

Comparison of dendrometric features of Scots pine trees and wood density from one of genetic origin obtained from the provenance surface in Forest Research Institute in Rogów

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Abstract: *Comparison of dendrometric features of Scots pine trees and wood density from one of genetic origin obtained from the provenance surface in Forest Research Institute in Rogów.* Scots pine is characterized by high variability of morphological-tribal and physiological-growth features, which also translates into high variability in wood density. The provenance area of LZD in Rogów was founded on the international project of IUFRO organization in 1966. It is composed by 16 genetic origins of Scots pine closely described and nurtured throughout the life of trees, which creates wood material from this surface unique in research. Due to the fact that Scots pine is the most important conifer species in Poland, both for forests and for the industry, comprehensive research with regard to genetic origin seems to be necessary.

Keywords: Scots pine, genetic origin, wood density, dendrometry

INTRODUCTION

Scots pine (*Pinus sylvestris* L.) is a coniferous tree occurring naturally in the temperate climate zone in Europe. It is a dominant species of Polish forests occupying 60% of the total forest area in Poland. The stock of thickened pine wood is about 950 mln m³, contained mainly in III and IV age class- these are tree stands of 41-80 years (Forests in Poland 2018). The species is characterized by high variability of morphological-tribal and physiological-growth characteristics (Jaworski 2004, Jaworski 2011, Andrzejak and Żybura 2012). Based on long-term provenance studies in Poland (e.g., Giertych 1997, Sabor 2006, Nowakowska 2007, Barzdajn 2008, Przybylski et al. 2015) 25 regions of pine origin were identified.

The variability of growth traits translates into high variability of pine wood properties. For example, the density of pine wood in the air-dry state ranges from 330 to 890 kg/m³, an average of 510 kg/m³ (Wagenführ 2007).

Research on the influence of genetic origin on the breeding value (selected morphological features) of pine trees was carried out, inter alia, on the surface of the Forest Experimental Plant in Rogów (Szeligowski et al. 2015). Pilot (for the origin of Bolewice), the relationships between structural features of wood and its density were also analyzed (Chmielowski et al. 2018). Selected physical and mechanical properties of the Scots pine wood from Rogów were also the subject of research carried out by Dzbeński et al. (2000).

Scots pine wood (code PNSY according to EN 13556:2003) is the main raw material of the Polish wood industry (Kozakiewicz 2019). Understanding the influence of genetic origins also on the characteristics and quality of the created wood is an important and current research issue. The purpose of this work is to determine the growth characteristics of trees and the density of the wood of Scots pine.

MATERIAL AND METHODOLOGY

Material for the study was acquired from the provenance surface in Rogów located in the Lodz region in Poland. The provenance area was founded on the international project of the IUFRO organization in 1966. During the installation of the experimental area, the habitat type of the forest was a fresh mixed forest. After the revision of the forest management, the forest type changed into a fresh mixed forest. The provenance surface was composed by 16 genetic origins of Scots pine (*Pinus sylvestris* L.). From each genetic origin, 15 trees from the top layer of the stand were cut down in 2016 (Kraft class 1 or 2). Then, 5 cm thick discs were picked from each tree (disc spaced every 2 m at the length of the trunk), dried and polished to accentuate annual increments. The discs were scanned and the images were analysed in the “CDendro 7.8” computer program.

For detailed analysis, one origin of Scots pine was selected from Polish tern (Rogów, near Lodz). The scope of the research included the analysis of:

- parametric features such as diameter at breast high, high and growing stock;
- incremental features such as average annual growth in four geographical directions and depending on the age class;
- wood density.

The material acquisition and research was carried out in accordance with Polish industry standards.

Wood moisture content was determined by the dryer-weight method according to ISO 13061-1:2014 and the density by the stereometric method according to ISO 13061-2:2014.

RESULTS AND DISCUSSION

Table 1 presents the numeration of individual origins with averaged dendrometric parameters such as: height, diameter at a height of 1.30 m (diameter at breast height) and growing stock as well as basic statistical analyzes.

Table 1. Dendrometric parameters of Scots pine trees from the provenance plot in Forest Research Institute in Rogów Data was collected from 2016.

