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MORPHO-ANATOMICAL TRAITS OF *QUERCUS CERRIS* AND *Q. RUBRA* ONE-YEAR-OLD SEEDLINGS CULTIVATED IN DIFFERENT CONTAINER TYPES

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ABSTRACT

The paper investigated the variability of the morphological-anatomical traits of one-year-old oak seedlings (*Quercus cerris* L. and *Quercus rubra* L.) produced in three different container types (Hiko, Plantagrah, biodegradable). A two-factorial ANOVA showed for the morphological characteristics (root collar diameter and height) statistically significant difference between the species and between the containers, too. The interaction between the variability factors (container type and species) also affects height and root collar diameter. As for the obtained results of two-factorial ANOVA for anatomical parameters (wood, bark, pith proportion, and vessel width), statistically significant differences were obtained for all of them between species, as well as between container types. On the other hand, the interaction of container type and species does not affect vessel width and bark content unlike wood and pith proportion. Comparing the species, it can be concluded that the average values of all traits, apart from vessel width, are higher in *Q.rubra* L. The largest dimensions of all elements regardless of the species were obtained for Hiko, then Plantagrah, and the smallest for biodegradable container.

KEYWORDS: Container seedlings, *Q.rubra*, *Q.cerris*, morphology, anatomy.

INTRODUCTION

In the last few decades, container seedlings production plays a central role in forest seedlings production. Compared to bare root seedlings, there are a lot of advantages of

container seedlings such as: higher survival rate during production and later during transplanting and less transplant shock, as well (Ivetić 2013,2021). One of the main disadvantages related to container seedlings is possibility of deformation of their root system, which negatively affects the afforestation process (Lindstrom 1990). In terms of forest species seedlings production, small containers are much more convenient for seedlings production by species with small seed (Ivetić 2013,2021), while species with large seed and strong root system need to be cultivated in large containers (Topić et al. 2006, Popović et al. 2014). In general, larger containers are connected with better seedlings growth (Hsu et al 1996) and survival (Matthes-Sears and Larson 1999) postplanting. Root collar diameter is the most important morphological trait of the seedlings (Grosnickle 2012) and larger root collar diameter is generally related to larger seedlings that are better adapted to dry sites compared to seedlings with small diameter (Andivia et al. 2021). As for the *Quercus* species, there are many papers which noted the positive effect of container volume on seedlings height and root collar diameter (Hanson et al. 1987, Cogliastro et al. 1995, Orešković et al. 2006, Jelić et al. 2014).

In addition to morphological parameters, some authors also investigated the anatomical characteristics of oak (Jokanović et al. 2024a) and pine (Jokanović et al. 2024b) seedlings. Based on the results obtained in the aforementioned papers, it can be concluded that wider conductive elements negatively affect plants resistance to water deficit. On the other side, a greater ratio of wood indicates an earlier onset of cambial activity, while a greater proportion of bark indicates better protection of the seedling from various environmental influences.

The aim of the paper is to determine, based on the dimensions of the morphological and anatomical elements of the two investigated oak species, which type of container is the most suitable for the production of seedlings, which is of a great importance in the practice of afforestation of problematic sites. The red oak (*Quercus rubra* L.) is an exotic that originates from North America, characterized by fast growth and in Serbia mainly grown in parks because of its beautiful habitus. *Q.rubra* L. is less demanding in terms of nutrients (Miltner et al. 2016, Nicolescu et al. 2018) and has less water need, i.e. it is resistant to water deficit compared to the native oaks such as *Q.cerris* L. and *Q.robur* L.and therefore can be very productive on soils with low fertility. It can grow on soils with a heavy texture, rich in clay, as well as *Q.cerris* L. and *Q.frainetto* Ten which are among the oak species most adaptable to such difficult edaphic conditions (Nicolescu et al. 2018). *Q.rubra* L. trees grow very quickly in height up to age of 40, reaching a maximal values in age between 15 and 20 and thus surpasses all autochtonous oaks, including *Q.cerris* L. which is characterized by the fastest growth in the juvenile stage among autochtonous oaks (Nicolescu et al. 2018). In Serbia, *Q. cerris* L. is found in a large number of xerothermic and mesothermal forests, usually in associations with *Q.frainetto* Ten. It is adapted to the sub-Mediterranean and temperate-continental climate of Southeastern Europe. *Q.cerris* L. prefers deeper, dry soils with slightly acidic reactions (Jokanović 2021). In terms of vertical zonation, it covers habitats at higher altitudes compared to *Q.frainetto* Ten and *Q.petraea* Liebl.

