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POMOLOGICAL CHARACTERISTICS OF WILD CHERRY GENOTYPES (*PRUNUS AVIUM* L. /MOENCH/) FROM POTKOZARJE POPULATION*

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SUMMARY: This paper presents the results of the investigation of wild cherry (Prunus avium L. /*Moench/*) *population in the area of Potkozarje. The studied genotypes grow in association with sweet chestnut (Castanea sativa Mill.) on acidic soil. Indicators of tree growth of wild cherry genotypes and pomological characteristics show a high variability inside the population. The selected specimens are an excellent source of reproductive material for the nursery production.*

Key words: *wild cherry, soil, pomological analysis, morphological properties.*

INTRODUCTION

Wild cherry trees (*Prunus avium* L. /Moench/) were selected from the population which belongs to forest communities of the chestnut and sessile oak (*Querco Castanetum sativae* Wrab.) in the area of Potkozarje. The site is located in the northwest part of the Republic of Srpska on the territory of Gradina and the altitude of 290 to 390 meters. Gradina is a hilly area above the village Dragočaj on the Banja Luka-Prijedor road, about twenty kilometres from Banja Luka. Gradina is a private property and the trees in the forest are of generative origin.

The relief of the sites has a western exposure with a greater inclination and a north one with lower. The flattened ridge at the highest ground is dominated by several plateaus. The bedrock consists of brown acid rocks on which acid brown soil (district cambisol) and illimerised soil (luvisol) have developed.

The selected wild cherry trees on the site Gradina are of different classes of age, indicating the diversity of the population. The study of the diversity of the genus Prunus, including the wild cherry (*Prunus avium* L. / Moench /), was done by

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Pandey et al. (2008) in the temperate regions of India and Mratinić et al. (2012) in the south-eastern part of Serbia. The pomological characteristics of the cherry fruit cultivars with different ripening stages in the Belgrade Danube basin were investigated by Milatović and Đurović (2010).

MATERIAL AND METHODS

Within natural populations of the chestnut, oak and beech, the wild cheery is present as an associated species. The site and tree selection and subsequent fruit harvesting was carried out during the 2011-2012 season. Two soil profiles and three soil semi-profiles were selected for analysis. For the profile number 1, where the observed populations were examined, morphological, physical and chemical properties were investigated, while the soil analysis was carried out in the laboratory of Agropedology at the Agricultural Institute in Banja Luka. The type of soil was determined based on the morphology profile studies and the soil maps were provided by the Agropedology Institute of Sarajevo. The wild cherry trees were isolated at the edge of the forest community.

The biometrical basis on ten selected trees of wild cherry (*Prunus avium L. /Moench/)* was determined and the inter-population variability of morphological characteristics of fruits was tested. Moreover, 30 fruits were randomly selected for the pomological analysis. Measurements of the fruit length and width as well as stem length were taken using a micrometre of 0.01 mm precision. Fruit and stone weight measurements were taken on an analytical scale (precision 0.01 g). The collected data was processed using STATISTICA 10 SOFTWARE application (StatSoft, Inc., Tulsa, OK, USA).

RESULTS AND DISCUSSION

The study area has a temperate continental climate characterized by cold winters and warm dry summers. According to data from the meteorological station of Banja Luka, in 2011 and 2012, the average annual temperature was 12.1 °C, which is in accordance with the mean monthly temperature of 12.2 °C, measured during the flowering of the wild cherry. At the time of fructification, the monthly average temperature was 17.2 °C and 20.4 °C in May and June, respectively. The overall annual precipitation was 588.2 mm, with 37.7 mm measured in April, 62.6 mm in May and 37.0 mm in June.

The above precipitation distribution is optimal for wild cherry populations, as it enables the development of the most significant pomological characteristics. Moreover, the overall annual precipitation is comparable to the values measured at similar sites across the wider area of Southeast Europe.

In the study population of wild cherry in Potkozarje area, Gradina locality, the pedological profile was opened on the November 6th, 2011, at 370 m alt. The topology of the analysed locality is mountainous, with south-western exposure and forest cover. The profile structure is: Aoh – A(B) – B(C) – C.