Origin number	Name of origin	Parameters		
		Average height of tree [m]	Average diameter at breast high [cm]	Average growing stock [m ³ /ha]
1	Rogów	19.47	18.9	278.0
2	Bolewice	20.76	20.2	345.4
3	Janów Lubelski	19.92	18.7	243.3
4	Rospuda	19.73	17.7	252.1
5	Lipowa	19.61	18.4	281.3
6	Spała	19.48	18.6	282.8
7	Dłużek	19.98	18.9	328.2
8	Karsko	20.09	19.0	331.2
9	Starzyna	19.50	18.2	283.2
10	Ruciane	19.22	17.9	285.8
11	Gubin	19.84	18.9	284.6
12	Jegiel	19.44	18.9	286.4
13	Rychtal	20.19	18.9	330.8
14	Tabórz	19.77	18.3	276.4
15	Supraśl	19.29	18.0	289.8
16	Nowy Targ	18.36	17.1	152.2
Average value for all origins (\bar{x})		19.70	18.6	283.2
Standard deviation (σ)		0.52	0.7	44,9
Coefficient of variation (v) [%]		2.63	3.8	15,9

Pine trees from Rogów were of average height, whereas the origin of Bolewice had the highest average height of trees and the origin of Nowy Targ was the smallest average height of trees (Fig.1.) The average diameter at breast height (Fig. 2.) and average growing stock (Fig. 3.) were similar, where the origin from Rogów was also average compared to the other origin. Analysis of variance for the pine trees height on the surface in Rogów showed that there are statistically significant differences between the groups. The F value in the Snedecor test was $0.0000 < 0.05$. According to Lemke (1972) the average arithmetic height of Scots pine trees at the age of 50 years in 1st biological Kraft's class is 20.51 m, while the average of trees in 2nd class is 19.22 m. The average height of pine trees from Rogów origin obtained from 1st or 2nd biosocial class fits in between the above-mentioned values and may be considered as a typical value.

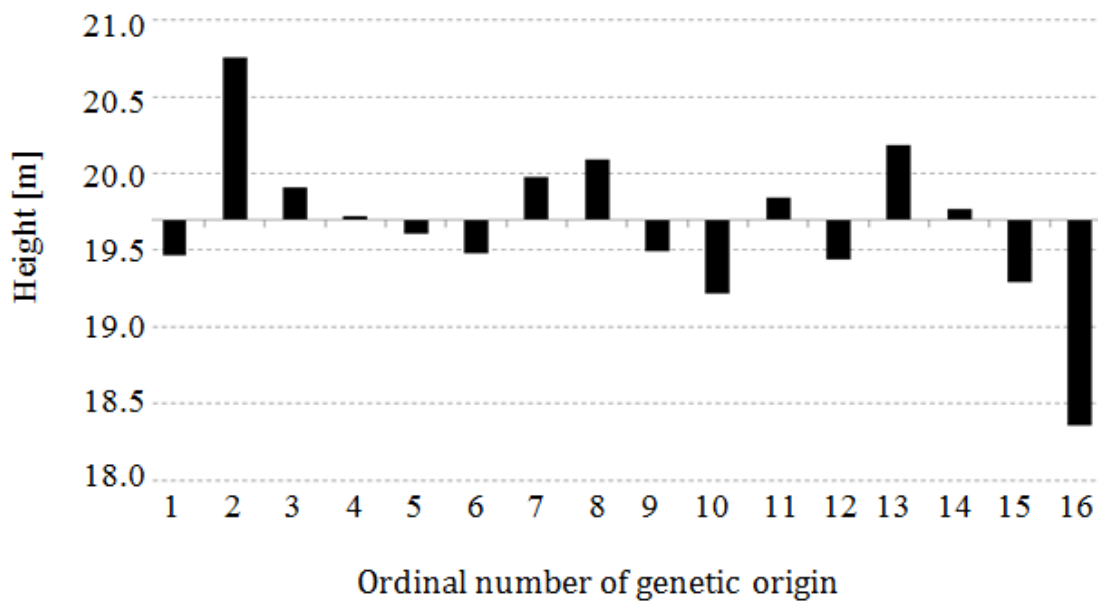


Figure 1. Average height of Scots Pine on the provenance plot (52 years old – 2016) 1-16 numbering of origin according to the table 1.

