

AGROSYM

BOOK OF PROCEEDINGS



*XV International Scientific Agriculture Symposium
"Agrosym 2024"
Jahorina, October 10-13, 2024*

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“AGROSYM 2024”**



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Technical editors

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PREFACE

Dear colleagues,

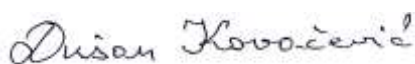
It is with great pleasure that I introduce the *Book of Proceedings* for the 15th International Scientific Agricultural Symposium “AGROSYM 2024.” I trust that you will find it a valuable resource in your work. This year, around 800 contributions have been accepted for inclusion in the *Book of Abstracts*. The themes of AGROSYM 2024 span the full spectrum of agricultural sciences, divided into seven key sessions: 1) Plant Production, 2) Plant Protection and Food Safety, 3) Organic Agriculture, 4) Environmental Protection and Natural Resource Management, 5) Animal Husbandry, 6) Rural Development and Agro-Economy, and 7) Forestry and Agroforestry.

There is growing consensus among scholars and practitioners that technological innovations have the potential to boost agricultural production, enhance supply stability, and reduce the environmental impact of farming. Technology has been especially pivotal in increasing the productivity of annual crops such as maize, rice, soybeans, wheat, and cotton. However, with trees having longer growth cycles, breeding programs for these crops require more time. New plant breeding techniques promise improvements in productivity, but they have sparked an ongoing academic debate regarding their advantages and drawbacks.

While much of the focus in the past has been on the production side of agriculture (e.g., productivity and efficiency), there is an increasing emphasis today on the consumption side and the intermediate stages of the food chain, such as processing and distribution. This shift is driving the transition toward a “farm-to-fork” approach. Globally, consumers are sending clearer signals about their preferences for higher quality, healthier, safer, and more flavorful products. In response, many agri-food companies are exploring innovative ways to gain greater control over production processes and ensure the quality and safety of final products. Furthermore, changes in investment strategies hold the potential to reduce the environmental and social costs of agriculture. It has become increasingly clear to investors that companies that prioritize sustainability and social responsibility tend to yield better long-term returns.

Agri-food systems are at the heart of global discussions surrounding sustainable development and the achievement of the United Nations Sustainable Development Goals (SDGs) by 2030. These systems are deeply connected to numerous global challenges, including climate change, poverty, food insecurity, biodiversity loss, resource depletion, and ecosystem degradation. A key goal of the sustainable agriculture movement is to create farming systems that mitigate or eliminate the environmental harms associated with industrial agriculture. Additionally, it is critical to improve the resilience of food systems to crises, shocks, and pandemics.

I would like to extend my heartfelt thanks to all the authors, reviewers, and colleagues who contributed to the editing of the *Book of Abstracts*. Special thanks are due to our co-organizers and partners for their unwavering collaboration and comprehensive support throughout this endeavor.



East Sarajevo, 10 October 2024

Prof. Dušan Kovačević, PhD

Editor in Chief, President of the Scientific Committee of AGROSYM 2024

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FORESTRY AND AGRO- FORESTRY

VARIABILITY OF VESSELS AND WOOD RAYS DENSITY BY CONTAINER SEEDLINGS OF DIFFERENT SPECIES FROM QUERCUS GENERA

Dušan JOKANOVIĆ^{1*}, Vesna NIKOLIĆ JOKANOVIĆ¹, Kristina ŽIVANOVIĆ², Marko MARINKOVIĆ³, Filip JOVANOVIĆ⁴

¹Faculty of Forestry, University of Belgrade, Serbia

²Institute for Multidisciplinary Research, University of Belgrade, Serbia

³PE „Vojvodinašume“, Preradovićeve 2, Petrovaradin, Serbia

⁴Institute of Forestry, Belgrade, Serbia

*Corresponding author: dusan.jokanovic@sfb.bg.ac.rs

Abstract

The anatomical traits of one-year old container seedlings of three species from *Quercus* genera – *Quercus robur*, *Quercus petraea* and *Quercus frainetto* were analyzed. Seedlings were planted in the same type of container. The scope of the paper was to establish density of vessels and wood rays per 1 mm². These two anatomical elements play a very significant role – vessels are conductive elements responsible for water and minerals moving from the root to the upper parts of the tree, while wood rays are in charge of nutrients storage. The obtained results showed that the greatest density of both anatomical elements was recorded by *Q. petraea* (110.07 vessels, and 34.07 wood rays per mm²) which means that this species had the narrowest vessels and wood rays. On the other hand, in *Q. robur* we found presence of 102.1 vessels, and 24.93 wood rays per mm², while *Q. frainetto* had the lowest vessels density (97.03), but came to the second place in terms of wood rays density (33.07). As for the possibility of using of investigated oaks container seedlings for reforestation purposes, *Q. petraea* would be more suitable for arid sites, according to the greatest density of vessels and wood rays, which should be related to the lowest width of these elements. Bearing in mind this fact, we can deduce that narrower vessels are more efficient for conducting, while smaller wood rays can store enough nutrients for a short time. However, in order to obtain reliable conclusions, in addition to analyzed parameters, it is needed to investigate some morphological (height and root collar diameter) and anatomical (vessels width, wood rays width and height) traits.

