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ZRÓŻNICOWANIE IGLIWIA SOSNY ZWYCZAJNEJ (*Pinus sylvestris* L.)

Abstract: The size of needles is usually described by their mass and length. These parameters depend on many factors, mainly on the amount of available water, light and temperature. The literature provides only rudimentary data on the surface of needles. But the surface of needles determines the growth of tree biomass, including wood, the product of the economic importance. The study aimed to verify if the mass of the needles is a good parameter to determine efficiency of the production in an individual pine or in population of pines. The material used consisted of needles from 48 model trees, collected at 31 study sites. All sites represented the same habitat type (fresh mixed coniferous forest), but they differed in the density and the age of trees. The study was conducted in young tree stands, between eight and twenty years old. We did not find any relation between the mean length of the needles and the age of trees. The shortest needles were found in 8 years old stand, and the longest needles came from 9 years old forest. The largest surface of the assimilation apparatus was found in a 20 years old pine. This corresponds with the culmination of the individuals' vertical growth in Scots Pine. The largest mass of the needles, 21 kg of the fresh mass, was recorded in the same tree stand, as well as the smallest and the largest number of needles on a tree.

Keywords: assimilation apparatus, needles, Scots Pine

The size of needles is usually described by their mass and length [1-3]. These parameters depend on many factors, mainly on the amount of available water, light and temperature [4]. Studies on the Scots Pine showed that the mass and the length of the needles was the largest in the top verticiles, and decreased regularly towards the base of the canopy [2]. The length of the needles was very variable even within a tree canopy [4]. The length of needles differed considerably between shoots that grew during different growth seasons. It has not been finally determined whether the needles reach their maximum dimensions during one growth season or are they still able to grow during following years.

We observed variation in the mass of the needles related with their location within the tree canopy. Needless in the side of the canopy exposed to sun are usually thicker and have thicker skin with xeric features than the needles at the shaded side, which are smaller and contain more water than those from the sunny side.

The literature provides only rudimentary data on the surface of needles. But the surface of needles determines the growth of tree biomass, including wood, and is the product of the economic importance. The study was aimed to compare two methods, the first one using the mass of needles and the second using the surface of needles, to calculate the efficiency of the biomass production in the Scots Pine.

Materials and methods

The material used consisted of needles from 48 model trees, collected at 31 study sites. All sites represented the same habitat type (fresh mixed coniferous forest), but they differed

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in the density and the age of trees. The study was conducted in young tree stands, between eight and twenty years old.

Study plots were established the Opole county, in the Niemodlin and Stobrawa Forests. All trees at the study plots were marked with individual numbers. Model trees were selected according to the variation of their diameters (d_0 or $d_{1,3}$) so that they were representative for the whole population. These trees were cut down, their needles were collected, and 1000 pairs of needles were selected from each tree and weighed to determine the number of needles at a whole tree. Analogously, 200 pairs of needles were measured for each model tree, to identify the length of the needles.

Results

The study showed that there was no direct relation between the mass of all needles and the age of a tree. Figure 1 shows the fresh mass of needles from model trees in relation to the age of trees. A 20 years old pine had the largest mass of needles - 21.14 kg. But a tree of the lowest mass of needles, only 0.20 kg, was found in the same population.

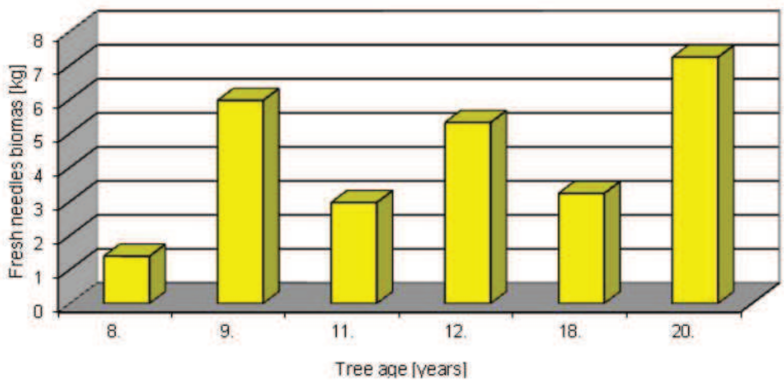

Fig. 1. The mean fresh mass of needles from model trees

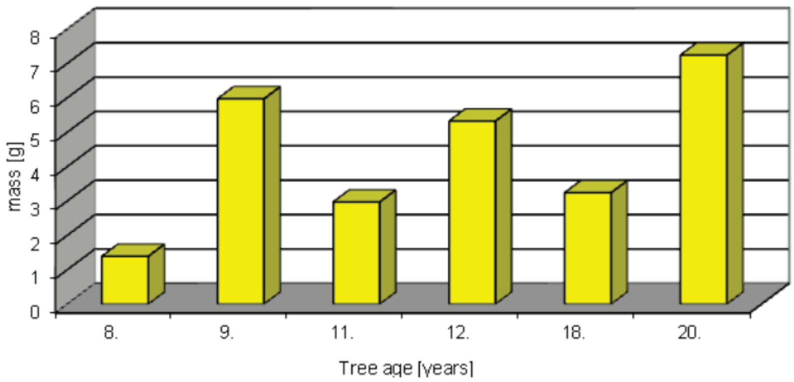

Fig. 2. The mean fresh mass of 1000 pairs of needles

The mean mass of 1000 pairs of needles was not related with the age of trees. The fresh mass of 1000 pairs of needles was between 55 g and 90 g in the tree stands of different age (Fig. 2). The mean length of needles was also not correlated with the age of the trees (Fig. 3). The number of needles at each tree was calculated from the proportion of the mass of all the needles at a tree to the mass of 1000 pairs of needles (Table 1).

