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EVALUATION OF LATE PLUM CULTIVARS IN THE REGION OF BELGRADE (SERBIA)

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ABSTRACT

Phenological traits, yield, and fruit characteristics of 14 plum cultivars of late maturation period were studied in the region of Belgrade in the five-year period (2013–2017). The control cultivar for comparison was 'Stanley'. The average time of flowering was in the first half of April, and of fruit maturation in the second half of August and the beginning of September. Yield per tree was lowest in the cultivar 'Pozna Plava' (10.2 kg) and highest in the cultivar 'Topking' (23.6 kg). Compared to the control, significantly lower yield was achieved in three cultivars: 'Pozna Plava', 'Vengerka Pozdnyaya', and 'Narach'. Fruit weight ranged from 26.1 g in the cultivar 'Elena' to 57.0 g in the cultivar 'Empress'. Compared to the control, it was significantly higher in three cultivars ('Empress', 'Vengerka Pozdnyaya', and 'Tophit'). All studied cultivars had high soluble solids content, ranging from 17.1% to 21.6%. The best rated cultivar for fruit appearance was 'Empress', while cultivars 'Nada' and 'Pozna Plava' were best scored for taste.

Key words: *Prunus domestica*, flowering, maturation, yield, fruit quality

INTRODUCTION

Plum is the most important fruit species in Serbia. The average production of 415,093 t per year in the period of 2014−2016 ranks Serbia on the third place in the world, after China and Romania [FAOSTAT 2018]. However, the average yield is low, only 5.3 t/ha. This is because the production is mostly extensive and cultural practices are often at a low level. Practically, the only used rootstock is Myrobalan (*Prunus cerasifera* Ehrh.) seedling. Plum cultivars grafted on Myrobalan seedling have strong growth, and late come into bearing [Sosna 2004, Glišić et al. 2016a]. The largest amount of produced plum fruits in Serbia is processed into brandy (more than 60%), while much smaller amounts are dried, frozen, and processed into other products. Fresh consumption of plums is quite small. In recent years, there is a tendency to increase export of fresh fruits, mostly to Russia [Milatović 2013].

The breeding of European plum (*Prunus domestica* L.) have been done in 13 European countries, within 21 breeding programs, and more than 170 new cultivars have been created in the past 20 years [Butac et al. 2013]. The most important goals of breeding are: climatic adaptation, high productivity, extension of the maturity range, good fruit quality (large and elongated fruits, dark blue skin, yellow and firm flesh, freestone), as well as resistance to disease causing agents, especially Plum Pox Virus [Neumüller 2010].

One of the largest plum breeding programs is located at the Fruit Research Institute in Čačak, Serbia, and it has been developed since 1946. The result of this program are 15 released cultivars [Glišić et al. 2015]. Most grown Serbian cultivars in new orchards are 'Čačanska Rodna' and 'Čačanska Lepotica'. Newly bred cultivars include 'Zlatka', 'Pozna Plava' and 'Nada' [Glišić et al. 2016b].

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In Germany, plum breeding started at the University of Hohenheim in 1980 with the main goals to extend the season, improve yield and fruit quality, and have resistance to plum pox. Some of the obtained cultivars are: 'Katinka', 'Hanita', 'Jojo', 'Elena' and 'Presenta' [Hartmann 1998]. The breeding program at Geisenheim Research Station in Germany has produced large-fruited cultivars such as 'Tophit' and high and regular bearing cultivars such as 'Topper' [Jacob 2007].

One of the important goals in plum breading is a creation of new cultivars of late maturation time. These cultivars can extend the plum season, especially if the fruits are kept in cold storage. Besides, at the end of the season, a better price can be achieved. Most of the late plum cultivars have higher content of dry matter and sugars than the early ones [Neumüller 2010, Milošević et al. 2012, Milatović et al. 2016, Božović et al. 2017].

Choosing suitable cultivars is the basic precondition of profitable plum production [Božović et al. 2017]. When growing introduced plum cultivars, it is important to determine their adaptability to local climatic and soil conditions [Blažek et al. 2004, Ionica et al. 2013].