Analysis of variance for diameter at breast of pine trees on the surface in Rogów showed that there are statistically significant differences between the groups. The F value in the Snedecor test was $0.0000 < 0.05$. According to Lemke (1972) the arithmetic diameter at breast height of Scots pine trees at the age of 50, in 1st biological Kraft's class is 21 cm, while the arithmetic diameter at breast height in 2nd class is approximately 17 cm. In this regard, the average of 18.8 cm of pines from Rogów origin also may be considered as a typical value.

The average growing stock is 278 m³/ha. It may be also considered as a typical value for the pine stand of age of 50 (Szymkiewicz 1971). Analysis of variance for the growing stock of pine trees on the surface in Rogów showed that there are statistically significant differences between the groups. The F value in the Snedecor test was $0.0000 < 0.05$.

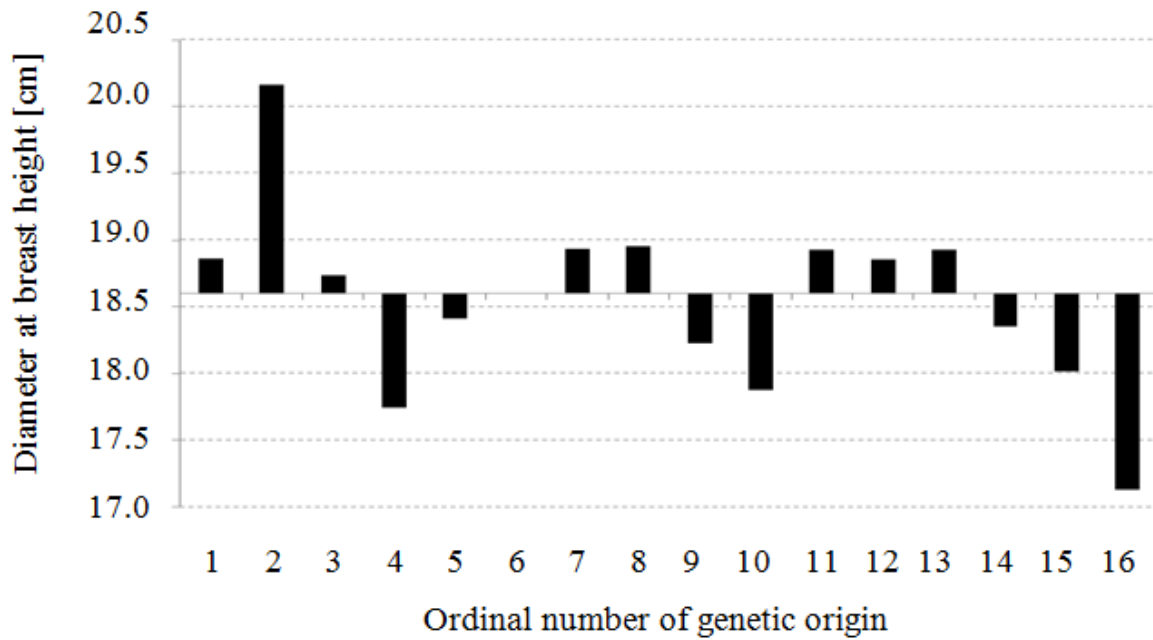


Figure 2. Average diameter at breast of Scots Pine on the provenance plot (52 years old – 2016) 1-16 numbering of origin according to the table 1.