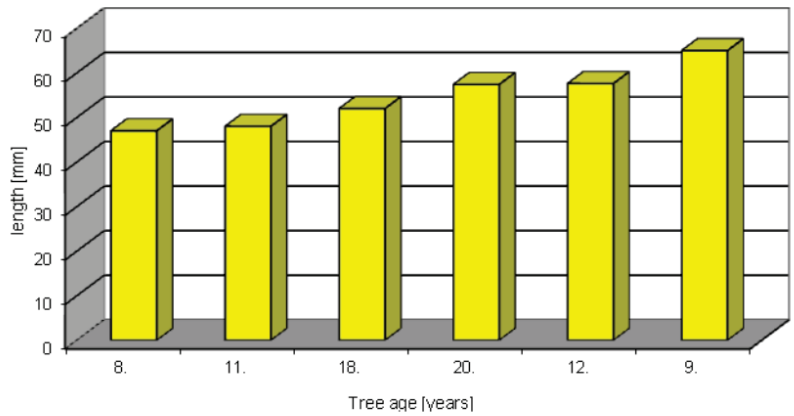

Fig. 3. The mean length of the needles

Table 1

The number of needles at the model tree

Tree age [years]	The number of needles at the model tree		
	Min	$\bar{x}$	Max
8	8901	24 075	46 861
9	1980	57 734	167 735
20	934	113 815	309 589

Knowing the surface of a needle of a given length and its mass we calculated the surface of all needles at each model tree. Having diameters of all the trees in a study plot and knowing the diameters of the model trees, we calculated the surface of needles if all trees in the study plot by interpolation. The 20 years old tree stand had the largest surface of needles (Table 2) [5].

Table 2

The surface of the assimilation apparatus

Stand age [years]	The surface of the assimilation apparatus [m^2/ha]	Relative values
8	37 318	0.30
11	65 955	0.53
18	89 953	0.73
20	123 399	1.0

The measurements of the length of needles, the number of pairs of needles in a tree canopy, the mass of 1000 pairs of needles and the mass of all needles at a tree, showed high variation of these features among trees of the same age and among the populations of Scots Pine of different age [5]. High inter-specific variability of the Scots Pine is the reason why pines of low and high mass of needles occurred next to each other. The density had a clear effect on the differences in the mass of the needles between pine populations of different age. Up to a certain level of competition between pines for resources required for life, individuals are not eliminated from the community but their size decreases and different features of the tree (stem, branches, needles) adapt to the density.

Analysing the relation between the growth of the biomass (Δm) and the mass of needles (m_l) in an individual tree, we noted that the increment increased with the increase of the mass of needles, but gradually slower. Because of the shade the lowest needles in the tree canopy are at the threshold of the natural compensation point, where the photosynthesis equals respiration within the 24-hours cycle. Thus these needles do not take part in the production of the wood biomass despite they enlarge the surface of the assimilation apparatus. This is because the needles from the upper part of the canopy shade the needles below, and this shading is the highest the largest is the mass of the needles. This probably affects the total production of the biomass.

Conclusions

1. The study showed that the assimilation surface of the needles provides a more accurate measure of the biomass production than the mass of the needles.
2. With the same mass of the needles, the photosynthetic surface can be up to four times higher with small needles, than with large needles.

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ZRÓŻNICOWANIE IGLIWIA SOSNY ZWYCZAJNEJ (*Pinus sylvestris* L.)

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Abstrakt: Wielkość szpilek charakteryzuje się najczęściej poprzez ich masę i długość, które zależą od wielu czynników, przede wszystkim od ilości wody, światła i temperatury. W literaturze przedmiotu znajdują się szczątkowe dane dotyczące pola powierzchni szpilek, które to decydują o przyroście biomasy, w tym drewna, czyli sortymentu ważnego z punktu widzenia gospodarczego. Celem badań było porównanie dwóch metod obliczeń wydajności produkcyjnej biomasy sosny zwyczajnej z ciężaru igliwia oraz z jego powierzchni. Materiał do badań stanowiło igliwie z 48 drzew modelowych pobranych z 31 stanowisk badawczych. Wszystkie powierzchnie reprezentowały ten sam typ siedliskowy (BMśw.), różniły się natomiast zagęszczeniem i wiekiem. Badania prowadzono w młodnikach, z których najmłodszy liczył 8 lat, a najstarszy 20 lat. Nie stwierdzono związku między średnią długością igieł a wiekiem drzew. Najkrótsze szpilki odnotowano w 8-letnim młodniku, najdłuższe 9-letnim. Największe pole aparatu asymilacyjnego miała 20-letnia sosna, co pokrywa się z kulminacyjnym przyrostem osobników na wysokość. W tym drzewostanie zarejestrowano również największą masę igliwia wynoszącą 21 kg (św.m.) oraz największą, a zarazem najmniejszą liczbę szpilek.

Słowa kluczowe: aparat asymilacyjny, igliwie, sosna zwyczajna