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EFFECT OF ECOLOGICAL CONDITIONS ON EXPRESSION OF BIOPOMOLOGICAL CHARACTERISTICS OF CHESTNUT (*Castanea sativa Mill.*) IN NATURAL POPULATIONS OF MONTENEGRO

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This paper presents the five-year long research results (2007-2011) of phenological observations (beginning, full flowering and the end of flowering), morphometric analysis (fruit weight, length, width and thickness of fruit, as well as length and width of the hilum), the ripening time and the average yield of selected genotypes of sweet chestnut (*Castanea sativa Mill.*). The results show that in terms of time of flowering chestnut trees examined in the group are very early flowering. The ripening of studied chestnut trees shows that the earliest harvest tree was Ostros II, VII and Kostajnica V (09.11.), and Kostajnica III (14.11.) were the latest. The average fruit weight of the selected sweet chestnut trees was (6.9 g). The highest average fruit weight (10.6 g), had the examined Ostros I tree, and the lowest (4.8 g), Kostajnica VI. The yield of the tested chestnut trees was on average (76.3 kg / tree). The selected trees Kostajnica II (66.0 kg / tree), Kostajnica I (69.0 kg / tree) had the smallest yield and Ostros VI (94.0 kg / tree) and Ostros V (87.0 kg / tree) had the highest. Obviously it can be concluded that population genetic variability is very high and gene expression is highly affected in tested samples on both locations. For further research it should be given attention to investigate genotypes in controlled conditions, the best *in* vitro in tissue culture.

Key words: Chestnut, chestnut tree, natural population, morphological and morphometric characteristics, yield.

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INTRODUCTION

European chestnut (*Castanea sativa Mill.*) is a very important species on the Balkan Peninsula with a high economic importance. By its biological features, the way and the place of growth and reproduction, it belongs to the group of fruit species, as well as forest trees (MURATOVIĆ *et al*. 1999).

Sweet Chestnut is a species of ancient Tertiary flora that is preserved through the ice age until today. The European chestnut homeland is Asia Minor. In the 5th century BC it was transferred to Europe, first to Greece and then Italy and Spain.

The Romans had the greatest contribution for its spreading through the countries of Central Europe and alongside the Mediterranean region. According to KONSTANTINIDIS *et al.* (2008), the first postglacial fossil data were found about this species in Spain, Greece, the Scandinavian countries and the regions of France, Italy, former Yugoslavia, Austria and Hungary, 9000 years ago.

Beside Europe, the European chestnut is widespread in North American and Asia and it grows in the northern and western parts of Africa (VOSSEN 1996).

The European countries that have large areas of chestnut are : France (1020.500 ha), Italy (765 837 ha), Spain (137 627 ha), Portugal (53 509 ha), Greece (33 651 ha), Turkey (28 892 ha), Switzerland (27 100 ha), Croatia (15,000 ha), Albania (8600 ha), Macedonia (5,058 ha), Germany (4,400 ha), BH (3057 ha) (CONEDERA *et al.* 2004).

In recent years there are important attempts to improve and revitalize fruit tree production in Montenegro (PRENKIĆ *et al.* 2009). In the southern part of Montenegro there are several sites of chestnut natural population Boka Kotorska (Herceg Novi, Kostajnica, Stoliv and Prčanj) and near Budva and Ulcinj. The largest population of chestnut is located between Bar and Virpazar (Ostros, Livarje, Briska, Dragovici and Kostajnica), on the southeastern slopes of Rumija to the vicinity of Skadar LakeIn this area there is a natural population on area of 300 ha of very heterogeneous genotypes of chestnut, where it held until today, primarily thanks to favorable micro-climate. This is the reason that this area is taken as the object of our research.

The economic importance of chestnut is manifold. It is used as food, as honey and medicinal herb. Chestnut tree has excellent technical value and its characteristics are as well appreciated as oak's. Because of his habitus, large, wide crown, beautiful glossy leaves and fruits, chestnut is highly prized as ornamental and park tree (MALTON *et al.* 2001).