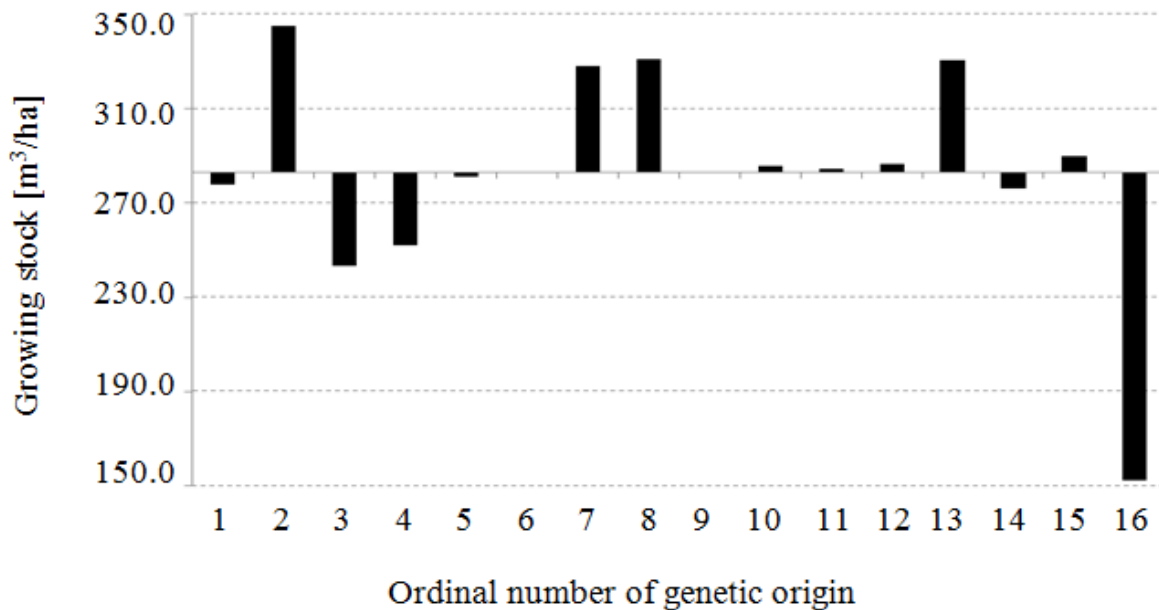


Figure 3. Average growing stock of Scots Pine on the provenance plot (52 years old – 2016) 1-16 numbering of origin according to the table 1.

On the basis of images of scanned discs, annual increments of the thickness of trees were measured. A number of analyses were performed, among others: average annual growth depending on the age class, as well as in individual geographic directions. This article focuses mainly on the origin of 1- Rogów.

The average annual growth of the pine thickness decreased with age and the initial thickness increase was 2,6 times higher than the increase in thickness in the final phase of the

experiment (Fig.5). It is a typical variation of the width of the annual growth rings for one age old coniferous stands (Jaworski 2011, Andrzejak and Żybura 2012). Scots pine juvenile wood (covering a number of first growth rings near the pith of the trunk) is characterized by clearly wider annual growth rings compared to the mature wood (Dzbeński et al. 2000, Fabisiak 2005, Chmielowski et al. 2018).

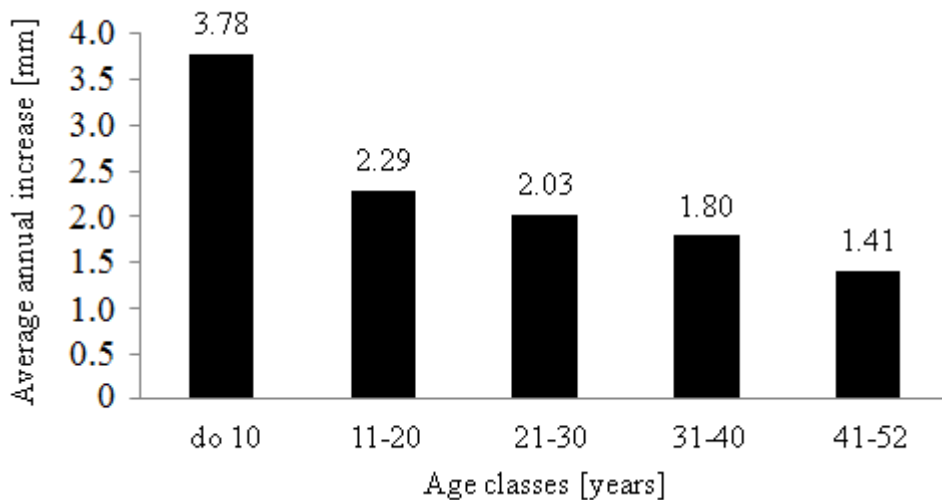


Figure 4. Average annual increase of Scots Pine on the provenance plot depending on the age classes.