The aim of this study was to evaluate phenological traits, yield and fruit characteristics of plum cultivars of late maturation time. The best performing cultivars will be recommended for growing in the region of Belgrade, as well as in other regions with similar environmental conditions.

MATERIALS AND METHODS

Plant material and experimental design

The study was conducted in the plum collection orchard at the Experimental Station "Radmilovac" of the Faculty of Agriculture in Belgrade (44°45'N, 20°35'E, 112 m a.s.l.) during the period of five years (2013–2017). The study included 14 plum cultivars. Five cultivars originate from Germany ('Elena', 'Top', 'Topper', 'Tophit', and 'Topking'), two cultivars from Serbia ('Nada' and 'Pozna Plava'), two from France ('Lorida' and 'Tardicot'), two from USA ('Empress' and 'Stanley') and one cultivar from Belarus ('Narach'), Russia ('Vengerka Pozdnyaya') and Canada ('Verity'). Control cultivar for comparison was 'Stanley'. All cultivars in the experimental orchard were represented by five trees.

The orchard was planted in 2009. The rootstock was Myrobalan (*Prunus cerasifera* Ehrh.) seedling, training system was central leader, and planting spacing 4.5 m × 3 m. In the orchard, standard cultural practices were applied, without irrigation.

Analytical methods

Flowering was recorded by recommendations of the International Working Group for pollination: start of flowering – 10% open flowers, full bloom – 80% open flowers, end of flowering – 90% of the petal fall [Wertheim 1996]. Trunk cross-sectional area (TCSA) was calculated on the basis of trunk circumference measured at the height of 30 cm above the grafting point. Cumulative yield efficiency was calculated by dividing the cumulative yield over five years by TCSA in the last year (2017) and it is expressed in kg per cm^2. Biennial bearing index was calculated using the formula given by Monselise and Goldschmidt [1982]:

$$BBI = \frac{1}{n-1} \times \left[\frac{|a_2 - a_1|}{|a_2 + a_1|} + \frac{|a_3 - a_2|}{|a_3 + a_2|} + \cdots + \frac{|a_n - a_{n-1}|}{|a_n + a_{n-1}|}\right]$$

where: BBI = biennial bearing index; n = number of experimental years; a_1, a_2, ... , a_n = yield in the 1st, 2nd, ... , nth year.

Fruit characteristics were measured on a sample of 25 fruits per cultivar. Fruit shape index was calculated using the formula: length × length / width × thickness. Soluble solids were determined by refractometer (Pocket PAL-1, Atago, Japan) and total acids (expressed as malic acid) by titration with 0.1 N NaOH. Sensory characteristics of the fruit (appearance and taste) were evaluated by a five-member jury, scoring the cultivars using the scale from 1 to 5 points.

Meteorological conditions

The region of study has a mid-latitude moderate continental climate with mean annual air temperature of 10.8°C and mean annual precipitation of 640 mm. The warmest month is July with an average temperature of 20.8°C and the coldest month is January with an average temperature of −0.5°C [Ruml et al. 2011]. Meteorological data during the period of study were measured at a climatological station located 300 m from the experimental orchard (Tab. 1).

Table 1. Average temperatures and sums of rainfall at the Experimental farm "Radmilovac" of the Faculty of Agriculture in Belgrade during the period of study (2013–2017)

Month	Average temperatures (°C)					Sum of rainfall (mm)				
	2013	2014	2015	2016	2017	2013	2014	2015	2016	2017
January	2.4	3.9	2.8	0.7	–4.6	69.0	14.0	37.2	37.8	5.2
February	3.8	6.3	2.9	7.9	4.0	55.0	13.6	41.2	35.2	23.4
March	5.7	9.8	7.2	8.0	11.1	93.8	50.2	107.4	89.4	58.2
April	13.4	12.7	12.1	14.1	11.6	24.2	72.6	31.0	49.6	62.6
May	17.8	15.7	17.6	16.2	17.2	96.4	265.8	49.6	73.8	78.8
June	20.0	20.3	20.5	21.5	22.7	41.4	53.8	50.2	100.8	53.4
July	22.6	21.8	24.6	22.6	23.8	12.2	148.4	6.0	53.0	64.4
August	23.5	21.0	24.1	20.7	24.1	23.6	83.0	50.0	88.8	28.0
September	16.2	17.1	19.0	17.8	17.1	69.4	99.4	77.4	47.2	58.8
October	13.5	12.7	11.2	10.1	12.3	34.8	54.8	63.8	71.6	70.4
November	8.7	8.2	7.8	6.2	7.1	39.6	13.8	50.8	62.0	47.8
December	1.9	3.2	3.0	−0.1	4.0	9.2	49.0	6.8	2.6	31.4
Year	12.5	12.7	12.7	12.1	12.5	568.6	918.4	571.4	711.8	582.4

