

Зборник Матице српске за природне науке / Proceedings for Natural Sciences, Matica Srpska  
Novi Sad, № 102, 53—58, 2002

UDC 582.623.2:631.524

*Nataša P. Nikolić*<sup>1</sup>, *Saša S. Orlović*<sup>2</sup>

<sup>1</sup> Faculty of Natural Sciences, Department of Biology and Ecology,  
Trg Dositeja Obradovića 2, 21000 Novi Sad, Yugoslavia

<sup>2</sup> Faculty of Agriculture, Poplar Research Institute, Antona Čehova 13,  
21000 Novi Sad, Yugoslavia

## GENOTYPIC VARIABILITY OF MORPHOLOGICAL CHARACTERISTICS OF ENGLISH OAK (*QUERCUS ROBUR* L.) ACORN

**ABSTRACT:** This paper deals with the acorn morphology (length, diameter and mass), analyzed in seventeen English oak genotypes (*Quercus robur* L.) from the English Oak Clonal Seed Orchard Banov Brod (Srem, Vojvodina). The highest values of acorn mass and length were measured in genotype 5. The largest diameters were measured in genotypes 6 and 21. Genotype 35 had the lowest acorn mass, length and diameter. The results from this study should serve as guidelines for the selection of trees yielding fruits possessing the desirable morphological characteristics.

**KEY WORDS:** acorn, morphology, *Quercus robur* L.

### INTRODUCTION

Genus *Quercus*, represented by deciduous and evergreen trees and shrubs, belongs to the *Fagaceae* family. In our region, this genus is represented by several species. The English oak (*Quercus robur* L.) is one of the most important forest species. English oak forests are the most valuable forests in Europe from the economic aspect (Orlović et al., 2000). Owing to reckless timber harvesting in our country the former English oak sites were often left unforested or they were regenerated by other species (Erdešić, 1985). One of the methods of regeneration and restocking of partly naturally regenerated areas is to produce and use selected forest seed, produced in seed orchards (Litvay, 1999).

Oak fruit, acorn, contains a seed without an endosperm and an achlorophyllous embryo (Watson and Dallwitz, 2000). The size of English oak acorn depends on tree age and site characteristics, but its form, which is ovoid, is constant (Šárkány and Szalai, 1966). The size of a mature acorn is not constant and depends on the yield and other growth factors

(Maksimović et al., 1982). A direct correlation between acorn size and young seedling survival in stress conditions and a positive correlation of seedling size and acorn size are reported by Aizen and Woodcock (1996).

The cultivation of high quality oak and the intensified timber volume production are based on the production of superior seed. For this reason, in 1973, the best stands of *Quercus robur* L. were selected in the River Sava basin and designated as seed stands (Maksimović et al., 1982). Also, an English oak clonal seed orchard was established in the Sremska Mitrovica Forest Estate, from which the material for the analyses originates. This morphological study of acorn should produce guidelines for the selection of genotypes that yield fruits with desirable characteristics.

## MATERIAL AND METHODS

Plant material was taken from the English Oak Clonal Seed Orchard Banov Brod, Forest Administration Višnjićevo, Forest Estate Sremska Mitrovica, State Enterprise "Srbijašume", Belgrade. The plantation is situated along the left bank of the River Sava, in the location "Šančine", the Banov Brod Forest, the village of Bosut. It was established by vegetative means, i.e. grafting. English oak seedlings of seed origin (acorn), aged from two to five years, were used as rootstock in the plantation establishment. Scions were taken from the trees (plus-trees) selected in the forests of East and West Srem and numbered from 1 to 85. The scions (shoots with three buds) were removed from plus-trees during the dormant period (early March) and kept until grafting (late April — early May). The scions for summer grafting were shoots with green bark whose buds were formed in May and June of the current year. In this way, the clonal seed orchard was established from 85 genotypes of English oak.

The following seventeen genotypes were selected for this study: 4, 5, 6, 16, 18, 20, 21, 22, 25, 28, 29, 30, 33, 35, 38, 40 and 85.

Acorn mass was determined by measuring the mass of 20 acorns and by calculating the average value.

Acorn length and diameter were measured using a slide gauge and expressed in cm.

The study results were processed statistically by the analysis of variance using the program MSTATC. The genotypes were compared using Duncan's test at  $\alpha = 0.05$  significance level, with the values of the least significant digits — LSD. The means of the study parameters were ranked and marked with letters.