However, as far as geographic directions are concerned, the largest average thickness gain was deposited on the eastern side of the tree, and the smallest on the west side (Fig. 5). This is probably related to the prevailing western winds being a cause of compressing the trunks on the eastern side. The consequence is the production of wider rings with the wood strands of compression wood on this side of the trunk. It also affects the relationship between the width of annual growth ring and the wood density (it is disturbed). Slightly wider annual growth rings do not give the expected reduction in wood density. No significant correlation was found between the features of the wood material discussed.

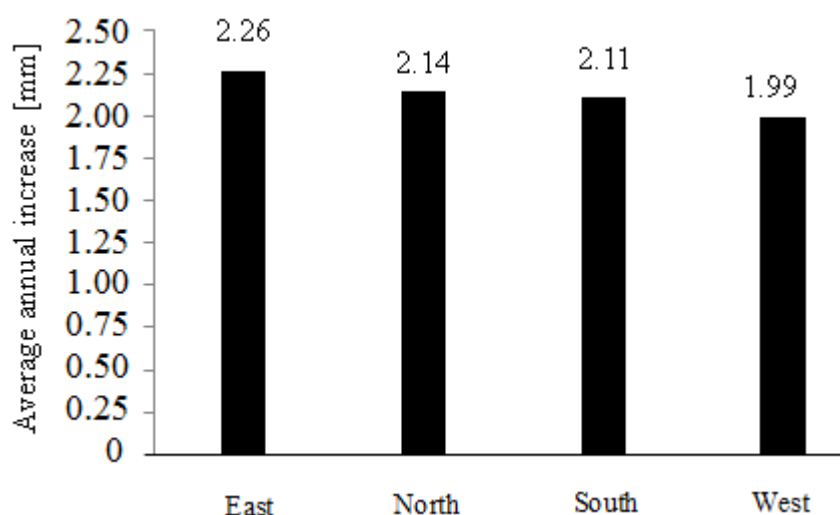


Figure 5. Average annual rings of Scots Pine on the provenance plot depending on geographical directions (NSWE).

The average density of wood divided the population from Rogów into two parts (Fig.6). The density variation in the population is 7.4 %. The tree with the highest density No. 152 had a density 1.3 times higher than the tree the lowest density - No. 138 (Fig. 6). The average density of pine wood from Rogów origin is 506 kg/m³ and the value is typical for the species, almost perfectly consistent with the average value given by Wagenführ (2007).

