INFLUENCE OF ACORN SIZE ON MORPHOLOGICAL CHARACTERISTICS OF ONE-YEAR-OLD NORTHERN RED OAK (Quercus rubra L.) SEEDLINGS

Vladan Popović, Aleksandar Lučić*, Ljubinko Rakonjac, Tatjana Ćirković-Mitrović and Ljiljana Brašanac-Bosanac

Institute of Forestry, Belgrade, Serbia

*Corresponding author: aleksandar.lucic@gmail.com

Abstract: The aim of this research was to examine the influence of acorn size on morphological characteristics of one-year-old Northern red oak (Quercus rubra L.) seedlings. The quality of seedlings correlates with the quality of the seed they are derived from. In species with large seeds, as in the case of Northern red oak, the seedling growth in the first growing season is closely related to seed size or the amount of reserve nutrients that are stored in the seed. The height and root collar diameter of one-year-old Northern red oak seedlings increases with increase in acorn size. The results obtained in this research can be used as a guideline for acorn grading, because they show that improved Northern red oak seedlings quality can be achieved using seeds of appropriate size.

Key words: Northern red oak; acorns; one-year-old seedlings

Received: January 21, 2015; Revised: February 9, 2015; Accepted: February 10, 2015

INTRODUCTION

Allochthonous tree species in the environmental conditions of Serbia have a specific population structure characterized by a small number of cultivated trees and underrepresentation of larger stands. Knowledge of the biology of allochthonous tree species is important, primarily for their successful adaptation to new habitats and the establishment of stable stands. Natural regeneration in artificially established stands in our environmental conditions is underrepresented, especially in the case of allochthonous tree species. Special attention should be paid to those factors that cannot be affected by silvicultural operations with the aim of ensuring the natural regeneration of forest stands. One of the most important factors in natural regeneration and the establishment of stable stands is a regular yield of quality seeds. Irregular yield of seeds and problems that occur in the natural regeneration of forest stands are reasons for the continuing increase in demand for forest seedlings. In increasing the amount of seedlings, it is also necessary to increase the production of better quality seedlings, which will ensure success when replanting in the field.

Seed size as a key factor in the initial growth and development of plants has been studied for many years. The study of several species of European and American oaks showed that acorn size has a positive effect on germination percent, shoot growth, survival rate, shoot:root ratio and faster recovery of seedlings from defoliation (Korstian, 1927, McComb, 1934, Tripathi and Khan, 1990, Tecklin and McCreary, 1991, Bonfil, 1998, Roth et al., 2009, Roth et al., 2011, Ivanković et al., 2011).

The influence of acorn size is most pronounced during germination and the first growing season. It is characteristic for all oak trees that during germination the roots develop first, followed by the taproot whereby the reserve nutrients stored in the acorn are used. As long as there is a stock of nutrients in the acorn, the seedling should develop three to four leaves (Roth et al., 2011).
The goal of this research is to examine the influence of acorn size on the morphological characteristics of one-year-old Northern red oak seedlings during the first growing season, especially the influence on the seedling height and the root collar diameter.

MATERIALS AND METHODS

Acorns from the 2011 yield originating from seed stand RS-2-2-qru-00-219, FE “Košutnjak” 4a, FMU Belgrade, were used for this research. After collection, the acorns were semidried to 35% of moisture and stored in cold storage at the temperature of 3°C.

To determine the criteria by which the acorns are sorted into size classes, measurements of mass, length and diameter of the acorns were carried out before sowing. The measurements were performed on a sample of 300 acorns. The length and diameter of the acorns were measured by vernier scale with an accuracy of 0.01 mm. Mass was measured by electronic scale with an accuracy of 0.01 g. After measurement, the acorns were classified into three categories based on mass: small acorns (≤5.50 g), medium-large acorns (5.51-7.00 g) and large acorns (≥7.01 g).

The experiment was set up in the seedling nursery of the Institute of Forestry in Belgrade. The acorns were sown in April 2012. Experiments were replicated three times (in each replication all three acorn size categories were represented). Three hundred pieces of acorn (3x100) per acorn size category were sown. The seedbed (dimensions 9 x 1m) was divided into 9 equal fields measuring 1 x 1 m. In each field, a total of 100 acorns at a distance 10 x 10 cm were sown. After sowing, the seeds were covered with a soil layer of about 3 cm.

