

## EVALUATION OF MEDIUM EARLY PLUM CULTIVARS IN THE REGION OF BELGRADE (SERBIA)

Dragan MILATOVIĆ<sup>1\*</sup>, Dejan ĐUROVIĆ<sup>1</sup>, Gordan ZEC<sup>1</sup>, Đorđe BOŠKOV<sup>1</sup>, Mirjana RADOVIĆ<sup>2</sup>

<sup>1</sup>Faculty of Agriculture, University of Belgrade, Serbia

<sup>2</sup>Faculty of Agriculture, University of East Sarajevo, Bosnia and Herzegovina

\*Corresponding author: mdragan@agrif.bg.ac.rs

### Abstract

Phenological traits, yield, and fruit characteristics of seven plum cultivars of medium early maturation time were studied in the region of Belgrade (Serbia) in the four-year period (2013-2016). Control cultivar for comparison was 'Čačanska lepotica'. The average time of flowering of tested cultivars was in the first half of April, and the average duration of flowering varied from 7.8 to 11.3 days. The average time of maturation ranged from July, 17 ('Valerija') to July, 31 ('Hanita'). The average yield per tree was the lowest in the cultivar 'Venera' (8.6 kg) and the highest in the cultivar 'Valerija' (28.6 kg). Compared to control, significantly higher yield was achieved in the cultivar 'Valerija', while the lower yield was found in cultivars 'Venera', 'Excalibur', 'Kišinjvska rana' and 'Čaradejka'. The lowest vigor was recorded in the cultivar 'Valerija', and the highest in the cultivar 'Reeves'. The average fruit weight ranged from 36.1 g in the cultivar 'Hanita' to 71.1 g in the cultivar 'Reeves'. Compared to control, fruit weight was significantly higher in cultivars 'Reeves', 'Excalibur' and 'Valerija'. High soluble solids content (above 18%) was found in cultivars 'Venera' and 'Kišinjvska rana'. Based on the obtained results, for growing in Belgrade region, cultivars 'Valerija' and 'Hanita' can be recommended.

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

### Introduction

Plum (*Prunus domestica* L.) is the most important fruit species in Serbia with the average production of 420.000 t per year in the period of 2011-2016 (Statistical Office of the Republic of Serbia, 2017). However, the average yield is low, only 5,4 t/ha. This is because the production is mostly extensive and cultural practices are often at a low level. The largest amount of produced fruits is processed into brandy (more than 60%), while much smaller amounts are dried, frozen, and processed into other product. Fresh consumption of plums is quite small. In recent years, there is a tendency to increase export of fresh fruits, mostly in Russia (Milatović, 2013).

A lot of work has been done on creation of new plum cultivars with improved characteristics, such as better adaptation to different ecological conditions, increased disease resistance, self-fertility, higher yield and better fruit quality. In the last 20 years more than 170 new plum cultivars were released in Europe (Butac et al., 2013). The introduction of new foreign cultivars and their study in Serbian climatic and soil conditions allow better choice of cultivars, and may improve the production of plums.

Plum breeding has been developed at the Fruit Research Institute in Čačak since 1946. The result of this programme are 15 released cultivars (Glišić et al., 2015). Most grown Serbian cultivars in new orchards are: 'Čačanska rodna', 'Čačanska lepotica' and 'Čačanska rana'.

The aim of this study was to evaluate phenological traits, yield and fruit characteristics of seven plum cultivars of medium early 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.

### Material and Methods

The study was conducted in the plum collection orchard at the Experimental Station “Radmilovac” of the Faculty of Agriculture in Belgrade during the period of four years (2013–2016). The orchard was planted in 2009. The rootstock is Myrobalan (*Prunus cerasifera* Ehrh.) seedling, training system is central leader, and planting distance is 4.5 x 3 m. All cultivars are represented by five trees. The study included seven plum cultivars: ‘Čaradejka’ (Belarus), ‘Excalibur’ (England), ‘Hanita’ (Germany), ‘Kišinjevska rana’ (Moldavia), ‘Reeves’ (Canada), ‘Valerija’ (Serbia), and ‘Venera’ (Belarus). Control cultivar for comparison was ‘Čačanska leptotica’.

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 ground level. Cumulative yield efficiency was calculated by dividing the cumulative yield over four years by TCSA in the last year (2016). 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 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.

The obtained data were statistically analyzed 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

Average time of flowering of tested cultivars was in the first half of April (Table 1). The earliest flowering was recorded in the cultivar ‘Valerija’, and the latest in the cultivar ‘Čaradejka’. The average difference between cultivars with earliest and latest flowering was 4 days.