The average yearly temperatures during the period of study (2013–2017) were by 1.3°C to 1.9°C higher compared to 50-year mean (1951−2000). During the experimental period, neither winter frosts nor late spring frosts were recorded, which could lead to the freeze of generative organs of plums. The absolute minimum temperature of −17.6°C was recorded on 10th of January 2017.

Regarding the sum of rainfall in three years (2013, 2015 and 2017), it was lower than the long-term average value for this region (640 mm). In two years (2014 and 2016), the rainfall sum was higher. Especially high rainfall sum was recorded in May and July in 2014 year.

Data analyses

The obtained data were statistically processed using analysis of variance. The significance of differences between mean values was determined using Duncan's multiple range test at 0.05 level of probability.

RESULTS AND DISCUSSION

Phenological characteristics

Average time of flowering of tested cultivars was in the first half of April (Tab. 2). The earliest start of flowering was recorded in cultivars 'Empress' and 'Topper' (31st of March), and the latest in the cultivar 'Narach' (5th of April). The average difference between cultivars with earliest and latest flowering was five days, and among years it varied from four to nine days.

Among years, the earliest flowering was in 2014, when the average date of flowering onset for all cultivars was on 24th of March. The latest flowering was in 2013 when the average date of flowering onset was on 17th of April. The difference between years with the earliest and latest flowering was 24 days and it was much larger than difference between cultivars. Based on this, it can be noted that ecological factors (primarily temperature) have a greater impact on the phenophase of flowering, than genetic characteristics of cultivars. This is in accordance with findings of Milatović [2005] for apricot.

The average duration of flowering ranged from 7.8 days ('Elena') to 11.4 days ('Topking'). Among years, the average duration of flowering ranged from 7.6 days in 2015 to 11.4 days in 2016. Flowering lasted longer in cultivars with earlier flowering period, as well as in years with earlier onset of flowering and lower temperatures during this phenophase.

Table 2. Phenological characteristics of plum cultivars (average 2013–2017)

Cultivar	Flowering dates			Duration of flowering (days)	Abundance of flowering (0–5 scale)	Harvest date
	start	full	end			
'Elena'	4th April	6th April	11th April	7.8	4.1	31st August
'Empress'	31st March	3rd April	11th April	10.8	4.2	24th August
'Lorida'	1st April	3rd April	10th April	9.2	4.7	31st August
'Nada'	4th April	6th April	13th April	9.6	4.3	19th August
'Narach'	5th April	8th April	14th April	8.6	3.9	18th August
'Pozna Plava'	4th April	7th April	12th April	8.4	3.8	2nd September
'Stanley' (control)	4th April	6th April	13th April	9.0	4.8	19th August
'Tardicot'	1st April	4th April	10th April	8.4	4.6	3rd September
'Top'	3rd April	5th April	12th April	9.2	3.9	28th August
'Topper'	31st March	4th April	10th April	10.0	4.9	27th August
'Tophit'	2nd April	6th April	13th April	11.2	2.8	28th August
'Topking'	1st April	4th April	13th April	11.4	4.6	17th August
'Vengerka Pozdnyaya'	3rd April	6th April	13th April	10.0	3.6	17th August
'Verity'	1st April	4th April	11th April	9.8	3.2	16th August

The most abundant flowering was recorded in the cultivar 'Topper' (score 4.9 on the 0–5 scale). The lowest flowering intensity (score 2.8) was recorded in the cultivar 'Tophit'.

The range of fruit maturity was from 16th of August ('Verity') to 3rd of September ('Tardicot'). For most cultivars, the earliest fruit maturation was in 2016, and the latest in 2015. Difference between years with the earliest and latest fruit maturation was 10 days on average, and among cultivars it ranged from five days ('Verity') to 16 days ('Top').