## RESULTS AND DISCUSSION

The morphological study of the selected plant acorns indicates the presence of significant differences in both length and diameter (Table 1). Among the analyzed morphological characteristics, the least genotypic variability was observed for *acorn length* (CV = 5.23%). The highest average (32.3 mm), and

the highest critical values (31.0 mm, i.e. 35.0 mm) characterize the genotype 5. Genotype 16 had the smallest acorn length (23.8 mm) and the lowest critical values (20.7 mm, i.e. 26.0 mm). In general, the average size of the studied parameter in all genotypes was 27.2 mm. Compared with its length, *acorn diameter* had a somewhat higher variability among the studied genotypes (CV = 6.28%). The average minimum value for all plants was 14.4 mm, maximum 17.4 mm. Genotypes 21 and 6 had the largest diameters, 18.0 mm and 17.9 mm, respectively. The smallest acorn diameter occurred in genotype 35 (13.9 mm). The average diameter size for all studied plants was 15.9 mm. Several authors have attempted to differentiate individual oak species based on acorn size and form. However, *Brookes and Wigston (1979)* report that these parameters are not reliable discriminants, either for the differentiation between *Quercus petraea* and *Quercus robur*, or between these species and their hybrids.

Table 1. — *Quercus robur* acorn morphology, plantation “Banov Brod”

Genotype	Length (mm)			Diameter (mm)			Mass (g)		
	x	min	max	x	min	max	x	min	max
4	26.7 <sup>d</sup>	24.0	29.4	16.0 <sup>def</sup>	14.0	17.2	4.4 <sup>d</sup>	2.98	5.74
5	32.3 <sup>a</sup>	31.0	35.0	16.8 <sup>bc</sup>	15.0	18.3	6.1 <sup>a</sup>	4.54	7.32
6	25.3 <sup>ef</sup>	22.5	27.0	17.9 <sup>a</sup>	17.0	19.6	5.5 <sup>bc</sup>	3.76	7.15
16	23.8 <sup>g</sup>	20.7	26.0	16.2 <sup>cde</sup>	14.4	17.5	3.7 <sup>fg</sup>	2.43	5.31
18	26.0 <sup>de</sup>	24.3	27.6	14.9 <sup>hi</sup>	14.0	16.0	3.6 <sup>g</sup>	2.93	4.99
20	28.0 <sup>c</sup>	23.3	30.7	15.5 <sup>fgh</sup>	14.0	17.0	3.8 <sup>efg</sup>	2.29	4.97
21	28.5 <sup>c</sup>	26.3	29.9	18.0 <sup>a</sup>	15.3	19.5	5.8 <sup>ab</sup>	3.83	6.87
22	26.5 <sup>d</sup>	24.5	28.2	16.1 <sup>def</sup>	14.4	17.2	4.4 <sup>d</sup>	3.39	5.43
25	25.1 <sup>ef</sup>	23.9	27.0	15.7 <sup>efg</sup>	14.4	17.3	3.8 <sup>efg</sup>	3.30	4.98
28	29.8 <sup>b</sup>	26.3	31.8	16.5 <sup>bcd</sup>	14.6	18.0	5.5 <sup>bc</sup>	3.32	6.83
29	26.7 <sup>d</sup>	23.9	29.1	16.2 <sup>cde</sup>	14.1	17.8	4.3 <sup>de</sup>	2.83	5.24
30	26.5 <sup>d</sup>	24.3	30.0	15.5 <sup>fgh</sup>	13.8	17.1	4.2 <sup>def</sup>	3.18	5.47
33	26.8 <sup>d</sup>	24.2	29.3	15.0 <sup>hi</sup>	13.8	16.2	3.9 <sup>defg</sup>	3.10	4.91
35	24.6 <sup>fg</sup>	21.9	26.0	13.9 <sup>j</sup>	12.4	15.8	2.8 <sup>h</sup>	1.97	4.12
38	28.7 <sup>c</sup>	27.2	29.9	17.0 <sup>b</sup>	15.5	18.5	5.1 <sup>c</sup>	4.14	6.06
40	26.7 <sup>d</sup>	25.4	28.1	14.6 <sup>i</sup>	13.3	15.8	3.8 <sup>efg</sup>	3.09	4.72
85	30.7 <sup>b</sup>	28.8	32.6	15.2 <sup>ghi</sup>	14.2	16.2	4.2 <sup>def</sup>	3.30	5.16
Average	27.2	24.9	29.3	15.9	14.4	17.4	4.4	3.20	5.60
LSD <sub>0.05</sub>	0.89	—	—	0.62	—	—	0.47	—	—
CV%	5.23	—	—	6.28	—	—	17.26	—	—