Key words: *Q.petraea*, *Q.robur*, *Q.frainetto*, vessels density, wood rays density.

Introduction

For decades, nursery production has been faced with a choice – container or bare-root seedlings. Container seedlings have many advantages compared to these produced in conventional manner: higher survival rate; lower physiological shock of seedlings during replanting; extended period of planting in spring, and earlier onset of planting in autumn, as well; afforestation of degraded sites; mechanical tools can be used during production and planting which reduce the overall costs; human activity is less needed while planting is performing (Matić et al., 1996; Ocvirek 1997; Orešković et al., 2006; Popović et al., 2014). On the other hand, the main disadvantage of container seedlings is related to irregular shape and deformation of the root system which causes many difficulties during outplanting process (Stilinović, 1991; Ivetić, 2013, 2021). The volume of the container greatly affects the growth and development of the plant, as well as its later performance after transplanting (Ivetić 2013, 2021). When we talk about forest seedlings, smaller containers are more desirable according to lower price, easy handling, and greater plants density per unit area and species with small

seed are often produced in this container type (Ivetić, 2013; Popović et al., 2014). However, larger containers are more suitable for species with big seed and strong root system (Ocvirek, 1997; Topić et al., 2006). Grossnickle (2012) claim that the most significant morphological feature that affects significantly development and growth of seedlings is root collar diameter. In terms of wood rays and tracheids dimensions, Jokanović et al. (2024 a) found these traits depend a lot on the species and container volume, as well. Wood rays are in charge of conducting nutrients through the plant and play a very significant role by hardwoods, particularly in winter when the leaves have fallen (Vilotić, 2019). As a result, all nutrients by these species in this time are stored in wood rays. Conductive elements (Jokanović et al., 2024 a) enable transport of water and mineral substances from the root to the aboveground parts of the tree. The same authors found that a smaller diameter of conductive elements is usually found in arid habitats in order to transport the small amounts of available water as efficiently as possible through the plant.

The aim of the paper is to analyse two anatomical traits (wood rays density and vessels density) in three different oak species (*Q.robur*, *Q.petraea*, *Q.frainetto*) produced in the same container type. The obtained results could indicate which of these species would be the most suitable for afforestation of difficult sites, taking into account that in order to make such conclusions it is necessary to investigate some additional anatomical and also morphological traits of the seedlings.

Material and Methods

Bosnaplast 180 container, made of plastic, was used for cultivation of investigated oak species. Seeds were collected from Gornji Srem (*Q.robur*), Fruška Gora (*Q.petraea*) and Lipovica (*Q.frainetto*). Container seedlings were produced in the nursery situated in Sremska Mitrovica that belongs to the PE „Vojvodinašume“. At the end of the growing season 2022, containers were filled manually during sowing. Plants were regularly watered, especially during hot summer. According to the producer instruction, Fitogal Galenika, Serbia, foliar fertilization was performed twice a week during June and July. Systemic fungicide Previcur was used in order to protect young individuals from pests attack. Onset of *Q.robur* seed germination was in the middle of April and lasted until the end of May, while for the other two species it started a few weeks later. At the end of the growing season, 30 saplings per species were lifted and transported to the laboratory in order to carry out necessary anatomical analysis. 30 wood rays and 30 vessels per unit area were measured for each species (Figure 1).

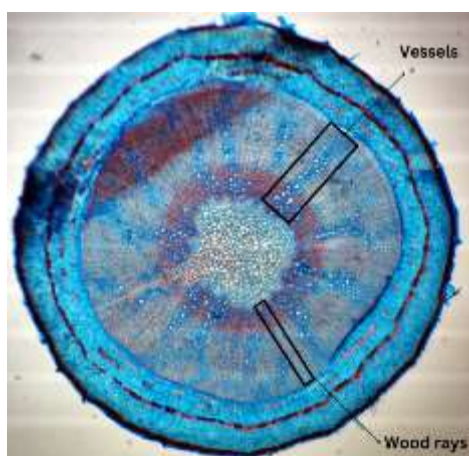


Figure 1. Display of analyzed anatomical traits

Anatomical analysis was conducted on permanent anatomical preparations made on transversal samples which were obtained by previous softening of the whole material, firstly kept in boiling water, and then in the mixture of water, glycerol and ethanol in the same volume proportions. The samples were cut using sliding microtome „Reichert“ in transversal segments 20-25 microns thick. The vessels are circular in shape and are scattered within the growth ring, unlike the wood rays that extend radially from the pith to the bark. All measurements were taken using a Boeco microscope that contains specialized software with calibration to recalculate the obtained dimensions of the investigated elements.

