardness was 4.2 mm, between the sites – 1.1 mm. For annual ring width it was 0.7 mm and 1.4 mm, and for wood density 27 kg/m^3 and 41 kg/m^3, respectively. The average by the sites individual heritability for wood hardness was 0.62, family heritability – 0.79. For annual ring it was 0.18 and 0.68, for wood density 0.03 and 0.18, respectively. There was negligible correlation of wood hardness with tree diameter at individual level. Weak but significant correlation was estimated of wood hardness (pin penetration) with ring width (0.16) and wood density (-0.12). The correlation was much higher at family mean level and for ring width it was 0.37, for wood density – -0.39. Site effect was much larger for ring width (variance component was 15%) and wood density (21%) compared to wood hardness, but due to large standard errors the effects were not significant. Block effect was significant only for wood hardness, but variance component was only 4.0%. Family variance component was highly significant only for wood hardness (16.6±3.9%).

Key words: *Pinus sylvestris* L., half-sib families, field trials, wood properties.

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INTRODUCTION

Over the last couple of decades, interest in wood properties and stem quality variability increased. Density is one of the most-studied properties of wood and is associated with a number of other wood characteristics that define quality. Average wood density of stem is difficult to assess precisely due to a number of factors, such as the tree species and age, the tree position with respect to neighbouring trees, site geographic position, as well as the growth rate and genetic factors. Measurement of wood hardness by using Pilodyn 6J allows assessing a number of trees in a non-destructive way. Wood hardness ussually correlates with the other important and more complex timber characteristics.

The study performed at Institute of Forestry (Lithuanian Research Centre for Agriculture and Forestry) results showed that genetic gain for Scots pine wood hardness (determined by PILODYN device) at family level might be improved up to 3% in one breeding cycle if selection index included only tree height and wood hardness. Genetic gain for wood hardness wood be even 9% at individual level. Currently applied breeding methods in Lithuania allow improving pine wood hardness of only 1-2% the second tree breeding cycle (selection of 25 best families and 50 trees in the selected families).

MATERIAL AND METHODS

Trees originating from nine open-pollinated families of different Lithuanian *Pinus sylvestris* populations were studied in five field trials (Fig. 1) with respect to wood hardness, annual wood ring and wood density at age 33. All five field trials are established in different forest types (*Cladoniosa*, *Vaccinio-myrtillosa*, *Oxalidosa*, *Myrtillo-oxalidosa*). Wood hardness was tested by using Pilodyn 6J. The other wood properties were tested by using Lignostation high-frequency densitometer with software Ligno Station 2.30 (RINNTECH, Heidelberg, Germany). Measurement precision was 0.001 mm. Wood increment cores for that purpose were sampled in all field trials. The last ten wood rings were analysed. The progeny trials have randomised complete-block design with 5 replicates and 10 tree line plots per family at spacing of 1-2 x 1.5 m.

Variance components were calculated using model:

$$y_{ijlmn} = \mu + d + b(t)_{ij} + t_j + f(p)_{lm} + \varepsilon_{ijlmn} \quad (1)$$

where - y_{ijlmn} the value of a single observation, μ - the grand mean, d- fixed effect of stem

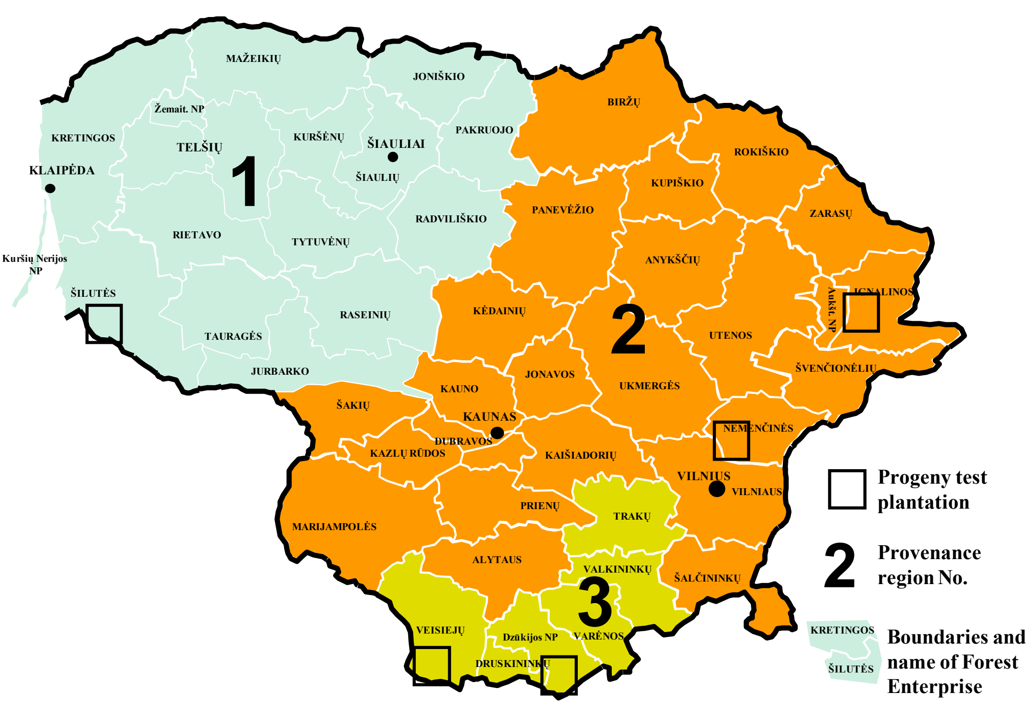

Fig. 1. Field trials with open-pollinated progeny of Lithuanian *Pinus sylvestris* L. populations, established in 1983.

diameter as a covariate, $b(t)_{ij}$ - the fixed effect of block i in the trial j,t_j - the random effect of the trial j, $f(p)_{lm}$ - the random effect of family l within population m, ε_{ijlmn} - the random error term.