Table 1. Phenological characteristics of plum cultivars (average, 2013–2016).

Cultivar	Flowering dates			Duration of flowering (days)	Abundance of flowering (0-5 scale)	Harvest date
	Start	Full	End			
Č. leptotica (control)	4 April	7 April	14 April	9.5	4.7	22 July
Čaradejka	6 April	9 April	16 April	10.0	4.1	18 July
Excalibur	5 April	7 April	14 April	9.0	3.7	30 July
Hanita	4 April	6 April	14 April	10.3	3.8	31 July
Kišinjevska rana	6 April	8 April	14 April	7.8	3.5	22 July
Reeves	6 April	8 April	15 April	8.8	3.5	24 July
Valerija	2 April	5 April	14 April	11.3	4.7	17 July
Venera	5 April	7 April	15 April	10.5	2.7	20 July

Among years, the earliest flowering was in 2014, when the average date of the flowering onset for all cultivars was March, 24. The latest flowering was in 2013 when the average date of the flowering onset was April, 17. The difference between years with earliest and latest flowering was 24 days and it was much bigger than the difference between cultivars.

The average duration of flowering ranged from 7.8 days ('Kišinjevska rana') to 11.3 days ('Valerija'). Among years, the average duration of flowering for all cultivars ranged from 7.8 days in 2015 to 11.5 days in 2016. The most abundant flowering was recorded in cultivar 'Valerija' (the same as in control cultivar, 'Čačanska leptotica'). The lowest flowering intensity was recorded in cultivar 'Venera'.

The range of fruit maturity was from July 17 ('Valerija') to July 31 ('Hanita'). For most cultivars the earliest fruit maturation was in 2016, and the latest in 2014. Difference between years with earliest and latest fruit maturation varied from 7 to 15 days.

Flowering and maturation time of plum cultivars in the region of Belgrade was earlier comparing to Czech Republic (Blažek and Pišteková, 2009), Central Bulgaria (Dragoyski et al., 2010), and Northern Montenegro (Božović and Jaćimović, 2012). These differences can be explained by different environmental conditions between the study regions.

The average yield per tree was the lowest in the cultivar 'Venera' (8.6 kg) and the highest in the cultivar 'Valerija' (28.6 kg) (Table 2). Compared to control, significantly higher yield was achieved in the cultivar 'Valerija', while the lower yield was found in cultivars 'Venera', 'Excalibur', 'Kišinjevska rana' and 'Čaradejka'.

Table 2. Yield, trunk cross-sectional area, and yield efficiency of plum cultivars.

Cultivar	Yield (kg per tree)					Trunk cross-sectional area (cm <sup>2</sup> )	Cumulative yield efficiency (kg/cm <sup>2</sup> )
	2013	2014	2015	2016	Average		
Č. leptotica (control)	10.3	36.7	5.5	30.5	20.8 b	79.8 cd	1.04
Čaradejka	6.1	3.7	23.2	15.4	12.1 cd	113.0 bc	0.43
Excalibur	6.3	25.4	5.1	6.2	10.7 d	151.4 b	0.28
Hanita	7.9	22.4	6.9	39.5	19.2 bc	97.5 cd	0.79
Kišinjevska rana	8.3	23.5	9.1	5.6	11.6 d	89.9 cd	0.52
Reeves	3.1	36.7	23.4	0.3	15.9 bcd	209.1 a	0.30
Valerija	13.3	32.4	12.1	56.4	28.6 a	68.5 d	1.67
Venera	2.5	5.4	3.0	23.6	8.6 d	109.0 c	0.32

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

Among studied cultivars, the lowest vigor was found in the cultivar 'Valerija', and the highest in the cultivar 'Reeves'. Our results of high vigor of cultivars 'Reeves' and 'Excalibur' confirm previous findings of Meland (2010).

Cumulative yield efficiency ranged from 0.28 to 1.67 kg/cm<sup>2</sup>. The cultivar 'Valerija' stands out for high cumulative yield efficiency. On the other side, cultivars 'Excalibur', 'Reeves' and 'Venera' are characterized by low yield efficiency.

All studied cultivars are characterized by large fruit (more than 30 g). Fruit weight ranged from 36.1 g in the cultivar 'Hanita' to 71.1 g in the cultivar 'Reeves' (Table 3). Compared to control, fruit weight was significantly higher in cultivars 'Reeves', 'Excalibur' and 'Valerija'.

Table 3. Fruit characteristics of plum cultivars (average, 2013–2016).