During the first growing season the dynamics of germination were monitored, and weeding, hoeing and watering were performed. At the end of the growing season, the seedling height and root collar diameter were measured.

The relation between mass and length of the acorns and between mass and diameter of the acorns was examined by linear regression analysis. The influence of acorn size on morphological parameters (height of seedlings and root collar diameter) of one-year-old seedlings was tested by analysis of variance (ANOVA). Mean values were separated using a post-hoc test, with significance level of p<0.05. Statistical analyses were performed in the software package Statgraph 6.0.

RESULTS AND DISCUSSION

Acorn mass is strongly linked to acorn diameter ($R^2=0.9362$) than to length ($R^2=0.7308$) (Fig. 1). A stronger relationship between acorn mass and diameter was determined in Pedunculate oak (Roth et al., 2011) and it is recommended to use the acorn diameter as the measure for size ranking. In species of the genus *Quercus*, a very strong correlation was found between fresh acorn mass and the mass of dry matter of cotyledons (Bonfil, 1998), and between acorn size and the content of nutrient reserves (Tripathi and Khan, 1990). Acorn diameter as a stronger indica-
The variability of morphometric characteristics of Northern red oak seedlings, post-hoc test.

<table>
<thead>
<tr>
<th>Acorn size class</th>
<th>Root collar diameter (mm)</th>
<th>Height of seedlings (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean value</td>
<td>Min</td>
</tr>
<tr>
<td>1</td>
<td>3.20&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.21</td>
</tr>
<tr>
<td>2</td>
<td>3.94&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.01</td>
</tr>
<tr>
<td>3</td>
<td>4.32&lt;sup&gt;c&lt;/sup&gt;</td>
<td>3.34</td>
</tr>
</tbody>
</table>

Values in the same columns followed by different letters are statistically different at p<0.05.

Table 2. Analysis of variance for morphometric characteristics of one-year-old seedlings.

<table>
<thead>
<tr>
<th>Root collar diameter</th>
<th>Sum of squares</th>
<th>Mean square</th>
<th>F – ratio</th>
<th>P – value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups</td>
<td>15.8329</td>
<td>7.91645</td>
<td>37.70</td>
<td>0.0000</td>
</tr>
<tr>
<td>Within groups</td>
<td>27.0897</td>
<td>0.209997</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>42.9226</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Height of seedlings</th>
<th>Sum of squares</th>
<th>Mean square</th>
<th>F – ratio</th>
<th>P – value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups</td>
<td>1055.45</td>
<td>527.725</td>
<td>68.04</td>
<td>0.0000</td>
</tr>
<tr>
<td>Within groups</td>
<td>1000.57</td>
<td>7.75636</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2056.02</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The minimum value of root collar diameter (2.21 mm) was measured in seedlings produced from the smallest acorns (acorn size class 1) and the maximum value (5.54 mm) was measured in seedlings produced from the largest acorns (acorn size class 3) (Table 1). The minimum value of the height of seedlings (7.8 cm) was measured in seedlings produced from the smallest acorns (acorn size class 1) and the maximum value (26.5 cm) was measured in seedlings produced from the largest acorns (acorn size class 3) Table 1.

ANOVA results showed statistically significant differences (p<0.05) between root collar diameter and height of seedlings produced from the three acorn size classes (Table 2). The post-hoc test showed clear separation into three homogeneous groups (Table 1). For root collar diameter and height, seedlings of acorn size class 1 are in a homogenous group with the lowest values, while the seedlings of acorn size class 3 are in a homogenous group with the highest values.

The results of this study have a practical value. They indicate that the use of larger seeds will ensure the production of better quality Northern red oak seedlings, which has a positive effect on replanting
seedlings and certainly increases the economic effects of nursery production.

Acknowledgments: The research is financed by the Ministry of Science and Technological Development of the Republic of Serbia, Project TR 31070 “The development of technological procedures in forestry with a view to an optimum forest cover realization” (2011-2014).

REFERENCES


Roth, V., Dubravac, T., Pilaš, I., Dekanić, S. and Z. Brekalo (2009). Acorn size of Pedunculate oak (Quercus robur L.) and Sessile oak (Quercus petraea Liebl.) as a factor in growth and development of seedlings. Šum. list. CXXXIII (5-6), 257-266.


Tripathi, R.S. and M.L. Khan, (1990). Effects of seed mass and microsite characteristics on germination and seedling fitness in two species of Quercus in a subtropical wet hill forest. Oikos. 57, 289-296.