Production of nuts is very insufficient in Montenegro, and its consumption is slightly above 1.0 kg per inhabitant (PRENKIĆ 2002).

The aim of this study was to separate, on the basis of our research, the best genotypes from natural populations of chestnut that can be successfully grown in plantations, as well as in parks as decorative tree.

MATERIALS AND METHODS

The research was carried out in natural population of chestnut in the southern part of Montenegro (the South Eastern slopes of Rumija to Skadar lake), the place of Krajina (Ostros and Kostajnica). In the period 2006-2011, 125 trees were included for wider research. During 2007-2011, the study was conducted on 14 trees that were shortlisted, based on their habitus, phenological-morphological and pomological characteristics of the chestnut. All selected trees were divided to two sites – seven for each site: Ostros I, II, III, IV, V, VI, VII and Kostajnica I, II, III, IV, V, VI, VII.

Field research included the determination of the beginning and end of the full flowering phenophase and the bloom energy, according to VELIČKOVIĆ (2006). The beginning of fruit ripening was determined, according to PAŠALIĆ (2006). Fruit weight was measured using a high precision balance type "E METTLER". Fruit dimensions (length, height and width), hilum dimensions (length and width) were measured by caliper. Statistical analysis of the time of flowering, ripening, yield of the mass and dimensions of the fruit was performed in SPSS for Windows Release 7.5, the standard version of the package ANOVA. The following statistical parameters were calculated: analysis of variance F-test and LSD-test. Comparisons were made within the examined trees and years of research as well as within the selected trees and fruit dimensions and their interaction in the period 2007-2011 on the level of significance of 0.05 and 0.01%.

On the basis of the entire mass of fruits per individual trees we have found the yield of selected chestnut trees. For all pomological measurements we used 50 fruits in three replicates of each tested tree, and values were compared and grouped according to international descriptor for chestnut (UPOV 1989, 1991).

Environmental conditions

Since the distribution of chestnut depends on the climate and geology and soil (edaphic) conditions in the first place, in the description of the site of Krajina (Ostros and Kostajnica), which also represent significant chestnut stands in Montenegro, a special attention was paid to these factors, according to DUBAK (2006).

Climate zone of Ostros and Kostajnic), with northeastern exposure, is open to the Skadar Lake. Due to the strong climatic contrasts between land and water in this area, there are sudden changes in climate parameters in the contact zone.

Temperature: Average annual air temperature is about 13 ^{0}C to 15 ^{0}C. The coldest month is January with about 4 °C to 5 °C, and the warmest period is July-August, with average monthly temperature about 24 ^{0}C.

The period of early spring: average daily temperature of 5 °C or more but less than 15 °C, in this zone is around February 11th to March 1st. The ending time of average daily temperatures above 5 °C is around December 11th.

Period of active daily temperature: average daily temperature above 10 ° C, begins around March 21st to April 11th and ends around November 11th to November 21st .

Period with average daily temperature: above 15 °C, warm days, starts around April 21st and ends around October 1st

Annual average is about 120-130 days of summer with a maximum temperature of 25 °C and about 50-70 days with tropical maximum temperature of 30 °C and above.

The warmest month is July with 24.3°C with a deviation of the average annual temperature of +10.1 °C, while the coldest month is January with 4.1 °C the same deviation of annual temperature. The average annual amplitude is 20.2 ^{0}C.

The sum of active temperature is around 4500 ° C per year.

The average duration of sunshine is about 2500 hours per year. The maximum daily duration of sunshine is in July, with about 11.5 hours a day. The minimum is in December with at least about 3.5 hours a day. Insolation is dependent on the degree of the cloud cover. Therefore, daily and annual amount of sunshine should be viewed in the context of reciprocal cloudiness. For example, reduced amount of sunshine in December is not only due to short days

but also due to increased cloudiness at the time. In other words, it is known that during December there is an intense cyclonic activity when sun shines zero hours a day, for several consecutive days. The very value of 3.5 hours per day indicates that there is a factor that reduces insolation, since a December day certainly takes longer than 3.5 hours.