Table 1. Mechanical composition of the studied district cambisol from locality Gradina
Tabela 1. Mehanički sastav ispitivanog distričnog kambisola sa lokaliteta Gradina

Depth(cm)/ *Dubina (cm)*	The percentage share of fractions/ *Procentaualni udeo frakcija*					Textural markings by Gračanin/ *Teksturna oznaka po Gračaninu*	Degree of colloid by Gračanin/ *Stepen koloidnosti po Gračaninu*
	Sand/ *Pesak*	Powder/ *Prah*	Physical clay/ *Fizička glina*	Colloid clay/ *Koloidna glina*			
	2.0-0.05mm	0.05-0.01mm	<0.01mm	<0.002 mm u NaOH	<0.002 mm u H_2O		
0-4	24.40	27.60	48.00	16.20	6.52	Clay loam/ *Glinovita ilovača*	Moderate colloidal/ *Umereno koloidno*
4-20	34.48	9.40	46.60	29.20	15.60	Clay loam/ *Glinovita ilovača*	Very colloidal/ *Jako koloidno*
20-40	44.00	7.12	58.40	47.00	25.20	Sandy clay/ *Peskovita glina*	Extrimely colloidal/ *Vrlo jako koloidno*

Table 1 indicates that the sand content increases with depth, making the soil mostly water-permeable, without prolonged stagnation. Moreover, the powder content decreases with depth. The soil particles less than 0.002 mm in diameter, containing NaOH, indicate that rough colloidal clay predominates at this site. Considering their percentage participation in the overall composition, the analysed district cambisol is moderately to highly colloidal. The percentage of clay increases from 48% to 58.40%, with increasing depth and precipitation filtration through the profile is high.

Soil pH reaction is an important property, as it affects many physical and chemical processes, as well as the vital functions of plants the soil supports.

Table 2. The pH reaction of the soil solution in the pedological profile from locality Gradina
Tabela 2. pH reakcija zemljišnog rastvora u pedološkom profile sa lokaliteta Gradina

Depth (cm)/ *Dubina (cm)*	pH reaction in/*pH reakcija u*		Hydrolytic acidity (me/100g)/ *Hidrolitička kiselost (me/100g)*
	H_2O	KCl	
0-4	5.10	3.70	35.50
4-20	4.82	3.60	33.13
20-40	5.00	3.50	20.50

The soil acidity was investigated, as the height of the active acidity in soil is primarily affected by carbonic acid, which leads to the soil acidification. The data reported in Table 2 indicate that the value of the active soil acidity slightly decreases

or remains unchanged (5.10-5.00 pH). Substitution acidity ranges from 3.70 in the first investigated horizon to 3.50 at the highest depth, i.e. the acidity increases with depth. According to the classification provided by Scheffer-Schachtschabel (1998), the studied district cambisole belongs to the category of very acidic soils.

Rodrigues et al. (2008) studied the sweet and sour cherry cultivars in germplasm bank in Portugal, with the aim of identifying the variability between different genotypes. The soil and agroecological conditions under which their study was conducted are similar to those found in this research area. The results Rodrigues et al. reported indicate presence of variability between pomological fruit properties.

Finally, it should be noted that the content of humus in the soil regulates fertility. Humus is a complex dynamic compound, created during degradation and humification of organic residues in the soil and should thus be investigated.

Table 3. Content of humus and nutrients of studied district cambisol from locality Gradina

Tabela 3. Sadržaj humusa i hraniva u ispitivanom distričnom kambisolu sa lokaliteta Gradina

Depth (cm)/ *Dubina (cm)*	Humus (%)/	$CaCO_2$	Accessible nutrients (mg/100g of soil)/ *Pristupačna hraniva (mg/100g of soil)*	
			P_2O_5	K_2O
0-4	5.00	-	1.60	14.70
4-20	1.96	-	-	6.50
20-40	0.64	-	-	7.50

The humus content in the analysed soil in the surface horizon is 5.00% (Table 3), and belongs to humic soil (Scheffer-Schachtschabel, 1998). Moreover, the percentage of humus decreases rapidly with depth. Although the wild cherry tends to favour deep and neutral pH soils, the wild cherry trees at the investigated site have adapted to the environmental conditions and soil type. The wild cherry trees observed in the study area were in good condition and vitality – the properties affecting the flowering and fructification, the variability of which was examined in this study.

The results of bioecological characteristics of the investigated wild cherry trees (Table 4) indicate that the tree height ranged from 3.00 m (G9) to 25.00 m (G3), which points to high variability (CV = 80.34%). Moreover, very high variability is observed in the values of trunk volume and diameter, with the coefficients of variation of 82.91% and 84.24%, respectively. The crown width of the investigated trees ranged from 4.15 m (G9) to 15.25 m (G3)—with the latter measured for the most developed specimen. The coefficient of variation for the crown width, as well as the trunk height, was slightly lower compared to other properties. Table 4 indicates that the crown width, measured at four exposure sites, varies depending on the tree position and the presence of neighbouring trees.