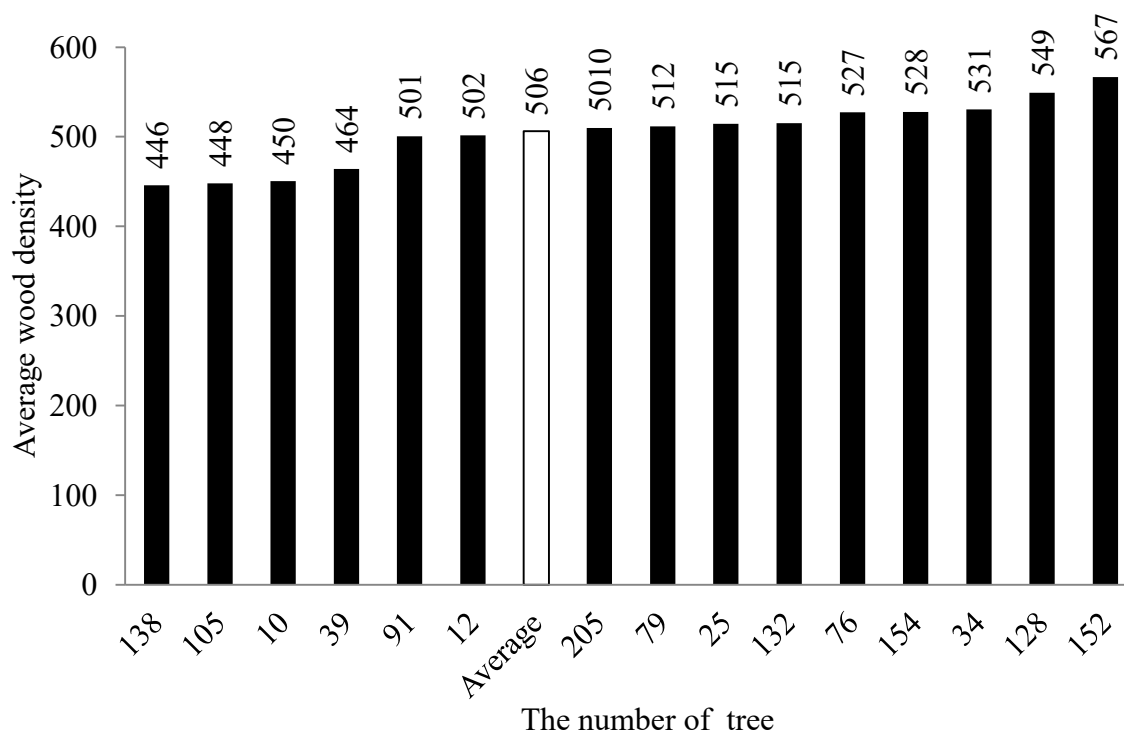


Figure 6. Average wood density of Rogów provenance Scots Pine on the provenance plot.

CONCLUSIONS

On the basis of investigation of dendrometric features of Scots pine trees and wood density from one of genetic origin Rogów, the following conclusions were formulated:

1. Genetic origin affects the growing stock in the same habitat. It also translates into differences in medium diameter at breast height and medium tree heights.
2. The analyzed origin Scots pine from Rogów is characterized rather by large diameter at breast high and low tree high, but typical for a 50-year-old pine tree stand.
3. The widest average annual rings was recorded in the eastern direction and the narrowest average annual rings in the western direction.
4. No relation was found between the average wood density and the average width of annual ring. The average density of air dry wood was typical and it was 506 kg/m³.

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Streszczenie: *Porównanie cech dendrometrycznych i gęstości drewna sosny zwyczajnej z wybranego pochodzenia genetycznego pozyskanego z powierzchni proveniencyjnej LZD w Rogowie. Sosna zwyczajna charakteryzuje się dużą zmiennością cech morfologiczno-pokrojowych i fizjologiczno-wzrostowych, co przekłada się także na wysoką zmienność gęstości drewna sosnowego. Powierzchnia proveniencyjna LZD w Rogowie została stworzona na potrzeby międzynarodowego projektu IUFRO w 1966 roku. Powierzchnia ta obejmuje 16 pochodzeń genetycznych sosny zwyczajnej, dokładnie opisanych, co sprawiło, że materiał badawczy z tego obszaru jest unikalny. W ramach niniejszej pracy przedstawiono wyniki pochodzenia nr 1 z Rogowa. Pod względem parametrów wzrostowych 50-o letnie sosny Rogowskie charakteryzują się typowymi parametrami dendrometrycznymi: średnia wysokość 19,47 m, średnia pierśnica 18,9 cm. Zasobność drzewostanu 278 m³/ha jest zgodna z wartościami tablicowymi. Pod względem słoistości drewno to wykazuje typową zmienność promieniową: szersze słoje przyrdzeniowe o stopniowo zmniejszającej się szerokości idąc w kierunku obwodu. Przy czym słoje na kierunku wschodnim od rdzenia są istotnie szersze, co wynika z obecności drobnych pasm twardzicy. Z tego w względu w badanej populacji nie uchwycono istotnej korelacji między szerokością słoików a gęstością drewna. Średnia gęstość drewna w stanie powietrzno suchym była również typowa i wyniosła 506 kg/m³. Pod względem badanych cech sosny zwyczajne pochodzenia rogowskiego nie wyróżniają na tle wartości tablicowych omawianego gatunku.*

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