Precipitation: Average annual rainfall is about 2504 lit/m2. The average annual number of rainy days (> = 0.1lit/m2) is about 90-100 days, including about 40 to 50 days with strong rainfall of over 20 lit/m2.

Table 1. Absolute climatogram for Ostros and Kostajnica, ^{0}C, lit/m2, (2007-2011.)

Ost.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	God.
Tem.	4.1	7.5	8.5	12.5	16.4	20.1	24.3	24.1	19.9	14.8	10.8	6.9	14.2
Prec.	310	270	260	180	131	74	31	54	149	295	390	360	2504

Relative annual fluctuation (RGC) is 14%, which indicates the existence of extremely wet and dry periods during the year. This is also confirmed by the fact that the November rainfall, as a rainy period, is 13 times higher than the rainfall in July, as the drought period. Precipitation in July is only 1.3% of the annual amount of precipitation, while in November it is 15.6% of the annual amount. RGC of 14% means that the difference between high rain and dry months is exactly 14% of annual precipitation. High RGC values, about 10% to 17%, indicate uneven or very uneven distribution of monthly quantity during the year while small values, around 3% to 6%, indicate a relatively homogeneous distribution of rainfall throughout the year.

The average relative humidity of the growing period is about 65% -70%.

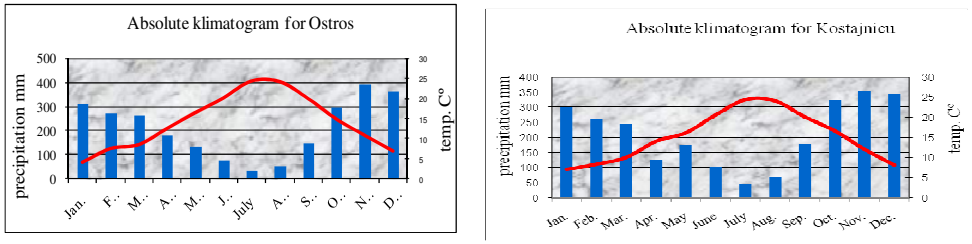

Fig. 1 Absolute klimatogram for Ostros and Kostajnica

Beside climate, soil is one of the most important factors for the chestnut growing. It grows best in deep, fresh noncarbonated soil.

The most widespread ground where the tested chestnut population has developed is sour brown soil or dystric cambisols. The geological substrate consists of limestone with interbeds of cherts, which appear on the surface in the form of small limestone cups or individual rocks, as well as in the soil at greater depths. On these grounds, the processes of deluviation sedimented the more powerful soil with more powder and clay fractions than a sandy beach. Although it is formed on limestone, this soil contains only trace amounts of CaCO3 (limestone scrubber with dissolving CaCO3 in the form of bicarbonate), and its impact on soil is insignificant.

Table 2. The chemical composition of soil at the experimental field-Ostros, 2007-2011.

Sample	Depth	$CaCO_3$	pH		mg/100g.soil		Humus
			H_2O	KCl	P_2O_5	K_2O	
A_1	0-10	1,49	6,65	6,15	4,00	25,00	3,04
A_2	30-50	1,27	6,57	6,06	0,50	25,00	1,83
A_3	50-80	2,76	6,03	5,76	0,50	18,00	0,69

Table 3. The chemical composition of soil at the experimental field-Kostajnica, 2007-2011.

Sample	Depth	$CaCO_3$	pH		mg/100g.soil		Humus
			H_2O	KCl	P_2O_5	K_2O	
A_1	0-10	1,46	6,66	6,35	7,02	31,56	4,90
A_2	10-30	1,25	6,01	5,20	0,57	16,68	3,11
A_3	30-50	1,25	5,98	4,85	0,42	24,57	3,00

According to DUBAK (2001), the pH values indicate acid weak soils. The humus content in the analyzed samples is high so the soil contains a lot of humus. The humus content decreases with depth.

According to FUŠTIĆ *et al.* (2000) to the value obtained by analyzing the samples, we conclude that the land is well provided with potassium, and phosphorus content is very low. The values of 1.25 and 2.76% CaCO3 in both profiles suggest that it is a little calcareous soil.