MATERIAL AND METHODS

Three container types - Hiko, Plantagrah, and biodegradable were used for seedlings planting of two *Quercus* species (Fig. 1, Tab. 1). Seeds of the investigated species originate from Belgrade parks (*Quercus robur* L). and Košutnjak area (*Quercus cerris* L.).

Seeds were collected on the population level. Container seedlings were produced in the nursery of the PE „Vojvodinašume“ close to Sremska Mitrovica area. Mixture of organic substrate „Pindstrup“ and perlite in a volume ratio of 2:1 was used for filling the containers. The process of containers filling was performed manually during sowing at the end of growing season 2024. Seedlings were regularly watered, particularly during hot summer days. The experimental plots were in open air conditions. In order to enable better growth and survival rate of the seedlings, combined liquid fertilizer Fitogal – Galenika (produced by Galenika-Fitofarmacija A.D., Serbia) was used. Fungicide Previcur (produced by BAYER 04, Germany) was used in order to protect seedlings from past attack. It belongs to a systemic fungicide that is especially effective in terms of young individuals protection. At the end of the growing season 2024, 90 seedlings per species (3 container types and 30 individuals per container) were transported to the laboratory due to morphological analysis performing.

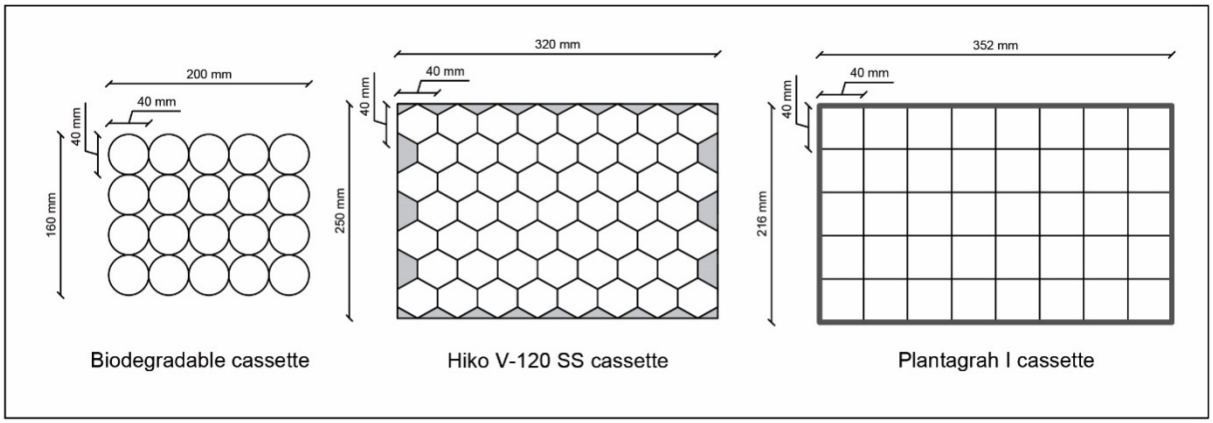

Fig. 1. Sheme of three container types used for seedlings production.

As for the number of measurements of morphological parameters, 30 root collar diameters and 30 heights were included per container type. The height (H) was measured with a ruler with an accuracy of 0.1 cm and the distance from the root collar to the terminal bud was determined. Root collar diameter (RCD) was measured at the level of transition from the root to the aerial part, using a digital calliper, with an accuracy of 0.1 mm (Ivetić 2013). The following anatomical traits were processed: ratio of bark, wood, and pith, and vessels width (VW). Anatomical analysis were performed on permanent anatomical preparations made on transversal samples obtained by previously softening. The material used for analysis was firstly kept in boiling water, and after that in the mixture of water, glycerol and ethanol in the same volume ratio. Sliding microtome „Reichert-Jung 820 II Histocut Microtome“ (Wien, Austria) was used for samples cutting in transversal segments thick 20-25 μm.

