PHYSIOLOGICAL AND GROWTH CHARACTERISTICS OF WHITE WILLOW (*SALIX ALBA* L.) CLONES

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ABSTRACT:

The samples from field experiment on five clones of white willow (Salix alba L.) in the adult phase, was investigated as follows: net photosynthesis and dark respiration, number and size of stomata and elements of growth (tree diameters and heights). The aim of the research is to determine if there are any relations between these physiological characters and the elements of growth, i.e. if any of them can be utilized in the early selection for growth vigor. The results show that all the characters are characterized by low coefficients of variation, statistically highly significant differences and high coefficients of heritability in a broad sense. As for the net of photosynthesis, the number of stomata on the adaxial and abaxial sides of the leaf is in high correlation with the elements of growth, which indicates that they can be used in the early selection for growth vigor.

Key words:

White willow, physiological characters, growth elements

1. INTRODUCTION

Tree-shaped willows in the conditions of Serbia are very important because they grow on the soils of heavier particle size composition and, in contrast to the other tree species on the alluvium, they can tolerate longer flood periods. In the sites where flood periods are too long for poplars, intensive experimental-production plantations of white willow are established from clonal material obtained by long-term breeding. Because of their high rate of growth, simple methods of regeneration, multiple use primarily in chemical [6] and mechanical processing of wood [7], willows are very suitable for research. Recently, the importance of this species has increased because of the creation of good conditions for the establishment of energy plantations, especially in the Scandinavian countries [15].

Previous work and research of tree-shaped willow breeding [7], was based on the selection for the straightness of the stem and fast growth, utilization of the effects of spontaneous mutations and inter-species hybridization. In addition, much attention was drawn to the research of its adaptive value, i.e. the width of reaction norm [7, 15], requirements of mineral nutrients [5], as well as its ability to form adventitious roots, in the aim of the maximum utilization of this species genetic potential. So far the research mainly included quantitative characters and genetic and phenotypic correlation willows [8], so as to increase the efficiency of selection.According to the available references, insufficient attention was drawn to the possibility of utilization of physiological characters in the early selection for growth vigor of white willow clones. Nowadays, in forest tree breeding, the trend is to make the time needed for the

creation of varieties maximally short. In this aim, structurally functional relations are researched (anatomical structure of plant organs and physiological processes) which enables the definition of characters based on which the genotypes with desirable properties can be recognized in the earliest possible ontogenetical phase [13]. The successful resolving of this problem shortens the period necessary for the research and lowers the financials [2]. One of the most desirable properties of willows, along with the low susceptibility to diseases and insects, is growth vigor. It is the result of complex genetic interactions, i.e. interactions of the genotype and the environment [11].

This paper presents the results of the research of variability of several physiological characters of white willow clones, in the aim to research their potential utilization in the selection for growth vigor.

2. MATERIAL AND METHOD

The research in field conditions was carried out on the samples from field experiment. The experiment was established from the clones of *Salix alba* in 1983 by deep planting with seedlings 1/0, spacing 4.25 m x 4.25 m on fluvisol at Kac forest (45^o 17' N, 19^o 53' E, Elevation 76 m). In autumn 1995 the samples of completely formed leaves exposed to light were determined as follows: net of photosynthesis and dark respiration, and the number and size of stomata. Diameters were measured at the height of 1.30 m and tree heights precisely to within 10 cm.

The leaf samples were taken from the top of the crown and all analyses and measurements have been done on the completed formed leaves fully exposed to light. The net photosynthesis and dark respiration were determined polarographically, by using Clark′s electrode. The net of respiration was determined by the quantity of absorbed oxygen (in the dark) and photosynthesis by the quantity of released oxygen in μmol m^{-2} s^{-1}. In the analysis, very thin leaf slices (up to 0.5 mm). The process of photosynthesis was carried out under complete saturation with white light produced by quartz -iodine lamp. The number and size of stomata was determined by the Wolf [18] method. By this method, microscopic preparations were made and the number of stomata per mm^2 was determined as well as their length and width in μm. The data were processed by the standard statistical method, and the table presents the arithmetical means, coefficients of variation, LSD test, correlations and heritability in the broad sense (by the formula: $h^2_{bs} = \frac{\sigma^2_c}{\sigma^2_c + \sigma^2_e}$; σ^2_c-Genotypic variance; σ^2_e=Environmental variance) [19]