Flowering and fruit maturation of plum cultivars in the region of Belgrade were earlier comparing to Germany [Jacob 1998], Czech Republic [Blažek and Pišteková 2009], Central Bulgaria [Dragoyski et al. 2010], and Poland [Markuszewski and Kopytowski 2013]. These differences can be explained by different environmental conditions between the study regions.

Yield and vigor

The average yield per tree was lowest in the cultivar 'Pozna Plava' (10.2 kg) and highest in the cultivar 'Topking' (23.6 kg) (Tab. 3). Compared to the control, significantly lower yield was achieved in three cultivars: 'Pozna Plava', 'Vengerka Pozdnyaya', and 'Narach'. High average yield (above 20 kg per tree) was obtained in cultivars 'Topking', 'Lorida', 'Stanley', 'Elena' and 'Nada'.

Among years of testing, the lowest yield was recorded in 2013. This is expected, given that the age of trees at that time was five years, which means that orchard was still in the period of initial cropping.

Some cultivars showed high variation in yield level by years that was determined using biennial bearing index (BBI). This is especially case with cultivars 'Tophit', 'Vengerka Pozdnyaya', 'Verity' and 'Narach' (BBI = 0.53–0.81). These cultivars are more prone to biennial bearing. The lowest values of BBI (0.10–0.19) were determined in cultivars 'Tardicot', 'Lorida', 'Stanley' and 'Nada'. These cultivars exhibit regular bearing.

The lowest vigor was found in the cultivar 'Topper', and highest in cultivars 'Lorida' and 'Tardicot'. Compared to the control cultivar ('Stanley'), the trunk cross-sectional area (TCSA) was significantly higher in four cultivars ('Lorida', 'Tardicot, 'Verity' and 'Tophit').

Table 3. Yield (2013–2017), trunk cross-sectional area (TCSA) in 2017, cumulative yield efficiency (CYA), and biennial bearing index (BBI) of plum cultivars

Cultivar	Yield (kg per tree)						TCSA (cm^2)	CYE (kg cm^{-2})	BBI
	2013	2014	2015	2016	2017	average			
'Elena'	14.7	24.7	15.7	27.1	18.6	20.2 ab	121.1 b-d	0.83	0.23
'Empress'	15.6	18.8	30.4	3.3	17.6	17.1 a-c	81.8 ef	1.05	0.45
'Lorida'	16.2	24.6	29.0	23.2	24.6	23.5 a	159.1 a	0.74	0.11
'Nada'	5.9	26.5	23.4	21.8	22.7	20.1 ab	79.0 f	1.27	0.19
'Narach'	7.8	21.6	16.4	2.5	21.7	14.0 bc	112.7 c-e	0.62	0.53
'Pozna Plava'	3.1	15.8	11.4	10.1	10.4	10.2 c	118.0 cd	0.43	0.23
'Stanley' (control)	16.1	13.0	28.5	30.7	25.1	22.7 a	93.4 d-f	1.21	0.15
'Tardicot'	16.3	21.4	21.3	23.3	15.4	19.5 ab	159.1 a	0.61	0.10
'Top'	13.1	18.5	24.7	11.6	17.9	17.1 a-c	83.1 ef	1.03	0.22
'Topper'	12.6	20.6	20.3	30.4	12.4	19.3 ab	72.6 f	1.33	0.22
'Tophit'	3.0	1.6	46.8	0.1	37.1	17.7 ab	129.9 a-c	0.68	0.81
'Topking'	9.2	31.8	12.8	45.5	18.7	23.6 a	96.1 de	1.23	0.49
'Vengerka Pozdnyaya'	7.0	19.4	0.3	16.4	10.3	10.7 c	92.9 d-f	0.57	0.66
'Verity'	12.8	25.9	8.8	40.3	5.8	18.7 ab	152.4 ab	0.61	0.56

Mean values followed by the same letter within a column do not differ significantly according to Duncan's multiple range test at $P \leq 0.05$

Cumulative yield efficiency ranged from 0.43 kg cm^{-2} to 1.33 kg cm^{-2}. Besides control, cultivars 'Topper', 'Nada', 'Topking, 'Empress' and 'Top' stood out for high CYE. Although cultivar 'Topper' was ranked only seventh in terms of yield per tree, while in terms of CYE it was the first one, due to its low vigor. Based on low values for TCSA and CYE, this cultivar can be recommended for growing in high density plantings. Our results of low vigor and high yield of the cultivar 'Topper' confirm previous findings [Jacob 1998, Blažek and Pišteková 2009]. High CYE of the cultivar 'Top' is in agreement with previous results [Cmelik et al. 2007, Markuszewski and Kopytowski 2013].