RESULTS AND DISCUSSION

The duration of flowering of the studied chestnut trees was quite uniform in the years of research (Table 4). The shortest interval of flowering energy was recorded for the selected trees Kostajnica II, IV and VII (14 days) and the longest in the tree Ostros I, II, IV and Kostajnica III (16 days). The studied trees, Ostros I, IV, V and Kostajnica I, III and VI, (09.06.) had the earliest flowering. Ostros III, VII and Kostajnica IV (26.06.) had the latest flowering completion. Analysis of variance showed statistically significant differences between examined trees at the beginning and at full flowering, until the flowering at the end of all clones was almost in the same period.

The condition of agro-ecological conditions in the localities Ostros Kostajnica primarily temperature and precipitation, affected the time of flowering of the selected chestnut trees. The favorable temperatures in May and June, and very low precipitation caused the relatively early flowering of the chestnut trees in question.

According to VELIČKOVIĆ (2004) it is necessary that continental fruits are exposed to low temperatures for some time, for normal, uniform and timely flowering. All tested chestnut trees, based on the time of flowering, are in the group of very early flowering (FURONES-PEREZ *et al.* 2009).

Favorable growing conditions in the researched region influenced the relatively uniform ripening fruits of chestnut. (Table 5.) The ripening of the researched chestnut trees shows that Kostajnica III (14.11.) were the last ready for harvest. Ostros II, VII (09.11.) were the earliest. Analysis of variance showed that the examined chestnut trees significantly differences in term of ripening.

Table 4. Time of flowering chestnut trees examined (Ostros - Kostajnica), 2007-2011

The study tree	Start flowering		Full flowering		End flowering		Duration flowering
OSTROS I	09.VI	c	18.VI	bc	25.VI	ab	16
OSTROS II	10.VI	bc	18.VI	bc	25.VI	ab	16
OSTROS III	11.VI	ab	19.VI	ab	26.VI	a	15
OSTROS IV	09.VI	c	18.VI	bc	25.VI	ab	16
OSTROS V	09.VI	bc	18.VI	bc	24.VI	b	15
OSTROS VI	10.VI	bc	17.VI	c	25.VI	a	15
OSTROS VII	11.VI	ab	19.VI	ab	26.VI	ab	15
KOSTAJNICA I	09.VI	c	17.VI	c	24.VI	ab	15
KOSTAJNICA II	11.VI	ab	18.VI	bc	25.VI	ab	14
KOSTAJNICA III	09.VI	c	17.VI	c	25.VI	ab	16
KOSTAJNICA IV	12.VI	a	20.VI	a	26.VI	a	14
KOSTAJNICA V	10.VI	c	18.VI	bc	25.VI	ab	15
KOSTAJNICA VI	09.VI	c	17.VI	c	25.VI	ab	15
KOSTAJNICA VII	11.VI	ab	18.VI	bc	25.VI	ab	14
	F = 0,000**		F = 0,0002**		F = 0,1756^{ns}		
	$LSD_{0,05}$=1,27		$LSD_{0,05}$=1,27		$LSD_{0,05}$=1,27		
	$LSD_{0,01}$=1,69		$LSD_{0,01}$=1,69		$LSD_{0,01}$=1,69		

Table 5. Ripening time and yield of sweet chestnut trees examined, kg / tree (Ostros -Kostajnica), 2007-2011.