The formula used for the narrow-sense heritability (Falconer 1989):

$$h_a^2 = \frac{4 \cdot \sigma_f^2}{\sigma_f^2 + \sigma_e^2} \quad (2)$$

where σ_f^2 - family variance component, σ_e^2 - the error variance component.

Family heritability are calculated according to the formula (Fins et al. 1992):

$$h_s^2 = \frac{\sigma_f^2}{\sigma_f^2 + \sigma_e^2/n} \quad (3)$$

where n - mean number of tree in the family.

All the calculations were done using SAS Software Release 9.4. For analysis of variance PROC MIXED (mixed model equations) and the REML (restricted maximum likelihood) option was used. Pearson correlations were calculated using procedure CORR. MS Excel was used for making the graphs.

RESULTS AND DISCUSSION

The number of survived trees in the field trials varied from 39 to 56% (Fig. 2). The best survival of pines was in the site where soil was least fertile

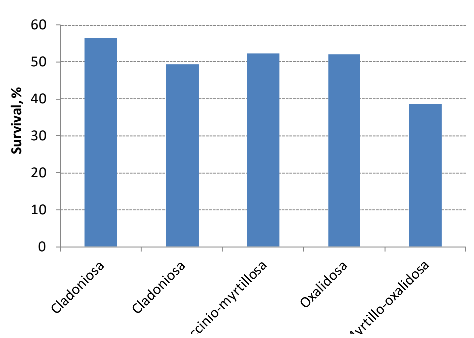

Fig 2. Tree survival (%) in the Scots pine field trials at age 30.

(*Cladionosa* forest type). Pilodyn pin penetration results showed the opposite direction, the higher site index the softer pine wood (Fig. 3).

Wood ring width increased with site index increase (Fig. 4). Early and latewood of the ring showed the same trends. The largest estimates for wood density were obtained in *Vaccinio-myrtillosa* forest type (Fig. 5).

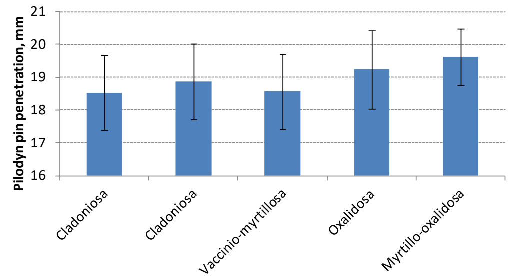

Fig 3. Wood hardness of nine Scots pine half-sib families in different field trials and forest types. Error bars indicate standard deviation.

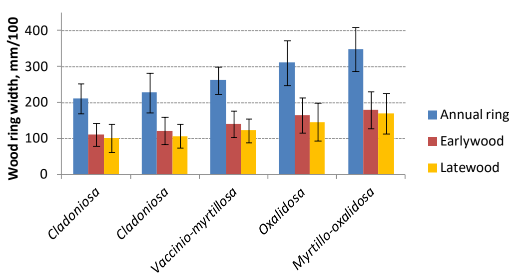

Fig 4. Wood ring width (total, early- and latewood) of nine Scots pine half-sib families in different field trials and forest types. Error bars indicate standard deviation.

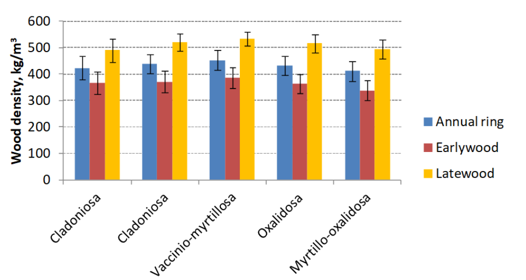

Fig 5. Wood density (annual ring, early- and latewood) of nine Scots pine half-sib families in different field trials and forest types. Error bars indicate standard deviation.

Finnish scientists studying Scots pine full-sib families have found that wood density differences were mainly due to the latewood density (Peltola et al., 2009). In their study, the largest wood density was estimated in the field trials with least stocking level. Our results did not follow similar trend, instead slightly denser wood was estimated in *Vaccinio-myrtillosa* forest type and tended to decrease with increased soil fertility. Peltola and others (2009) showed that wood density was only slightly affected by stand spacing. The suggested explanation for such result was that earlywood and latewood density had lower estimates but at the same time proportion of latewood had higher estimates at higher stand density. Our results showed no relationship of growth traits with wood density and this is in agreement with the results reported by the other scientist from young Scots pine trial studies (Peltola et al., 2009; Hannrup et al., 2000; Persson et al., 1995). Generally, wood density correlates with the proportion of latewood in pine stands (Hannrup et al., 2001). Negative correlation of wood hardness with diameter was reported based on the data from series of Scots pine trials in Finland (Haapanen et al. 1997).

CONCLUSIONS

Mean value of pine families for Pilodyn pin penetration was 19.3 mm, for annual wood ring – 2.7 mm, for wood density – 431 kg/m3. Wood density was slightly higher in less fertile sites.

The average difference between family mean estimates for wood hardness was 4.2 mm, between the sites – 1.1 mm. For annual ring width it was 0.7 mm and 1.4 mm, and for wood density 27 kg/m3 and 41 kg/m3, respectively.

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