Fruit characteristics

Fruit weight ranged from 26.1 g in the cultivar 'Elena' to 57.0 g in the cultivar 'Empress' (Tab. 4). Compared to the control, fruit weight was significantly higher in three cultivars ('Empress', 'Vengerka Pozdnyaya', and 'Tophit') and significantly lower also in three cultivars ('Elena', 'Topper', and 'Topking').

Among years, fruit weight was significantly higher in 2014 and 2016 compared to the remaining three years. This can be explained by higher amount of rainfall in these two years in the period of development of plum fruits. The sum of rainfall in the period from April to August 2014 was 624 mm, and in 2016 it was 366 mm (Tab. 1). In the remaining three years, the amount of precipitation in this period was significantly lower (187–287 mm).

Stone weight ranged from 1.17 g ('Top') to 2.46 g ('Empress'). Stone share in the fruit weight ranged from 3.3% ('Vengerka Pozdnyaya') to 5.7% ('Pozna Plava').

Significant differences were found between cultivars for fruit dimensions. Fruit dimensions were highest in the cultivar 'Empress'. On the other hand, the lowest fruit length was found in the cultivar 'Narach', width in cultivars 'Elena', 'Lorida' and 'Tardicot', and thickness in the cultivar 'Tardicot'. Based on dimensions, fruit shape index was calculated, the values of which ranged from 1.17 in 'Narach' to 2.19 in 'Tardicot'. Most of the studied cultivars had an elongated (elliptic or ovate) shape of the fruit.

Very small stalk length was found in cultivar 'Vengerka Pozdnyaya' (1.1 cm). On the other hand, long stalk was found in cultivars 'Lorida' and 'Tardicot' (2.8 and 3.0 cm, respectively).

Table 4. Fruit characteristics of plum cultivars (average 2013–2017)

Cultivar	Fruit weight (g)	Stone weight (g)	Stone share (%)	Fruit dimensions (cm)			Shape index	Stalk length (cm)
				length	width	thickness		
'Elena'	26.1 f	1.45 cd	5.6	4.1 e	3.2 e	3.3 e	1.62	1.9 bc
'Empress'	57.0 a	2.46 a	4.3	5.6 a	4.2 a	4.1 a	1.81	1.5 d
'Lorida'	28.0 ef	1.30 de	4.6	4.7 bc	3.2 e	3.2 e	2.18	2.8 a
'Nada'	38.8 bc	1.65 bc	4.3	4.7 bc	3.7 bc	3.7 b-d	1.60	1.7 cd
'Narach'	34.2 d-f	1.26 de	3.7	4.0 e	3.6 b-d	3.7 b-d	1.17	1.7 cd
'Pozna Plava'	28.9 fg	1.66 bc	5.7	4.4 c-e	3.4 c-e	3.3 e	1.71	2.3 b
'Stanley' (control)	33.2 c-e	1.78 b	5.4	4.9 b	3.5 c-e	3.4 de	2.02	2.2 b
'Tardicot'	27.1 ef	1.26 de	4.7	4.7 bc	3.2 e	3.1 e	2.19	3.0 a
'Top'	27.2 ef	1.17 e	4.3	4.1 e	3.4 c-e	3.3 e	1.50	1.8 b-d
'Topper'	26.6 f	1.38 de	5.2	4.2 de	3.3 de	3.2 e	1.71	2.0 bc
'Tophit'	42.2 b	1.85 b	4.4	4.6 b-d	4.0 ab	3.8 a-c	1.42	1.5 d
'Topking'	26.6 f	1.43 cd	5.4	4.1 e	3.3 de	3.2 e	1.61	1.6 d
'Vengerka Pozdnyaya'	43.7 b	1.43 cd	3.3	4.9 b	3.6 b-d	4.0 ab	1.62	1.1 e
'Verity'	37.6 bc	1.77 b	4.7	4.7 bc	3.8 bc	3.5 c-e	1.69	2.3 b