Tab. 1: Characteristics of containers used for sowing Turkey and red oak seeds.

Container characteristics	**Container type**		
	BiodegradablePlantagrah 1	**Hiko V-120 SS**	
Cell shape	circular	hexagonal	square
Cell volume (cm^3)	151	120	120
Depth (mm)	120	120	110
Plant density (n/m^2)	400	660	526
Material	baking soda paper	hard plastic	hard plastic
Drain hole	bottom-open	at the bottom	on the bottom and on the side walls
Cell wall	smooth	smooth	smooth
Dimensions of the cassette (mm)	40 x 120	360 x 250 x 120	352 x 216 x 110
The number of cells in the cassette	20	56	40

Vessels are ovoid or elliptical in shape, and taking into consideration these are ring-porous species, the border between early- and latewood zone within the annual ring is not so clear. Vessels are arranged individually or in smaller radial rows, and their width is calculated by taking the average value of the dimensions measured in perpendicular directions. Bark width was measured as the distance from the cambium zone to the place where the secondary rhytidome ends, and the final value was obtained as the arithmetic mean of the measurements at two adjacent ends. The pith width covered a narrow zone from the center of the sample to the beginning of the woodzone. The wood width was obtained when the sum of the pith width and bark width was substracted from the total root collar diameter. All the aforementioned parameters (wood, bark, and pith proportion) were expressed in percentages in relation to the root collar diameter in order to make it easier to draw conclusions about their participation.

Statistical analysis

The obtained numerical data was processed using the two-way analysis of variance (ANOVA) and Fisher's least significant difference (LSD) test. Statistical analysis was performed using the Statgraphics software, v. XVI.I (2009; Statpoint Technologies, Inc., Warrenton, VA, USA).

RESULTS

Based on the results of two-way analysis of variance (ANOVA) (Tab.2), it can be observed that there are statistically significant differences ($P < 0,05$) between the seedling height (H) of oak species analyzed. There are also statistically significant differences between the H of oak seedlings in different container types. Finally, there is interaction between the variability factors (species and container type), which affects H (Tab. 1).

Tab. 2:A two-way ANOVA (species x container type) for the height (cm) of oak container seedlings.

Source of variation	**Sum of squares**	**Degree of freedom**	**Mean square**	**F-ratio**	***P*-value**
A: Species	294.144	1	294.144	163.70	**0.0000**
B: Container type	870.565	2	435.282	242.25	**0.0000**

AB interaction	23.241	2	11.6205	6.47	**0.0020**
Residual	312.646	174	1.79682		
Total	1500.6	179			

Note. Boldfaced numbers denote statistically significant values.

Tab. 3: An LSD test of species influence on the height (cm) of oak container seedlings.

Species	**Sample size**	**Mean value**	**Standard error of the difference between the means**	**Homogeneous groups**
Q. cerris	90	11.14	0.141296	X
Q. rubra	90	13.70	0.141296	X
Comparison		*Difference*	*+/- Limits*	
Q. cerris–Q. rubra		-2.55667	0.39439	

As can be seen from the results of LSD test of the effect of species on H (Tab. 3), species *Quercus cerris* and *Q. rubra* are not homogeneous – there is a statistically significant difference between the mean values of H. Namely, the average H of *Q. rubra* is 13.70 cm, which is significantly greater than H of *Q. cerris* (11.14 cm). There is a statistically significant difference between the H of oak seedlings in different container types. The highest average H of oak container seedlings is determined for Hiko (14.88 cm), and the smallest for Biodegradable (9.54 cm) (Tab. 4).

Tab. 4: An LSD test of container type influence on the height (cm) of oak container seedlings.