The study tree			Ripening	Ripening			Yield (kg/tree)
	2007.	2008.	2009.	2010.	2011.	X	
Ostros I	11.11.	09.11.	12.11.	10.11.	13.11.	11.11.cdef	88 b
Ostros II	09.11.	08.11.	10.11.	09.11.	11.11.	09.11.f	81 de
Ostros III	12.11.	11.11.	13.11.	12.11.	14.11.	12.11.abcd	77 f
Ostros IV	13.11.	12.11.	15.11.	13.11.	13.11.	13.11.ab	83 cd
Ostros V	12.11.	10.11.	14.11.	12.11.	15.11.	13.11.abc	87 b
Ostros VI	11.11	09.11.	12.11.	10.11.	12.12.	11.11.cdef	94 a
Ostros VII	09.11.	08.11.	10.11.	09.11.	11.11.	09.11.f	85 bc
Kostajnica I	10.11.	09.11.	11.11.	10.11.	12.11.	10.11.def	69 hi
Kostajnica II	12.11.	10.11.	13.11.	11.11.	13.11.	12.11.abcde	66 i
Kostajnica III	14.11.	12.11.	15.11.	13.11.	14.11.	14.11.a	72 gh
Kostajnica IV	12.11.	11.11.	14.11.	12.11.	13.11.	12.11.abcd	72 gh
Kostajnica V	09.11.	09.11.	10.11.	10.11.	11.11.	10.11.ef	73 g
KostajnicaVI	11.11.	10.11.	12.11.	11.11.	13.11.	11.11.bcdef	78 ef
KostajnicaVII	12.11.	11.11.	13.11.	12.11.	14.11.	12.11.abcd	70 gh
	F= 0,0000**		$LSD_{0,05}$=2,83	$LSD_{0,01}$= 3,77			

The moment of chestnut ripening in our studies differed in relation to different sites of growing chestnuts in our country and the world. The fruits of selected chestnut trees ripen about a week later than those from the analysis that was published in Slovakia (BOLOVANSKY *et al.* 2001). SKENDER *et al.* (2011) state that in Bosnia and Herzegovina chestnut fruits ripen by the end of October, i.e. about two weeks earlier than in our study. All tested chestnut trees belong to a group of late middle to late ripening time (UPOV, 1989), taking the ripening time into account.

Fruit size of sweet chestnut is difficult to determine. Therefore the fruit weight is often used for its assessment. The average fruit weight for the three-year study period, as well as statistical indicators specific to this feature, are given in (Table 6). The average fruit weight of the selected trees was (6.9 g). The absolute highest average fruit weight (10.6 g), had the Ostros I tree and the lowest (4.8 g), Kostajnica VI, in the research period. During the research, we found that beside the selected tree Ostros I, Ostros II to VII also had the fruit weight which ranged in the interval (from 7.5 to 9.9 g).

Fruit weight of some tested chestnut trees, (Table 6), varied in years of study, and it depends primarily on environmental, agricultural factors. It also has a hereditary character, which is consistent with the reports of ERTAN (2007). Fruit weight of selected chestnut trees in Spain, Italy and Portugal varies (from 9.2 to 17.2 g) (DIAZ-FERNANDEZ, 2002). High variability in the average fruit mass (2.8-19.1 g) was reported for 21 of the Romanian species (5.3 - 15.1 g) (MUJIĆ *et al.* 2010). SKENDER *et al.* (2011) state that the average fruit weight in a natural population of BiH was (6:26 g), which fully equals our studies. According to the international descriptor for the chestnut, the fruit weight of sweet chestnut trees examined is in a group of small to medium-large fruits (UPOV, 1989).

The average length of the fruit of selected chestnut trees varied differently during the study period (Table 6.). The lowest average length of the fruit was found in the selected tree Kostajnica VI (19.6 mm) and highest in the tree Ostros I (30.6 mm). The minimum average width of the fruit was found in the tested tree Ostros VI (23.7 mm) and Kostajnica VI (23.8 mm), and highest in the Ostros II (34.9 mm). The average thickness of the fruit of selected chestnut trees was the lowest in the tree Kostajnica VI (13.2 mm) and highest in the tree Ostros II (23.8 mm). Biometric data processing indicates a significant difference in fruit size and the interaction between varieties and sizes of fruit. According to MUJIĆ-IN *et al.* (2010), significant morphological characteristics of chestnut fruit are its dimensions (length, width and thickness), which depends on the size of the fruit. Also, the dimensions of the chestnut fruit from the Mediterranean countries are not much different, which equals our research.

The selected trees Kostajnica II, IV, VI (19.0 mm) had minimal length of the hilum, and Ostros I (31.0 mm) had the maximum. However, the minimum width of hilum was found in the selected trees Kostajnica I, II, IV, Vi and VII (11.0 mm), while the highest width is detected in the tested tree Ostros I and II (16.0 mm). These results indicate a significantly smaller size of hilum at the site, to Ostros, which is consistent with the research of SKENDER (2011), who performed their tests in BiH.