Cultivar	Fruit weight (g)	Stone weight (g)	Stone share (%)	Fruit dimensions (mm)			Shape index	Stalk length (mm)
				Length	Width	Thickness		
Č. leptotica (control)	39.4 cd	1.6 d	4.0	43.7 b	37.9 bc	36.8 cd	1.36	14.4 bc
Čaradejka	42.2 bcd	1.9 c	4.5	44.4 ab	38.0 bc	38.7 cd	1.34	17.0 b
Excalibur	64.0 a	2.3 b	3.5	48.1 a	45.8 a	45.2 ab	1.12	21.7 a
Hanita	36.1 d	2.0 c	5.5	46.0 ab	35.5 c	36.4 d	1.64	16.3 b
Kišinjevska rana	42.9 bcd	1.5 d	3.4	43.6 b	38.4 bc	39.8 bcd	1.24	10.9 c
Reeves	71.1 a	2.8 a	4.0	47.8 a	47.7 a	51.1 a	0.94	15.5 b
Valerija	49.6 b	1.9 c	3.9	43.5 b	42.6 ab	42.8 bc	1.04	16.0 b
Venera	46.1 bc	2.3 b	5.0	44.9 ab	39.6 ab	39.8 bcd	1.28	17.3 ab

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

Stone weight ranged from 1.5 g ('Kišinjevska rana') to 2.8 g ('Reeves'), and its share in the fruit weight ranged from 3.4% ('Kišinjevska rana') to 5.5% ('Hanita').

Fruit length was highest in the cultivar 'Excalibur', whereas width and thickness were highest in the cultivar 'Reeves'. Significant differences were found between cultivars for fruit dimensions. Based on the fruit dimensions the shape index was calculated, whose values ranged from 0.94 in 'Reeves' (flat round shape) to 1.34 in 'Čaradejka' (ovate shape). Stalk length was the shortest in 'Kišinjevska rana' (10.9 mm), and the longest in 'Excalibur' (21.7 mm).

Results of fruit characteristics are in accordance with the previous findings for some cultivars (Hartmann, 1998; Dragoyski et al., 2010; Milatović et al., 2011; Ionica et al., 2013).

Cultivars 'Kišinjevska rana' and 'Venera' are characterized by high soluble solids content (18.2-18.7%), significantly higher than in the control (Table 4). Cultivars 'Excalibur' and 'Kišinjevska rana' are characterized by low acid content.

Table 4. Indices of fruit quality of plum cultivars (average, 2013–2016).

Cultivar	Soluble solids (%)	Total acids (%)	Soluble solids /Total acids	Sensory evaluation (1-5)	
				Appearance	Taste
Č. leptotica (control)	15.3 bc	1.26 ab	12.1	4.2	4.1
Čaradejka	16.9 ab	1.04 bc	16.2	2.9	3.3
Excalibur	16.3 abc	0.70 d	23.3	3.8	4.1
Hanita	16.3 abc	1.38 a	11.9	4.0	4.1
Kišinjevska rana	18.2 a	0.79 cd	23.0	3.9	4.1
Reeves	15.1 bc	0.92 cd	16.4	4.0	3.4
Valerija	13.8 c	0.99 bcd	13.9	4.2	3.5
Venera	18.7 a	0.94 cd	19.8	4.1	3.9

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

It is a well-known fact that the ratio between the soluble solids content and total acids (SSC/TA), rather than the very content of soluble solids, represents a reliable indicator of a cultivar's suitability for acceptance by consumers (Crisosto et al., 2004). Cultivars 'Excalibur' and 'Kišinjevska rana' are characterized by high SSC/TA ratio (above 20).

The data on the chemical composition of fruits are in good agreement with most of the previous findings (Hartmann, 1998; Vangdal et al., 2007; Bohačenko et al., 2010; Dragoyski et al., 2010; Milatović et al., 2011; Ionica et al., 2013).

The highest scores for fruit appearance obtained the cultivar 'Valerija', and for taste cultivars 'Hanita', 'Excalibur' and 'Kišinjevska rana'. Our results for taste for cultivars 'Excalibur' and 'Reeves' are in accordance with those of Vangdal et al. (2007) and for cultivar 'Hanita' with those of Hartmann (1998).

### Conclusion

Based on the four-year evaluation of seven plum cultivars of medium early maturation time, for growing in Belgrade area can be recommended cultivars 'Valerija' and 'Hanita'. Both of them are suitable for fresh fruit consumption. Besides, the cultivar 'Hanita' is also suitable for fruit processing.

### Acknowledgements

This work was realized as a part of the project TR 31063 financed by the Ministry of Education, Science and Technological Development of the Republic of Serbia.

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