Container type	**Sample size**	**Mean value**	**Standard error of the difference between the means**	**Homogeneous groups**
Biodegradable	60	9.54	0.173052	X
Plantagrah	60	12.83	0.173052	X
Hiko	60	14.88	0.173052	X
Comparison		*Difference*	*+/- Limits*	
Biodegradable–Hiko		-5.33917	0.483027	
Biodegradable–Plantagrah		-3.28933	0.483027	
Hiko–Plantagrah		2.04983	0.483027	

The results of two-way ANOVA in Tab.5show there are statistically significant differences between the root collar diameter (RCD) of two oak species analyzed. There are also statistically significant differences between RCD of seedlings in different container types. Finally, there is interaction between the variability factors (Tab.5).

Tab. 5: A two-way ANOVA (species x container type) for the root collar diameter (mm) of oak container seedlings.

Source of variation	**Sum of squares**	**Degree of freedom**	**Mean square**	**F-ratio**	***P*-value**
A: Species	29.2175	1	29.2175	219.53	**0.0000**
B: Container type	44.6277	2	22.3138	167.66	**0.0000**
AB interaction	4.50846	2	2.25423	16.94	**0.0000**
Residual	23.1575	174	0.133089		
Total	101.511	179			

Note. Boldfaced numbers denote statistically significant values.

Tab. 6: An LSD test of species influence on the root collar diameter (mm) of oak container seedlings.

Species	Sample size	Mean value	Standard error of the difference between the means	Homogeneous groups
Q. cerris	90	3.21	0.0384548	X
Q. rubra	90	4.02	0.0384548	X
Comparison		*Difference*	*+/- Limits*	
Q. cerris–Q. rubra		-0.805778	0.107336	

Based on the results of LSD test of the effect of species on RCD (Tab. 6), there is a statistically significant difference between the mean values of RCD. Namely, the average RCD of *Q. rubra* is 4.02 mm, which is significantly greater than RCD of *Q. cerris* (3.21 mm). There is a significant difference between RCD of oak seedlings in different container types. The highest average RCD is determined for Hiko (4.29 mm), and the smallest for Biodegradable (3.09 mm) (Tab. 7).

Tab. 7: An LSD test of container type influence on the root collar diameter (mm) of oak container seedlings.

Container type	Sample size	Mean value	Standard error of the difference between the means	Homogeneous groups
Biodegradable	60	3.09	0.0470973	X
Plantagrah	60	3.47	0.0470973	X
Hiko	60	4.29	0.0470973	X
Comparison		*Difference*	*+/- Limits*	
Biodegradable - Hiko		-1.19433	0.131459	
Biodegradable - Plantagrah		-0.383	0.131459	
Hiko - Plantagrah		0.811333	0.131459	

The results of two-way ANOVA in Tab.8show there are statistically significant differences between the vessel width (VW) of two oak species analyzed. In addition, there are statistically significant differences between VW of oak seedlings in different container types, but there is no interaction between the two factors (Tab.8).

Tab. 8: A two-way ANOVA (species x container type) for the vessel width (µm) of oak container seedlings.

Source of variation	Sum of squares	Degree of freedom	Mean square	F-ratio	*P*-value
A: Species	61.9285	1	61.9285	205.33	**0.0000**
B: Container type	139.1	2	69.5499	230.60	**0.0000**
AB interaction	0.660621	2	0.330311	1.10	0.3368
Residual	52.4782	174	0.301599		
Total	254.167	179			

Note. Boldfaced numbers denote statistically significant values.

Tab. 9: An LSD test of species influence on the vessel width (µm) of oak container seedlings

Species	Sample size	Mean value	Standard error of the difference between the means	Homogeneous groups
Q. rubra	90	4.26	0.0578887	X

Q. cerris	90	5.43	0.0578887	X
Comparison		*Difference*	*+/- Limits*	
Q. cerris–Q. rubra		1.17311	0.16158	

The results of LSD test of the effect of species on VW show that there is a statistically significant difference between the mean values of VW (Tab. 9). The average VW of *Q. cerris* is 5.43 μm, significantly greater than in *Q. rubra* (4.26 μm). There is also a statistically significant difference between VW of seedlings in different container types. The highest average VW is determined for seedlings in Hiko (5.91 μm), and the smallest for Biodegradable (3.76 μm) (Tab. 10).

Tab. 10: An LSD test of container type influence on the vessel width (μm) of oak container seedlings.