The yield of the tested chestnut trees was on average (76.3 kg / tree) (Table 6.). The selected trees Kostajnica II (66.0 kg / tree), Kostajnica I (69.0 kg / tree) had the smallest yield and Ostros VI (94.0 kg / tree) and Ostros V (87.0 kg / tree) had the highest. Analysis of variance showed statistically significant differences in the yield of chestnut trees examined. The yield of chestnut depends on hereditary characteristics as well as agro-ecological conditions in a given

locality. It can be concluded that the yield and the fruit size was, on average, higher at Ostros than at Kostajnica. According to HADROVIĆ (1987) the yield of selected types of chestnuts from the native population in Metohija ranged (from 40 to 100 kg / tree), which is entirely consistent with our research. According to international descriptor all European chestnut trees examined belong to the group of average yield (UPOV, 1991).

Table 6. Morphological characteristics of fruit chestnut, g, mm (Ostros-Kostajnica), 2007-2011.

The study tree	Morphological characteristics of fruit chestnut				Dimension of hilum	
	Fruit mass	Fruit length	Fruit width	Fruit thickness	Length	Width
Ostros I	10.6	30.6 a	34.5 a	18.8 ab	31.0	16.0
Ostros II	9.9	28.2 a	34.9 a	23.8 a	28.0	16.0
Ostros III	7.8	25.6 ab	34.8 a	17.7 ab	23.0	15.0
Ostros IV	9.2	27.3 a	33.4 a	16.7 ab	27.0	15.0
Ostros V	7.5	26.4 ab	30.6 a	20.5 a	27.0	13.0
Ostros VI	7.6	24.6 ab	23.7ab	21.1 a	21.0	13.0
Ostros VII	7.8	27.8 a	31.6 a	21.3 a	27.0	14.0
Kostajnica I	5.1	21.3 ab	25.2 ab	15.7 ab	19.5	11.0
Kostajnica II	5.1	20.1 ab	24.7 ab	14.3 ab	19.0	11.0
Kostajnica III	5.5	22.1 ab	26.2 ab	16.8 ab	20.0	12.0
Kostajnica IV	5.4	20.6 ab	24.6 ab	14.3 ab	19.0	11.0
Kostajnica V	5.0	22.1 ab	26.5 ab	16.7 ab	20.0	12.0
Kostajnica VI	4.8	19.6 ab	23.8 ab	13.2 ab	19.0	11.0
Kostajnica VII	5.1	21.5 ab	25.7 ab	15.4 ab	19.5	11.0
$F_{A0.05}$ (4,140) = 2.37;		$F_{B0.05}$(13,140) = 1.75;		$F_{AB0.05}$(52,140) = 1.35		
F_A =0.66^{ns};		$F_{B=}$ 0.29^{ns};		$F_{AB=}$ 0.97^{ns}		
$F_{A0.01}$(4,140) = 3.32;		$F_{B0.01}$(13,140) = 2.18;		$F_{AB0.01}$(52,140) = 1.52		
$F_{A0.05}$ (13,168) = 1.75;		$F_{B0.05}$(2,168) = 2.99;		$F_{AB0.05}$(26,168) = 1.46		
F_A =0.52^{ns};		$F_{B=}$3.44*;		$F_{AB=}$0.52^{ns}		
$F_{A0.01}$(13,168) = 2.18;		$F_{B0.01}$(2,168) = 4.60;		$F_{AB0.01}$(26,168) = 1.69		
		$LSD_{0.05}$=2.60 $LSD_{0.01}$=3.13				