Table 4. Indicators of tree growth of wild cherry genotypes from locality Gradina
Tabela 4. Pokazatelji rasta genotipova divlje trešnje sa lokaliteta Gradina

Genotype / *Genotip*	Tree height (m)/ *Visina stabla (m)*	Trunk height (m)/ *Visina debla (m)*	Trunk volume (m)/ *Obim debla (m)*	Diameter at brest height (m)/ *Prsni prečnik (m)*	Crown width (m)/ *Širina krošnje (m)* East/ *Istok*	West/ *Zapad*	North / *Sever*	South / *Jug*	Mean value of crown width/ *Sr.vrednost širine krošnje*
G1	6	1.05	0.61	0.1940	1.5	3.2	2.4	2.3	4,70
G2	14	2.80	0.80	0.2540	3.7	3.3	3.8	3.9	7,35
G3	25	3.30	2.02	0.6430	5.3	8.1	9.1	8.0	15,25
G4	5	1.75	0.32	0.1019	5.1	0	3.8	0	4,45
G5	6.5	3.25	0.46	0.1460	2.4	2.0	1.1	3.0	4,25
G6	7	1.20	0.62	0.1974	4.8	1.2	1.1	3.9	5,50
G7	7.5	2.70	0.62	0.1970	6.7	8.0	2.1	4.2	10,50
G8	3.5	1.25	0.18	0.0574	2.8	1.5	2.3	2.0	4,30
G9	3	1.80	0.17	0.0541	2.5	1.3	3.0	1.5	4,15
G10	5	1.80	1.70	0.5414	3.5	2.3	3.5	2.3	5,80
X	8.25	2.09	0.75	0.2374	3.8	3.1	3.2	3.1	6,60
SD	6.62	0.85	0.62	0.1999	1.61	2.78	2.28	2.13	3.61
Cv (%)	80.34	40.81	82.91	84.24	42.08	90.20	71.07	68.77	54.53

The correlation analysis included five measured parameters (Table 5) and the results indicate a high correlation between tree height and other parameters. The interrelation of the trunk volume, trunk diameter and crown width was also statistically significant for the analysed correlation coefficients. These results are in accordance with those reported by Faust and Zagaja (1984) and Khadivi-Khub et al. (2011). Moreover, these authors suggest that the correlation between the tree height and the trunk diameter (measured at breast height) of wild cherry specimens of different height and age found in natural populations of Iran was positive.

Table 5. Correlation analysis of wild cherry genotypes morphometrical characteristics from locality Gradina.
Tabela 5. Korelaciona analiza morfometrijskoh karakteristika geniotipova divlje trešnje sa lokaliteta Gradina

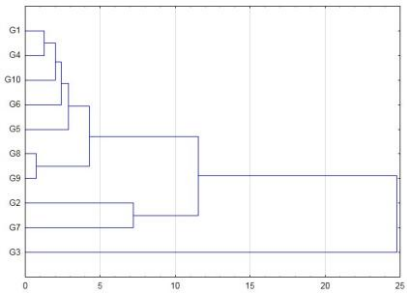
	Trunk height/ *Visina debla*	Trunk volume/ *Obim debla*	diameter at breast height/ *Prsni prečnik*	Crown width/ *Širina krošnje*
Tree height/ *Visina stabla*	0.646*	0.718*	0.718*	0.879*
Trunk height/ *Visina debla*		0.404	0.403	0.621
Trunk volume/ *Obim stabla*			1.000*	0.715*
Diameter at breast height/ *Prsni prečnik*				0.715

- marked values represent statistically significant correlation coefficients
- *vrednosti označene zvezdicom predstavljaju statistički značajne koeficijente korelacije*

Hjalmarsson and Ortiz (2000) studied the variability of wild cherries in different habitats in three Scandinavian countries in order to investigate potential differences in populations. Their findings suggest existence of different wild cherry ecotypes, which vary in fruit quality and resistance to low temperatures.

The cluster analysis based on quantitative morphological characteristics indicates two major groups of genotypes with five subclusters (Figure 1). The first cluster consists of all genotypes of the wild cherry except genotype G3, which has extremely high values of tree height, trunk diameter at breast height and crown width.