Mean values followed by the same letter within a column do not differ significantly according to Duncan's multiple range test at $P \leq 0.05$

Results of fruit characteristics are in accordance with previous findings for some cultivars [Dragoyski et al. 2010, Bozhkova 2013, Glišić et al. 2015]. Values obtained in this study for some cultivars, especially 'Tophit', were lower than those recorded by Blažek and Pišteková [2009] in Czech Republic, and Kovács [2013] and Molnár et al. [2016] in Hungary.

All studied cultivars had high soluble solids content (SSC) (Tab. 5). In that regard, they all satisfied requirement for late plum cultivars of SSC above 17% given by Neumüller [2010]. In the cultivar 'Tardicot', SSC was significantly higher in relation to the control. High SSC (above 20%) was also found in cultivars 'Pozna plava', 'Topking', 'Verity', and 'Tophit'.

Total acids content (TAC) ranged from 0.48% in the cultivar 'Nada' to 1.29% in the cultivar 'Empress'. Compared to the control, TAC was significantly higher in six cultivars.

The ratio between contents of soluble solids and total acids (SSC/TAC), rather than the SSC alone, represents a reliable indicator of a cultivar's suitability for acceptance by consumers [Crisosto et al. 2004]. Cultivars 'Nada' and 'Elena' are characterized by very high SSC/TAC ratio (above 30). Very high SSC/TAC ratio in the cultivar 'Nada' confirm previous results of Glišić et al. [2015].

Data on chemical composition of fruits are in good agreement with previous findings for some cultivars [Blažek and Pišteková 2009, Voća et al. 2009, Kovács 2013, Molnár et al. 2016]. On the other hand, in our study, higher SSC and lower TAC were found compared to results of Markuszewski and Kopytowski [2013] in Poland and Bohačenko et al. [2010] in Czech Republic. These differences can be explained by higher temperatures and lower rainfall in the region of Belgrade.

Best rated cultivar for fruit appearance was 'Empress' that obtained significantly higher score than control cultivar. On the other hand, the lowest scores, significantly lower than in control, were obtained in cultivars 'Tardicot' and 'Narach'. Best rated cultivars for taste were 'Nada' and 'Pozna Plava' that obtained significantly higher scores than control cultivar.

Table 5. Indices of fruit quality of plum cultivars (average 2013–2017)

Cultivar	Soluble solids (%)	Total acids (%)	Soluble solids/ Total acids	Sensory evaluation (1−5)	
				appearance	taste
'Elena'	18.0 bc	0.52 g	35.0	3.5 de	3.9 a-c
'Empress'	18.4 bc	1.29 a	14.2	4.7 a	3.8 b-d
'Lorida'	19.7 ab	0.82 c-e	23.9	3.5 de	3.3 d
'Nada'	18.3 bc	0.48 g	37.9	4.2 a-c	4.4 a
'Narach'	18.5 bc	0.75 d-f	24.7	3.3 e	3.5 d
'Pozna Plava'	20.8 ab	0.74 d-f	28.1	3.9 b-d	4.2 ab
'Stanley' (control)	18.2 bc	0.62 fg	29.5	4.0 b-d	3.6 cd
'Tardicot'	21.6 a	0.76 d-f	28.3	3.2 e	3.5 d
'Top'	17.1 c	0.76 d-f	22.5	3.6 de	3.4 d
'Topper'	19.5 a-c	0.66 e-g	29.5	3.7 c-e	3.8 b-d
'Tophit'	20.1 ab	0.95 bc	21.1	4.3 ab	3.8 b-d
'Topking'	20.4 ab	1.10 b	18.5	3.7 c-e	3.6 cd
'Vengerka Pozdnyaya'	19.7 a-c	1.07 b	18.3	4.3 ab	4.1 a-c
'Verity'	20.4 ab	0.85 cd	24.0	4.0 b-d	3.7 b-d

Mean values followed by the same letter within a column do not differ significantly according to Duncan's multiple range test at $P \leq 0.05$

CONCLUSIONS

1. The flowering of studied plum cultivars in the region of Belgrade was in the first half of April, and the fruit maturation was in the second half of August and the beginning of September.