CONCLUSION

On the bases of the results obtained in the five-year period (2007-2011) we can conclude that the climate and soil conditions influence onthe occurrence and distribution of chestnut. Considering climatic conditions in our region it can be rightly concluded that they are optimal for chestnuts growing. Flowering is largely dependent on agricultural conditions in a given locality. The earliest flowering tree was Ostros V and the latest completed was Ostros III, IV and Kostajnica IV tree. Chestnut trees examined in the study are in very early flowering group.All tested chestnut trees belong to the group of late middle to late time ripening.The average fruit weight of the selected sweet chestnut trees was 6.9 g. The highest average fruit weight had the examined Ostros I tree, and the lowest Kostajnica VI.The lowest average length of the fruit was found in the Kostajnica VI tree and highest in the Ostros I tree. The minimum average width was found in fruit trees Ostros VI and Kostajnica VI and the maximum in the Ostros II trees. The

average thickness of the fruit was the lowest in the Kostajnica VI tree and highest in the Ostros II tree.The selected trees Kostajnica II, IV and VI had minimal length of the hilum and Ostros I had the maximum. The minimum width of hilum was found in the selected trees Kostajnica I, II, IV, VI and VII, while the highest width is detected in the tested tree Ostros I and II.

The yield of the tested chestnut trees was 76.3 kg / tree in average. The selected trees Kostajnica II, Kostajnica I had the smallest yield while Ostros VI and Ostros V had the highest.

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REFERENCES

BOLOVANSKY, M., L. MENDEL (2001): Revised descriptor list for the evaluation of genetic resources of European chestnut (*Castanea sativa Mill.*), For. Snow Landsc. Res. *76,3*, 439-444.

CONEDER, M., M. MANETTI, F. GIUDICI, E. AMORINI (2004): Distibution and economic potential of the sweet chestnut (Castanea sativaMill.) in Europe. Ecologic mediterranea, tome *30*, fascicule *2*, 179-193.

DIAZ-HERNANDEZ, M. (2002): Los cultivares de castano en Asturias. Ph.D. Thesis. Universidad de Santiago de Compostela, Lugo, 46-52, Spain.

DUBAK, D. (2001): Studies on some bio-ecological characteristics of the fungus *Cryphonectria parasitica* (Murr.) Barr. in Montenegro. Master thesis. Faculty of Forestry, 1-84, Belgrade, Serbia.

DUBAK, D. (2006): Cancer chestnut in Montenegro. VII Symposium on Plant protection, Book of Abstracts, pp. 127, Zlatibor, Serbia.

ERTAN, E. (2007): Variability in the leaf and fruit morphology and in fruit composition of chestnuts (*Castanea sativa Mill.*) in the Nazilli region of Turkey. Genet. Reseour Crop Ev *54,* 691-699.

FURONES-PEREZ, P., J. FERNANDEZ-LOPEZ (2009): Morphological and phenological description of 38 sweet chestnut cultivars (*Castanea sativa Mill.*) in a contemporary collection, Spain J Agric Res, *7* (4), 829-843.

FUŠTIĆ, B., G. ĐURETIĆ (2000): Land of Montenegro. University of Montenegro. In: III part Production value and soil utilization issue, Spalević, V. Ed.), 557-580, Podgorica, Montenegro.

HADROVIĆ, H. (1987): Chestnut Growing. Nolit, In: Biological characteristics of chestnut, Milošević, S. (Ed.), 31-55, Belgrade, Serbia.

KONSTANTINIDIS, P., G. TSIOURLIS, P. XOFIS, G. BUCKLEY (2008): Taxonomy and ecology of *Castanea sativa Mill*. forest in Greece. Plant Ecol., *195*, 235-256.

MALTONI A., A. PIERGUIDI, P. PIUSSI, A. TANI (2001): Grafting chestnut Guide. Distaf Universita degli Study di Firenze, Italy.

MUJIĆ J., V. ALIBABIĆ, J. ŽIVKOVIĆ, S. JAHIĆ, S. JOKIĆ, Ž. PRGOMET, Z. TUZLAK (2010): Characteristics of chestnut Castanea sativa with the Una-Sana Canton, Journal of Central European Agriculture, Vol. 11, $N_0$2, 1-8.

MURATOVIĆ A., M. KURTOVIĆ, DŽ. JAREBICA (1999): Fruit growing. Student printing, Balic, B. (Ed.), 1-176, Sarajevo< Bosnia and Hercegovina.