The first subcluster consists of genotypes G2 and G7, with approximately uniform values of trunk height. The next group consists of wild cherry genotypes G1, G4, G5, G6, G8, G9 and G10. In this subcluster, genotypes G1 and G4 were grouped based on their tree height values. Genotypes G8 and G9 also stand out based on their uniform tree height, trunk volume and diameter (at breast height), as well as the average value of the crown width. In the next subcluster, genotype G5 stands out due to the lower values of trunk diameter at breast height and average crown width. Genotypes G6 and G10 are in the fifth subcluster, based on similar crown width measurements.



Graph. 1. Cluster analysis of wild cherry genotypes growth parameters from locality Gradina.

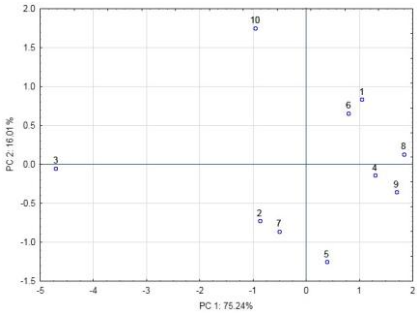
Graf. 1. Klaster analiza pokazatelja rasta genotipova divlje trešnje sa lokaliteta Gradina

According to the multivariate principal component analysis, the most variable among examined parameters were tree height, crown width, and the trunk circumference and diameter. These parameters loaded on the first principal component axis and contributed to the total variation by 75.24%. The second principal component axis accounted for a further 16.01% of the total variance and was defined by the trunk height (Table 6). Principal component values were not significant for the third and fourth axis. Scatterplot showed separation of genotype G3 from all other genotypes, along the first axis, as well as separation of genotype G10 on the second axis. Several groups of genotypes could be recognized. First group comprised genotypes G1 and G6, second included G4, G8 and G9, while the third was constituted of genotypes G2, G5 and G7. As the cluster analysis results were fully confirmed by those of the principle component analysis, outliers G3 and G10 can be considered significantly different from other investigated genotypes (Figure 2).

Table 6. Multivariate principal component analysis of wild cherry genotypes growth parameters, from locality Gradina.

Tabela 6. Analiza glavnih komponenata pokazatelja rasta ispitivanih genotipova divlje trešnje sa lokaliteta Gradina

	PC 1	PC 2	PC 3	PC 4
ree height/ *Visina stabla*	-0.918*	-0.166	-0.256	0.253
Trunk height/ *Visina debla*	-0.683	-0.691*	0.330	-0.017
diameter at breast height/ *Prsni prečnik*	-0.900*	0.404	0.160	-0.005
Trunk volume/ *Obim debla*	-0.900*	0.405	0.158	-0.003
Crown width/ *Širina krošnje*	-0.912*	-0.145	-0.304	-0.235
Eigen value/ *Svojstvena vrednost*	3,761	0,801	0,317	0,119
Total variance explained (%)/ *Ukupna varijansa (%)*	75,24	16,01	6,35	2,40
Cumulative variance explained (%)/ *Kumulativna varijansa (%)*	75,24	91,25	97,60	100,0



Graph. 2. Multivariate principal component analysis scatterplot based on morphological parameters of wild cherry genotypes from locality Gradina.

Graf 2. Dijagram rasporeda genotipova divlje trešnje sa lokaliteta Gradina zasnovan na morfološkim parametrima pokazatelja rasta

In addition to the investigation of morphological growth parameters of wild cherry trees, a pomological investigation was also performed (Table 7). The average fruit length and width values were 12.60 mm and 13.60 mm, respectively. Fruit stalk length varied from 33.45 mm (G9) to 49.20 mm (G8). The average fruit weight was 1.38 g, while the coefficient of variation for this characteristic was 29.79%. The greatest value of fruit weight was measured for genotype G9 (1.85 g), while the lowest was found for genotype G3 (0.81 g). The genotype labelled G3 had greatest vigour, according to morphological parameters, highest yield, lowest fruit weight, and highest flesh ratio. The most variable parameter was fruit stone weight—ranging from 0.20 g (G3) to 0.30 g (G10)—with the coefficient of variation of 39.42%. Stone/fruit ratio was also calculated and was in the range 12.97 % (G9) to 28.26% (G4).

The differences between the investigated wild cherry genotypes were determined by Duncan multiple range tests, which indicate that genotypes G3, G2

and G9 were significantly different from other genotypes, according to fruit width. High value of fruit stalk length differentiated genotype G8 from others. Based on fruit weight, differences were also determined among genotypes G1, G6 and G8.