Container type	**Sample size**	**Mean value**	**Standard error of the difference between the means**	**Homogeneous groups**
Biodegradable	60	3.76	0.0708988	X
Plantagrah	60	4.87	0.0708988	X
Hiko	60	5.91	0.0708988	X
Comparison		*Difference*	*+/- Limits*	
Biodegradable–Hiko		-2.153	0.197895	
Biodegradable–Plantagrah		-1.10717	0.197895	
Hiko–Plantagrah		1.04583	0.197895	

The results of two-way ANOVA in Tab. 11show there are statistically significant differences between the wood content (WC) of species analyzed. There are also statistically significant differences between the WC of seedlings in different container types. Finally, there is interaction between the variability factors (species and container type), which affects WC (Tab. 11). As can be seen from the results of LSD test of the effect of species on WC (Tab. 12), species *Quercus cerris* and *Q. rubra* are not homogeneous – there is a statistically significant difference between the mean values of WC. The average WC of *Q. rubra* is 40.61%, which is significantly greater than WC of *Q. cerris* (28.13%). There is a statistically significant difference between WC of oak seedlings in different container types. The highest average WC of container seedlings is determined for Hiko (41.02%), and the smallest for Biodegradable (26.91%) (Tab. 13).

Tab. 11: A two-way ANOVA (species x container type) for the wood content (%) of oak container seedlings.

Source of variation	**Sum of squares**	**Degree of freedom**	**Mean square**	**F-ratio**	***P*-value**
A: Species	3508.25	1	3508.25	663.15	**0.0000**
B: Container type	3014.9	2	1507.45	284.95	**0.0000**
Interactions AB	98.0106	2	49.0053	9.26	**0.0002**
Residual	444.385	84	5.29029		
Total	7065.55	89			

Note. Boldfaced numbers denote statistically significant values.

Tab. 12: An LSD test of species influence on the wood content (%) of oak container seedlings

Species	Sample size	Mean value	Standard error of the difference between the means	Homogeneous groups
Q. cerris	45	28.13	0.342873	X
Q. rubra	45	40.61	0.342873	X
Comparison		*Difference*	*+/- Limits*	
Q. cerris–Q. rubra		-12.4869	0.964271	

Tab. 13: An LSD test of container type influence on the wood content (%) of oak container seedlings.

Container type	Sample size	Mean value	Standard error of the difference between the means	Homogeneous groups
Biodegradable	30	26.91	0.419932	X
Plantagrah	30	35.19	0.419932	X
Hiko	30	41.02	0.419932	X
Comparison		*Difference*	*+/- Limits*	
Biodegradable–Hiko		-14.1067	1.18099	
Biodegradable–Plantagrah		-8.27667	1.18099	
Hiko–Plantagrah		5.83	1.18099	

The results of two-way ANOVA in Tab. 14show there are statistically significant differences between the bark content (BC) of oak species analyzed. There are also statistically significant differences between BC of seedlings in different container types, but there is no interaction between the variability factors (Tab. 14). Based on the results of LSD test of the effect of species on BC (Tab. 15), there is a statistically significant difference between the mean values of BC. The average BC of *Q. rubra* is 17.54%, which is significantly greater than in *Q. cerris* (13.02%). There is also a significant difference between BC of oak seedlings in different container types. The highest average BC is determined for Hiko (17.94%), and the smallest for Biodegradable (12.54%) (Tab. 16).

Tab. 14: A two-way ANOVA (species x container type) for the bark content (%) of oak container seedlings.

Source of variation	Sum of squares	Degree of freedom	Mean square	F-ratio	*P*-value
A: Species	458.6	1	458.6	196.34	**0.0000**
B: Container type	437.111	2	218.556	93.57	**0.0000**
Interactions AB	5.08478	2	2.54239	1.09	0.3414
Residual	196.207	84	2.33579		
Total	1097.0	89			

Note. Boldfaced numbers denote statistically significant values.

Tab. 15: An LSD test of species influence on the bark content (%) of oak container seedlings.

Species	Sample size	Mean value	Standard error of the difference between the means	Homogeneous groups
Q. cerris	45	13.02	0.22783	X
Q. rubra	45	17.54	0.22783	X
Comparison		*Difference*	*+/- Limits*	
Q. cerris–Q. rubra		4.51467	0.640732	

Tab. 16: An LSD test of container type influence on the bark content (%) of oak container seedlings.