2. High productivity in terms of yield per tree and yield efficiency, was recorded in cultivars 'Topking', 'Nada', 'Topper', 'Top' and 'Empress'. In this regard, these cultivars are at the same level as highly productive control cultivar, 'Stanley'.

3. Cultivars 'Empress', 'Vengerka Pozdnyaya', and 'Tophit' are characterized by large fruit size (over 40 g), significantly higher compared to the control.

4. The best rated cultivar for fruit appearance was 'Empress', while cultivars 'Nada', and 'Pozna Plava' were best scored for taste.

5. On the basis of obtained results, for cultivation in the region of Belgrade, it is possible to recommend 'Nada', 'Topper' and 'Topking' as cultivars of combined traits (suitable both for fresh consumption and for processing). Besides, cultivars 'Empress' and 'Tophit' can also be grown as predominantly table cultivars (for fresh consumption).

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REFERENCES

Blažek, J., Pišteková, J. (2009). Preliminary evaluation results of new plum cultivars in a dense planting. Hortic. Sci., 36(2), 45–54.

Blažek, J., Vávra, R., Pištěková, I. (2004). Orchard performance of new plum cultivars on two rootstocks in a trial at Holovousy in 1998–2003. Hortic. Sci., 31(2), 37–43.

Bohačenko, I., Pinkrová, J., Komárková, J., Paprštein, F. (2010). Selected processing characteristics of new plum cultivars grown in the Czech Republic. Hortic. Sci., 37(2), 39–45.

Bozhkova, V. (2013). Plum genetic resources and breeding. AgroLife Sci. J., 2(1), 83–88.

Božović, D., Bosančić, B., Velimirović, A., Ercisli, S., Jaćimović, V., Keles, H. (2017). Biological characteristics of some plum cultivars grown in Montenegro. Acta Sci. Pol. Hortorum Cultus, 16(2), 35–45. DOI: 10.24326/asphc.2017.2.0.

Butac, M., Bozhkova, V., Zhivondov, A., Milosevic, N., Bellini, E., Nencetti, V., Blazek, J., Balsemin, E., Lafarque, B., Kaufmane, E., Gravite, I., Vasiljeva, M., Pintea, M., Juraveli, A., Webster, T., Hjalmarsson, I., Trajkovski, V., Hjeltnes, S.H. (2013). Overview of plum breeding in Europe. Acta Hortic., 981, 91–98. DOI: 10.17660/ActaHortic.2013.981.9.

Cmelik, Z., Druzic Orlic, J., Duralija, B., Tonjko, S., Strikic, F. (2007). Growth and yield of plum trees 'Felsina', 'Top' and 'Elena' grafted on GF 655/2. Acta Hortic., 734, 337–339. DOI: 10.17660/ActaHortic.2007.734.47.

Crisosto, C.H., Garner, D., Crisosto, G.M., Bowerman, E. (2004). Increasing 'Blackamber' plum (*Prunus salicina* Lindley) consumer acceptance. Postharvest Biol. Technol., 34, 237–244. DOI: 10.1016/j.postharvbio. 2004.06.003.

Dragoyski, K., Minev, I., Dinkova, H., Stoyanova, T., Minkov, P. (2010). Evaluation of some introduced plum cultivars in RIMSA Troyan. Acta Hortic., 874, 311–316. DOI: 10.17660/ActaHortic.2010.874.44.

FAOSTAT (2018). http://www.fao.org/faostat/en/#data/QC [date of access: 3.01.2018].

Glišić, I., Milatović, D., Milošević, N., Lukić, M. (2015). Biological and pomological properties of promising plum hybrids created at the Fruit Research Institute, Čačak. VI International Scientific Agricultural Symposium "Agrosym 2015", Jahorina, pp. 424–429.