Table 7. Pomological characteristics of investigated wild cherry genotypes from locality Gradina.

Tabela 7. Pomološke karakteristike ispitivanih genotipova divlje trešnje sa lokaliteta Gradina

Genotype/ *Genotip*	Fruit length(mm)/ *Dužina ploda*	Fruit width (mm)/ *Širina ploda*	Fruit stalk length (mm)/ *Dužina peteljke*	Fruit weight (g)/ *Masa ploda*	Stone weight (g)/ *Masa koštice*	Yield (%)/ *Randman*
G1	12.15^{cd}	12.69^{de}	45.27^{b}	1.13^{e}	0.26^{ab}	23.01
G2	13.18^{ab}	13.34^{d}	40.45^{c}	1.39^{cd}	0.29^{ab}	20.86
G3	12.47^{abc}	11.08^{f}	35.73^{de}	0.81^{f}	0.20^{c}	24.70
G4	11.13^{d}	12.02^{e}	41.01^{c}	0.92^{f}	0.26^{ab}	28.26
G5	12.74^{abc}	13.34^{d}	34.64^{e}	1.47^{c}	0.28^{ab}	19.04
G6	13.30^{ab}	14.31^{c}	44.95^{b}	1.63^{b}	0.25^{abc}	15.33
G7	11.65^{cd}	14.24^{c}	37.76^{d}	1.50^{c}	0.25^{abc}	16.66
G8	12.19^{cd}	13.41^{d}	49.20^{a}	1.26^{d}	0.25^{abc}	19.84
G9	13.43^{ab}	16.19^{a}	33.45^{e}	1.85^{a}	0.24^{bc}	12.97
G10	13.72^{a}	15.40^{b}	45.30^{b}	1.84^{a}	0.30^{a}	16.30
Average	12.60	13.60	40.78	1.38	0.26	19.70
SD	2.56	2.07	6.60	0.41	0 .10	4.67
Cv(%)	20.30	15.24	16.19	29.79	39.42	23.70

The correlation analysis of wild cherry pomological characteristics revealed statistically significant relationships between the investigated features (Table 8). The most statistically significant correlation coefficients were determined for fruit length and width, followed fruit length and weight, fruit width and weight, and finally fruit and stone weight.

Table 8. Correlation analysis of wild cherry genotypes pomological characteristics from locality Gradina.

Tabela 8. Korelaciona analiza pomoloških karakteristika ispitivanih genotipova divlje trešnje sa lokaliteta Gradina

	Fruit width/ *Širina ploda*	Fruit stalk length/ *Dužina peteljke*	Fruit weight/ *Masa ploda*	Stone weight/ *Masa koštice*
Fruit length/ *Dužina ploda*	0.198*	-0.032	0.296*	0.051
Fruit width/ *Širina ploda*	1.000	-0.030	0.707*	0.107
Fruitstalk length/ *Dužinapeteljke*		1.000	-0.027	0.041
Fruit weight/ *Masa ploda*			1.000	0.173*
Stoneweight/ *Masa koštice*				1.000

-statistically significant correlation coefficients, p≤0.01

- statistički značajni koeficijenti korelacije, p≤0.01

The discriminant analysis of pomological characteristics determined those which carry most of the variability of the sample (Table 9). Of the five investigated characteristics (values ≥ 0.700), the most significant was fruit weight, which separated genotypes along the first axis. The second axis was determined by fruit petiole length. As the discriminant analysis indicated that the first two variables explain over 95% of total variability of the sample, the subsequent interpretation includes only the first and second axis (DA1 and DA2). The first principal component contributes to the variability by 59.90%, the second explains 35.8% (Figure 3), whereas the remainder is explained by successive components of declining significance.

The discriminant analysis results indicate significant sample heterogeneity. However, we cannot group all the genotypes, as only G2, G5 and G7 as well as G6 and G10 formed their respective groups, based on similar values of the investigated pomological characteristics. The lowest fruit weight separated genotype G3 on the second axis (DA2) and the values of fruit stalk length separated genotypes G8 and G9, as these showed significant differences.