Container type	Sample size	Mean value	Standard error of the difference between the means	Homogeneous groups
Biodegradable	30	12.54	0.279034	X
Plantagrah	30	15.36	0.279034	X
Hiko	30	17.94	0.279034	X
Comparison		*Difference*	*+/- Limits*	
Biodegradable–Hiko		-5.39633	0.784733	
Biodegradable–Plantagrah		-2.82167	0.784733	
Hiko–Plantagrah		2.57467	0.784733	

The results of two-way ANOVA in Tab. 17show there are statistically significant differences between the pith content (PC) of two species analyzed. There are also statistically significant differences between PC of oak seedlings in different container types. Finally, there is interaction between the two factors (Tab. 17). The results of LSD test of the effect of species on PC show that there is a statistically significant difference between the mean values of PC (Tab. 18). The average PC of *Q. rubra* is 54.33%, significantly greater than in *Q. cerris* (46.36%). There is also a statistically significant difference between PC of seedlings in different container types. The highest average PC is determined for seedlings in Hiko (60.55%), and the smallest for Biodegradable (41.05%) (Tab. 19).

Tab. 17: A two-way ANOVA (species x container type) for the pith content (%) of oak container seedlings.

Source of variation	Sum of squares	Degree of freedom	Mean square	F-ratio	*P*-value
A: Species	1430.02	1	1430.02	219.40	**0.0000**
B: Container type	5741.78	2	2870.89	440.47	**0.0000**
Interactions AB	107.437	2	53.7184	8.24	**0.0005**
Residual	547.497	84	6.51782		
Total	7826.74	89			

Note. Boldfaced numbers denote statistically significant values.

Tab. 18: An LSD test of species influence on the pith content (%) of oak container seedlings.

Species	Sample size	Mean value	Standard error of the difference between the means	Homogeneous groups
Q. cerris	45	46.36	0.380579	X
Q. rubra	45	54.33	0.380579	X
Comparison		*Difference*	*+/- Limits*	
Q. cerris–Q. rubra		7.97222	1.07031	

Tab. 19: An LSD test of container type influence on the pith content (%) of oak container seedlings.

Container type	Sample size	Mean value	Standard error of the difference between the means	Homogeneous groups
Biodegradable	30	41.05	0.466112	X
Plantagrah	30	49.45	0.466112	X
Hiko	30	60.55	0.466112	X

Comparison	*Difference*	*+/- Limits*
Biodegradable–Hiko	19.503	1.31086
Biodegradable–Plantagrah	11.0983	1.31086
Hiko–Plantagrah	-8.40467	1.31086

DISCUSSION

Jokanović et al. (2024 a) investigated the influence of Bosnaplast 18 (hard plastic) container on morpho-anatomical traits of three oak species (*Q.robur, Q.frainetto* and *Q. petraea*) and the obtained results for the seedlings height mean values were much higher compared to *Q.rubra*, and especially to *Q.cerris* in our paper. As for the average values for root collar diameter for the aforementioned three oak species, they were not significantly different compared to researched *Q.rubra* and *Q.cerris* in our paper. Mijatović et al. (2022) observed the effects of three container types (paper, Bosnaplast 18 and Hiko V-265) on *Quercus robur* seedlings and both morphological parameters (height and root collar diameter) were much higher compared to *Q.cerris* and *Q.rubra* seedlings. If we compare mean values obtained for vessels width in our paper to this parameter in the paper Jokanović et al. (2024 a), we can conclude that *Q.cerris* and, particularly, *Q.rubra* have very narrow vessels unlike *Q.robur, Q.frainetto,* and *Q.petraea.* The other three anatomical traits (wood, pith, and bark ratio) are not significantly different by *Q.rubra* and *Q.cerris* from one side, and *Q.robur, Q.frainetto,* and *Q.petraea* on the other side. Popović et al. (2014) studied the effects of three plastic containers on the morphological parameters of *Quercus robur* seedlings and the obtained results for the mean height were much higher compared to these in our paper, while the average dimensions of root collar diameter were similar to each other. Jokanović et al. (2024 b) used completely the same containers as in our paper in order to establish their influence on the morphological and anatomical traits of *Pinus nigra* and *Pinus sylvestris* dimensions. Comparing to our results, we can conclude that the mean values of seedlings height and conductive elements width are much higher by oaks compared to pines, which is related to bioecological properties of the species.