3. RESULTS

Table 1 presents the results of the research of net photosynthesis and dark respiration intensities. The results show that the highest net (rate) was that of the clone 107/65/6 with 17.14 μmol $m^{-1}s^{-1}$, and the lowest was 282 (12.52 μmol $m^{-1}s^{-1}$). The highest intraclonal variability of this parameter was measured for the clone 377 (11.00%), and the lowest for the clone 107/65/8 (7.77%). LSD test determined that all the clones except the clone 282 occur within one interval of homogeneity, i.e. that between them there are no statistically significant differences.

Respiration net (rate) was the highest for the clone 73/64/8 (11.70 μmol $m^{-1}s^{-1}$), and the lowest for the clone 107/65/8 (7.47 μmol $m^{-1}s^{-1}$). The characteristic of this parameter is that three clones (378, 107/65/6, 377) had very low, and the other two clones (73/64/8 and 282) had high coefficients of variation. By the analysis of variance, it was observed that the differences between the clones were statistically

highly significant, which is also proved by LSD test, by which the researched clones were grouped into two intervals of homogeneity.

For the net photosynthesis and dark respiration, very high coefficients of heritability in the broad sense were obtained (photosynthesis 0.91 and respiration 0.90). The number and size of leaf stomata in the researched white willow clones have been shown in Table 1. The results of the research show that all the clones had a higher number of stomata on the abaxial compared to the adaxial surface. The highest number of stomata per mm^2 of leaf area was in the clone 377 (81 adaxial and 91 abaxial), and the lowest number was in the clone 282 (51 adaxial and 61 abaxial). LSD test produced several intervals of homogeneity, which means that the clones showed the highly significant statistical difference.

The stomatal length on the upper epidermis (adaxial) ranged between 21.92 μm (clone 378) to 26.60 μm (clone 73/64/8). On the lower epidermis (abaxial), stomatal length ranged between 22.12 μm to 29.76 μm. As for this parameter, statistically highly significant differences were observed on both surfaces of the leaf. The largest width of stomata on both surfaces of the leaf was found for the clone 377 (22.60μm adaxial and 19.76μm abaxial), and the smallest width, for the clone 107/65/6 (14.40μm) on the adaxial and 73/64/8 (15.88μm) on the abaxial epidermis.

All the stomatal characters (number, length and width) are characterized by high coefficients of heritability in the broad sense and low coefficients of variation.

The largest tree diameters (Table 1) were in the clone 377 (15.75 cm), and the smallest - the clone 282 (14.55 cm). As for this parameter, the analysis of variance showed statistically highly significant differences between the clones, which is also proved by the Height growth (Table 1) was best for the clone 377 (18.45 m), and the least for the clone 378 (12.45 m). LSD test showed the existence of two intervals of homogeneity, which means that, as regards this parameter, the clones showed statistically highly significant differences.

The correlation analysis was performed in order to research the relationship between the analyzed physiological characters and the elements of growth. Table 1 shows the coefficient of correlation between the researched characters and the elements of growth. The results show that the following were in high positive correlation with tree diameters: net photosynthesis, stoma number (adaxial and abaxial) and stoma width (adaxial), and with tree height: net photosynthesis, stoma number (adaxial) and stoma width (adaxial).

4. DISCUSSION

The results of the research of several physiological characters and elements of growth indicate that there is a very marked variability within the species *Salix alba*. The greatest number of these characters is characterized by low coefficients of variation and by statistically significant differences between the clones, which leads to a conclusion that these characters are under genetic control to a high extent. The net photosynthesis and respiration were within the limits of previous researches by several authors [14].

The net photosynthesis was in a high positive correlation with the elements of growth, which has so far been observed for several woody species: poplars [4,11,12], larch [9,10]. This means practically that this parameter can be used unfailingly in the selection for growth vigor. The number of stomata on the upper epidermis (adaxial) was also in the positive correlation with the elements of growth, which has already been observed for the clones of black poplar [11,13]. The researched physiological

characters are characterized by high coefficients of heritability in the broad sense (h^2_{bs}), which has a high significance in the enhancement of selection methods in the aim of maximum utilization of the genetic potential of tree-shaped willows.

5. REFERENCES

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