*Kormanik et al. (1998)* reported of the dependence of *Quercus rubra* L. seedling development on acorn size. Plant height, root collar diameter and seedling survival are significantly correlated with acorn mass. *Miao (1995)* provided data on the effect of acorn mass on seedling growth in *Quercus rubra*. The results show that the total biomass increased with the increase of initial acorn mass.

Acorn mass is the morphological characteristic with the highest variability (Table 1) among the studied plants. Disregarding the genotype, the values ranged between 3.2 and 5.6 g. The average acorn mass was 4.4 g. The values of individual genotypes varied between 3.6 g and 6.1 g, measured in genotypes 18 and 5, respectively. It was interesting to note that genotype 5, along with the highest acorn mass, also excelled all studied plants in acorn length.

The study of the above morphological characteristics of English oak acorn also included correlations (Table 2). Positive correlations were found between length and width and length and acorn mass. There was a very high correlation between width and acorn mass ( $r^2 = 0.87$ ).

Table 2. — Correlation of acorn morphological features

Acorn morphology	Correlation coefficient
length — width	0.36
length — mass	0.66
width — mass	0.87

The shares of individual parts of the fruit in its total mass were also different (Table 3). On average, cotyledons amounted to about 87.5% of the fresh acorn mass, while pericarp and testa accounted for about 12.5%. The values of individual genotypes varied only up to four percent (from 86% to 90% for cotyledons, i.e. from 10% to 14% for the other part of the fruit). It is interesting that the percentage of individual parts of the fruit in its dry mass showed different tendencies compared with fresh mass. Namely, while the cotyledon percentage decreased, the percentage of pericarp and testa increased.

Table 3. — Percentage of individual fruit parts in its total mass

Genotype	Percentage in fresh mass (%)		Percentage in dry mass (%)	
	Cotyledon	Pericarp and testa	Cotyledon	Pericarp and testa
4	90	10	86	14
5	88	12	85	15
6	86	14	81	19
16	86	14	82	18
18	88	12	84	16
20	88	12	82	18
21	87	13	84	16
22	87	13	84	16
25	88	12	86	14
28	87	13	85	15
29	89	11	87	13
30	88	12	86	14
33	88	12	84	16
35	87	13	84	16
38	89	11	85	15

40	86	14	83	17
85	86	14	83	17
Average	87.5	12.5	84.2	15.8

## CONCLUSION

The study of acorn morphological features in seventeen English oak genotypes from the English Oak Clonal Seed Orchard Banov Brod (Srem, Vojvodina) points to genotype 5 with the highest measured values of acorn mass and length. The largest diameters were measured in genotypes 6 and 21. The lowest acorn mass and sizes occurred in genotype 35.

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ГЕНОТИПСКА ВАРИЈАБИЛНОСТ МОРФОЛОШКИХ ОСОБИНА  
ЖИРА ХРАСТА ЛУЖЊАКА (*QUERCUS ROBUR* L.)

Наташа П. Николић<sup>1</sup>, Саша С. Орловић<sup>2</sup>

<sup>1</sup> Природно-математички факултет, Институт за биологију и екологију,  
Трг Доситеја Обрадовића 2, 21000 Нови Сад, Југославија

<sup>2</sup> Пољопривредни факултет, Институт за тополарство, Антона Чехова 13,  
21000 Нови Сад, Југославија

Резиме

У раду су анализирани морфолошке особине (дужина, пречник и маса) жира код седамнаест генотипова храста лужњака (*Quercus robur* L.) из вегетативне семенске плантаже Банов Брод (Срем, Војводина). Највише вредности масе и дужине жира утврђене су код генотипа 5, највећи пречник код генотипова 6 и 21, док је генотип 35 имао најниже вредности масе, дужине и пречника жира. Добијени резултати треба да буду једна од смерница у одабирању оних генотипова који дају плодове са пожељним морфолошким карактеристикама.