Glišić, I.P., Milošević, T., Glišić, I.S., Ilić, R., Paunović, G., Milošević, N. (2016a). Tree vigour and yield of plum grown under high density planting system. Acta Hortic., 1139, 131–136. DOI: 10.17660/ActaHortic.2016.1139.23.

Glišić, I., Karaklajić-Stajić, Ž., Paunović, S.A., Lukić, M. (2016b). Plum cultivars Zlatka and Pozna Plava (*Prunus domestica* L.) bred at the Fruit Research Institute in Čačak. Hortic. Sci., 43(1), 10–16. DOI: 10.17221/61/2015-HORTSCI.

Hartmann, W. (1998). New plum cultivars from Hohenheim. Acta Hortic., 478, 171–174. DOI: 10.17660/ActaHortic.1998.478.26.

Ionica, M.E., Nour, V., Trandafir, I., Cosmulescu, S., Botu, M. (2013). Physical and chemical properties of some European plum cultivars. Not. Bot. Horti Agrobot. Cluj Napoca, 41(2), 499–503. DOI: 10.15835/nbha4129354.

Jacob, H.B. (1998). Top, Topper and Tophit: Three new late ripening plum cultivars for a profitable market. Acta Hortic., 478, 165–168. DOI: 10.17660/ActaHortic.1998.478.24.

Jacob, H.B. (2007). Twenty-five years plum breeding in Geisenheim, Germany: breeding targets and previous realisations. Acta Hortic., 734, 341–346. DOI: 10.17660/ActaHortic.2007.734.48.

Kovács, S. (2013). Examination of the adaptation of German plum varieties in Hungary. Hung. Agric. Res., 22(2), 4–11.

Markuszewski, B., Kopytowski, J. (2013). Evaluation of plum cultivars grafted on 'Wangenheim Prune' rootstock in the northeast of Poland. Folia Hortic., 25(2), 101–106. DOI: 10.2478/fhort-2013-0011.

Milatović, D. (2005). Cvetanje sorti kajsije u beogradskom području. Voćarstvo, 39, 285–293.

Milatović, D. (2013). Pflaumen- und kirschenanbau in Serbien. Obstbau, 38(2), 115–119.

Milatović D., Đurović D., Zec G., Radović M. (2016). Phenological traits, yield and fruit quality of plum cultivars created at the Fruit Research Institute in Čačak, Serbia. VII International Scientific Agriculture Symposium "Agrosym 2016", Jahorina, pp. 789–795.

Milošević, N., Mratinić, E., Glišić, S.I., Milošević, T. (2012). Precocity, yield and postharvest physical and chemical properties of plums resistant to Sharka grown in Serbian conditions. Acta Sci. Pol. Hortorum Cultus, 11(6), 23–33.

Molnár, Á.M., Ladányi, M., Kovács, S. (2016). Evaluation of the production traits and fruit quality of German plum cultivars. Acta Univ. Agric. Silvic. Mendel. Brun., 64(1), 109–114. DOI: 10.11118/actaun201664010109.

Monselise, S.P., Goldschmidt, E.E. (1982). Alternate bearing in fruit trees. Hort. Rev., 4, 129–173. DOI: 10.1002/9781118060773.ch5.

Neumüller, M. (2010). Fundamental and applied aspects of plum (*Prunus domestica* L.) breeding. Fruit Veg. Cereal Sci. Biotech., 5(spec. issue 1), 139–156.

Ruml, M., Milatović, D., Vulić, T., Vuković, A. (2011). Predicting apricot phenology using meteorological data. Int. J. Biometeorol., 55(5), 723–732. DOI: 10.1007/s00484-010-0387-0.

Sosna, I. (2004). The estimation of the production value of several plum cultivars grafted on 'Myrobalan' seedlings in Wroclaw area (Poland). Acta Sci. Pol. Hortorum Cultus, 3(1), 47–54.

Voća, S., Galić, A., Šindrak, Z., Dobričević, N., Pliestić, S., Družić, J. (2009). Chemical composition and antioxidant capacity of three plum cultivars. Agric. Conspec. Sci., 74(3), 273–276.

Wertheim, S.J. (1996). Methods for cross pollination and flowering assessment and their interpretation. Acta Hortic., 423, 237–241. DOI: 10.17660/ActaHortic.1996.423.30.