Montagnoli et al. (2021) found a positive correlation between the amount of cambium vascular cells and container volume. It may affect an earlier onset of cambium activity in larger containers or may be related to the total higher cambial activity (Montagnoli et al. 2019). Bobinac and Vilotić (1998) investigated multiphase growth of Turkey oak seedlings and its correlation with morpho-anatomical wood traits concluding that almost all parameters increase with cambial age. The same authors (Bobinac and Vilotić 1995) studied multiphase growth of *Fagus sylvatica* juvenile individuals and found the same pattern like in Turkey oak seedlings. Devetaković et al. (2017) noted the significance of container type by black pine seedlings and deduced that one-year-old seedlings can be better adapted to the outplanting than two-year-old seedlings in case container type and nursery treatment are convenient.

The obtained results for the investigated species in our paper suggest that *Q.rubra* has larger dimensions for all analyzed elements apart from vessels width compared to *Q.cerris*. A larger root collar diameter indicates that *Q.rubra* develops stronger seedlings that can better adapt to harsh habitat conditions. In addition to this, a larger proportion of pith and wood by

Q.rubra indicates a faster start of cambial growth, while a larger ratio of bark leads to the creating of much more powerful physical and physiological barrier for the pathogens invasion compared to *Q.cerris*. On the other hand, narrower vessels by *Q.rubra* enable better adaptation of the species to conditions of water deficit compared to *Q.cerris*. Namely, species with wider vessels are at risk of facing embolism. If the average values of all analyzed traits between the three container types are compared, the largest dimensions for all characteristics were obtained for Hiko, then Plantagrah, and the smallest for the biodegradable container. Based on this, it means that seedlings cultivated in Hiko containers would have the best reception and survival rate during outplanting process.

CONCLUSIONS

There was analyzed the influence of three container types (Hiko, Plantagrah, biodegradable) on morphological (root collar diameter and height) and anatomical (wood, bark and pith content, vessel width) traits of one-year-old seedlings of two oak species – *Q. cerris* L. and *Q.rubra* L. Considering the average values of seedling height (H), it was detected 13.70 cm for *Q.rubra*, and 11.14 cm for *Q.cerris*, respectively.The highest mean value of seedling height was recorded for Hiko container (14.88 cm), but the least for biodegradable container (9.54 cm). As for an average value of root collar diameter (RCD), it was also higher in *Q.rubra* (4.02 mm) than in *Q.cerris* (3.21 mm).The greatest RCD was found in Hiko container (4.29 mm), but the smallest in biodegradable container (3.09 mm).On the other hand, the analysis of the anatomical parameters showed also higher mean values for all measured elements apart from vessel width in *Q.rubra* L. seedlings. Based on the aforementioned facts, we can deduce that *Q.rubra* L. is more suitable for the afforestation of harsh sites compared to *Q.cerris* L. Greater height and radial increment of *Q.rubra* L. suggests it is characterized by strong root system and aboveground part that enables to be more resistant to undesirable site conditions, especially in the juvenile development stage. In terms of vessel width, we can establish that vessels are narrower in *Q.rubra* L. compared to *Q.cerris* L., so for that reason, red oak is better adapted to dry soil conditions with typical water deficit.Namely, an average vessel width value (VW) was 5.43 μm in *Q.cerris*, but 4.26 μm in *Q.rubra*. As for containers, the greatest VW was detected in Hiko (5.91μm), while the smallest in biodegradable (3.76 μm). Taking into account the development characteristics of red oak (rapid height and radial increment), as well as a high adaptibility degree to difficult sites, our recommendation is to afforest Serbia with this species to a greater extent. We just need to pay attention that the root system can often be deformed in containers, due to no enough space for growth, which makes afforestation process more difficult.

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