Regarding the measurement of the density of vessels and wood rays, 30 measuring fields were randomly selected and on each one the amount of vessels and wood rays was counted separately. After that the area of each measuring field was calculated and the number of studied anatomical traits was converted to area of 1 mm² using a simple proportion. It should be noted that only completely formed vessels and wood rays were taken into consideration.

The numerical data was processed using descriptive statistics. There were determined mean value, minimum, maximum, and for each mean value, standard deviation and coefficient of variation were calculated, as well.

Results and Discussion

Based on the obtained results for vessels density (Table 1) we can deduce that the greatest number of these conductive elements per unit area was recorded in *Q.petraea*, then *Q.robur* came to the second place, and finally *Q.frainetto*. As for standard deviation and coefficient of variation, there was no big difference between investigated species. A low degree of variability (0-10 %) was detected for all analyzed oaks.

Table 1. Descriptive statistics of vessels density per unit area

	<i>Q.robur</i>	<i>Q.petraea</i>	<i>Q.frainetto</i>
Mean value	102.1	110.07	97.03
Minimum	82	95	85
Maximum	115	123	110
Standard deviation	7.95	7.86	6.04
Coefficient of variation (%)	7.79	7.14	6.22

Number of wood rays per unit area (Table 2) is again the highest in *Q.petraea*, while the lowest values were established in *Q.robur*. In terms of this anatomical element, a very similar standard deviation was recorded in *Q.robur* and *Q.petraea*, while this value was two times less in *Q.frainetto*. As for the coefficient of variation, a very diverse trend was found – a low degree of variability was recorded in *Q.frainetto* (0-10 %), then moderate in *Q.petraea* (10-20 %) and strong in *Q.robur* (over 20 %).

Table 2. Descriptive statistics of wood rays density per unit area

	<i>Q.robur</i>	<i>Q.petraea</i>	<i>Q.frainetto</i>
Mean value	24.93	34.07	33.07
Minimum	16	22	27
Maximum	40	45	38
Standard deviation	6.61	6.75	3.30
Coefficient of variation (%)	26.51	19.81	9.98

The highest number of vessels and wood rays per unit area in *Q.petraea* (Table 1 and 2) can be associated with the very small width of these elements, which implies that saplings of these species could be used for afforestation of dry sites, taking into account that the small width of the conductive elements means a greater efficiency of conducting. In addition to that, a greater number of wood rays allows large amounts of nutrients to be stored, which is especially important for hardwoods when the growing season stops, because their leaves have fallen and all nutrients are accumulated in wood rays. However, it is needed to be said when recommending planting material for afforestation, it is necessary to consider the dimensions of the morphological and anatomical traits of the seedlings, as well as the shape and development characteristics of the root system in order to make the right decision (Orešković et al., 2006; Kolevska et al., 2020; Mijatović et al., 2022; Jokačević et al., 2024 a).

Jokačević et al. (2024 a) found that container volume affected very much the dimensions of the anatomical traits in Scots pine and black pine seedlings – by larger containers, both wood rays and tracheid width had significantly higher mean values. Martin et al. (2010) investigated how different ecological conditions affected wood anatomical traits by Scots pine and established that trees grew in the driest regions had a very large tracheid lumens, while cell walls were thick, and the number of ray tracheids was very high which enabled a great storing capacity in the sapwood. However, Esteban et al. (2012) found that black pine trees in arid environment had short tracheids which can be associated with their poor growth, while at higher altitudes these plants tended to form very large resin ducts as a physiological and physical barrier. In our paper, two anatomical traits of one-year-old seedlings of three oak species that were grown in the same habitat conditions (one type of container) were analyzed, and some differences, mainly caused by the bioecological features of the investigated species, were established. Jokačević et al. (2024 b) investigated the influence of pollutants on the morpho-anatomical traits of four willow clones and found that the vessel diameter and wood rays height were higher in the control compared to the contaminated site. Significant differences were also detected between individual clones in the same site conditions, especially when it comes to vessel diameter, which can be linked to the genetic characteristics of these clones.

Conclusions

In the paper was investigated the variability of two anatomical parameters (vessels density and wood rays density) in three different *Quercus* species (*Q.robur*, *Q.petraea*, *Q.frainetto*) cultivated in the same type of container. Based on the obtained results, the highest values of both traits were established in *Q.petraea* seedlings. As for the number of vessels, *Q.robur* came to the second place unlike wood rays density. The analysis of the dispersion elements of the probability distribution shows there are no major differences in the values of standard deviation and the coefficient of variation between the investigated species for vessel density. However, in the case of wood rays density, the value of the standard deviation is two times less in *Q.frainetto* compared to the other oaks, and the coefficient of variation differs significantly between the species.

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