Summary

The purpose of the present study was to find out the sources of variability in biometric traits of Scots pine needles among the factors determining the productivity of forest sites, whose influence on the variability of these needle traits is significant

The study was carried out in the whole range of Scots pine distribution in Poland. The research material consisted of needles of the second year collected from model trees selected and measured on 310 research plots. The description of trophic conditions was based on data from soil pits 80 cm deep. 21 bioclimatic variables were used to characterise climatic conditions. Spatial variability of biometric traits of Scots pine needles at the national scale was studied using multivariate analyses (cluster analysis, MDS and PCA). Using generalized additive models (GAM), the influence of site productivity factors on the variation in needle length and width of Scots pine was analyzed.

The mean length of Scots pine needles from all study plots was 68.68 mm and their mean width was 1.17 mm. Considering needle length, needle width, and geographic coordinates in the cluster analysis, two sets of model trees were distinguished, with the predominance of needles with length greater than average (long-needle set) and with length less than average (short-needle set). These sets split into seven subsets, the distribution of which appeared to largely follow the division of the country into natural forest regions.

Edaphic factors were most important for explaining variability in needle length and width, both for all model trees and for the aforementioned, more homogeneous sets of Scots pine trees. Among this group of factors, soil type, grain size, C/N ratio, and pH_{KCl} in the organic horizon appeared to be important with this respect. Climatic factors were the second most important in explaining the needle traits variability, especially for each of the two sets, which was confirmed by the fact that the distribution of the subsets largely corresponded to the dendroclimatic regions distinguished in Poland. For example, needle width variability was most significantly influenced by the temperature of the coldest month. As with the previous group of factors, the importance of topographic factors in explaining variability in needle biometric traits appeared to be greater for sets of long- and short-needle pine sets than for all model trees.

The spatial variability of biometric traits in Scots pine cannot be explained solely by the site shaping factors, as the specimen traits (model tree age, height, and position in the stand) and their genetic background also play important roles. The importance of specimen traits was particularly high when explaining needle length variation for model trees from all study plots and for trees from the short-needle pine set.

A total of 16 variables (site factors and specimen traits of model trees) were used in developing the final models. They explained between 27.8 and 52.1% of the variation in biometric traits of Scots pine needles. Both values concerned variation in needle width, the former from all study plots and the latter from the set of short-needle pine trees.

Furthermore, it was observed that the length of Scots pine needles increased between 51^{o} -53 ^{o} latitude and from west to east, while their width was smaller in these intervals while it increased from 53 ^{o} latitude onwards. There was a negative correlation of needle length with the age of model trees and a positive one with their height. The needles of pine trees growing in stands of the IInd and IIIrd age classes were 20 mm longer than those of pine trees growing in stands of older age classes. Needle width was negatively correlated with the age of model trees and with their height.

Key words: site productivity, Scots pine, needle biometric traits