PAŠALIĆ, B. (2006): Picking, packing and storage of fruit products. Faculty of Agriculture, In: Determination of optimal moment for harvest, Markovic, J. (Ed.), 23-45, Banja Luka., Bosnia and Hercegovina

PRENKIĆ, R., A. ODALOVIĆ (2002): Fruit production in Montenegro, the situation and the possibility of development. – Proc. of International Symposium "Production of food", 9 -10th December, Belgrade - Zemun, Serbia, 143 - 155.

PRENKIĆ, R., A. ODALOVIĆ, M. RADULOVIĆ, R. POPOVIĆ, M. ČIZMOVIĆ (2009): Revitalization of fruit growing in Montenegro. Journal of Pomology, 43, 121-129.

SKENDER, A., M. KURTOVIĆ, S. HADŽIABULIĆ, F. GASI (2011): Pomological variability of sweet chestnut populations (*Castanea sativa Mill.*) in Bosnia and Herzegovina. 22nd International scientific-expert conference of agriculture and food industry – Sarajevo, 631/635:664 (082), 163-165.

UPOV, (1989): Guidelines for the conduct of tests for distinctness homogeneity and stability. Chestnut (*Castanea sativa Mill.*), TG/124, International Union for the Protection of New Varietis of Plants, TG/124/3, pp *23*. Geneve.

UPOV, (1991): International Convention for 1 New Varieties of Plants. International Union Protection of New Varieties of Plants, of 1961, as revised at Geneva on November-October 23, 1978, and on March, 19, 199.

VELIČKOVIĆ, M. (2004): Fruit growing I. Faculty of Agriculture, In: Fruit bodies and their functions, Vulić, T.(Ed.), 63 – 129, Belgrade, Serbia.

VELIČKOVIĆ, M. (2006): Fruit growing. Faculty of Agriculture, In: Biology of fruit trees Vulic, T. (Ed.), 35 – 64, Belgrade, Serbia.

VOSSEN, P. (1999): Chestnut culture in California. University of California Cooperative Exstension Farm Advisor Sonoma Contry.

EFECAT USLOVA SREDINE NA EKSPRESSIJU BIOPOMOLOŠKIH KARAKTERISTIKE KESTENA (*CASTANEA SATIVA MILL.*) U PRIRODNIM POPULACIJAMA U CRNOJ GORI

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Izvod

U radu su prikazani petogodišnji rezultati (2007-2011.) godine fenoloških osmatranja (kretanje vegetacije, početak, puno i kraj cvjetanja), morfometrijskih analiza (masa ploda, dužina, širina i debljina ploda, dužina i širina hiluma), vrijeme zrijenja i prosječan prinos odabranih genotipova pitomog kestena (*Castanea sativa Mill*.). Rezultati istraživanja pokazuju da se u pogledu vremena cvjetanja ispitivana stabla pitomog kestena nalaze u grupi vrlo ranocvjetnih. Zrijenje ispitivanih stabala kestena pokazuje da je za berbu najranije pristiglo stablo Ostros II, Ostros VII i Kostajnica V (09.11.), a najkasnije stablo Kostajnica III (14.11.). Prosječna masa ploda u odabranih stabala pitomog kestena iznosila je (6.9 g). Apsolutno najveću prosječnu masu ploda (10.6 g), imalo je ispitivano stablo Ostros I, a najmanju (4.8 g), KostajnicaVI. Prosječan prinos u ispitivanih stabala pitomog kestena je iznosio (76.3 kg/stablu). Najslabiji prinos imala su odabrana stabla Kostajnica II (66 kg/stablu) i Kostajnica I (69.0 kg/stablu), a najbolji ispitivana stabla Ostros VI (94.0 kg/stablu) i Ostros V (87.0 kg/stablu). Očigledno proizilazi zaključak da je genetička varijabilnost populacija veoma visoka i ekspresija gena je pod jakim uticajem spoljne sredine u ispitivanim lokacijama. Za dalja istraživanja neophodno je usmeriti istraživanja u kontrolisanim uslovima na materijalu definisane genetičke structure, optimalno *in vitro* u kulturi tkiva.

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