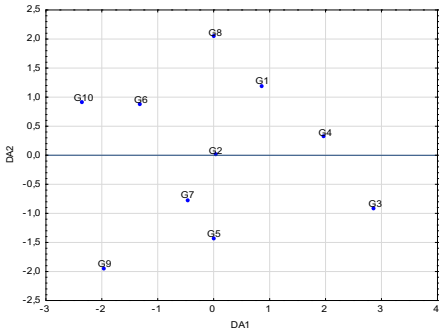
Table 9. Discriminant analysis of pomological characteristics of the wild cherry genotypes, from locality Gradina

Tabela 9. Diskriminantna analiza pomoloških karakteristika ispitivanih genotipova divlje trešnje sa lokaliteta Gradina

	DA1	DA2	DA3	DA4	DA5
Fruit length/Dužina ploda	0.04303	0.04439	0.45914	0.67009	0.62072
Fruit width/Širina ploda	0.32575	0.01294	0.77618*	0.09455	0.67158
Fruit stalk length/ Dužina peteljke	0.20891	1.00624*	0.03000	0.05966	0.03439
Fruit weight/Masa ploda	0.88794*	0.12032	0.39878	0.02964	0.58878
Stone weight/Masa koštice	0.00314	0.10425	0.47836	0.75711*	0.44892
Eigen value/ *Svojstvena vrednost*	2.50184	1.49642	0.09008	0.06383	0.02372
Cumulativevariance explained/*Kumulativna proporcija (%)*	0.59911	0.95746	0.97903	0.99431	1.00000

-marked values are significant to the axis of the discriminant analysis

-vrednosti označene zvezdicom su značajne za osu diskriminantne analize



Graph. 3. Diagram of pomological characteristics of wild cherry genotypes from locality Gradina based on the first two axes of discriminant analysis

Graf. 3. Dijagram rasporeda pomoloških karakteristika genotipova divlje trešnje sa lokaliteta Gradina na osnovu prve dve ose diskriminantne analize

The pomological characteristics indicate great variability in the population of the selected genotypes of wild cherry in the area of Potkozarje.

CONCLUSION

The area Potkozarje, Gradina locality, is characterized by the district cambisol or brown acid soil type with the Aoh – A(B) – B(C) – C profile. The first two studied horizons are of clay loam, and the third horizon is of sandy clay type. These soils are water-permeable and well aerated. Their chemical properties indicate strong acidity while their base content is low. The soil also lacks physiologically active

phosphorus, while potassium content ranges from poor to moderate. The wild cherry is well adapted to the conditions of habitat.

The results reported here indicate great variability in the development of wild cherry specimens. The height of the investigated wild cherry trees in the population of Potkozarje ranged from 3.00 m (G9) to 25.00 m (G3), indicating high variability (CV = 80.34%). Very high variability was also observed for the trunk volume and diameter measured at breast height, with the variation coefficients of 82.91% and 84.24%, respectively. Crown width of the investigated trees ranged from 4.15 m (G9) to 15.25 m (G3).

The pomological characteristics indicate that the average fruit length and width values were 12.60 mm and 13.60 mm. Fruit petiole length varied from 33.45 mm (G9) to 49.20 mm (G8). The average fruit weight was 1.38 g, while the coefficient of variation for this property was 29.79%. The highest weight was measured in genotype G9 (1.85 g), and the lowest in genotype G3 (0.81 g). The most variable feature is the stone weight, with the coefficient of variation of 39.42% and the measured values ranging from 0.20 g (G3) to 0.30 g (G10). Finally, flash ration ranged from 12.97% (G9) to 28.26% (G4).

The study population of the wild cherry in habitats of Southeast Europe is important for selection of trees that have adapted to existing environmental conditions. The selected specimens are an excellent source of reproductive material for the nursery production of rootstocks, and will thus be used for grafting cherry cultivars.

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POMOLOŠKE KARAKTERISTIKE GENOTIPOVA DIVLJE TREŠNJE (*PRUNUS AVIUM* L. /MOENCH/) IZ POPULACIJE SA POTKOZARJA

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Izvod

U radu su prikazani rezultati ispitivanja populacija divlje trešnje (*Prunus avium* L. /Moench/) na lokalitetu Potkozarja. Ispitivani genotipovi rastu u sastojini sa pitomim kestenom (*Castanea sativa* Mill.) na zemljištu kisele hemijske reakcije. Pokazatelji rasta stabala kao i pomološke karakteristike plodova divlje trešnje pokazuju veliku varijabilnost unutar populacije. Izabrani genotipovi predstavlju izvor reprodukcionog materijala za rasadničku proizvodnju.

Ključne reči: divlja trešnja, zemljište, pomološka analiza, morfološke osobine.

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