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Morphology and anatomy of sylleptic shoots of plum trees (*Prunus domestica* L.) as influenced by different dates of shoot heading during summer pruning

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Abstract. This study was conducted during two years under the environmental conditions of Čačak (western Serbia) to evaluate the effects of different dates of shoot heading during summer pruning on the intensity of sylleptic shoot formation and the main morphological and anatomical traits of sylleptic shoots in plum cultivar 'Čacanska Rodna' grafted on Myrobalan rootstock during five and six years after planting. The experiment was established with a spacing of 4 m × 2 m (1,250 trees ha^{-1}). Shoots were headed back to four buds from the base at five different dates to stimulate sylleptic shoot development. The first heading-back date (T1) was 30 days upon the beginning of shoot growth and the remaining ones (T_2, T_3, T_4, and T_5) continued at 15-day intervals. At the end of winter dormancy (February), measurements of morphological traits of sylleptic shoots, including length and diameter of sylleptic shoots (cm), node number, node length (cm), and number of vegetative and flowering buds, as well as of anatomical traits, i.e., xylem area width (µm), number of tracheae per mm^2 and trachea diameter (µm) were made. Results showed that T_4 and T_5 were late shoot heading dates (around July 5 and July 20, respectively), given the very poor development of sylleptic shoots until the end of the growing season. Among the remaining three shoot heading dates, T_3 (around June 20) was the most favorable as it produced sylleptic shoots of moderate length, i.e., vigour, having a very good ratio of flower buds to vegetative buds, and normal anatomical traits. These results provide new insight into dates and methods of summer pruning of plums grown in a high density planting system aimed at regulating tree vigor and improving cropping potential.

Key words: morphological and anatomical traits, *Prunus domestica* L., shoot heading, summer pruning, sylleptic shoos

Introduction

Lateral shoot development is directly correlated with the phenomenon of apical dominance (Wilson, 2000). Apical dominance is the active mechanism of inhibition of lateral shoots exerted by the growing terminal bud (Cline, 1997; Bubán, 2000). Sylleptic branches grow out of lateral buds during the same growing season in which the buds are formed (Cline & Dong-Il, 2002). Sylleptic shoot formation in fruit trees is affected by a variety of factors, particularly species and cultivar (Wertheim, 1978; Marini, 2010). Certain fruit species, such as peaches [*Prunus persica* (L.) Batsch], have a higher genetic tendency to sylleptic shoot formation than other fruit species (Hipps et al., 1995). Some cultural practices, such as increased mineral fertilisation, especially nitrogen supply, can increase the proportion of both proleptic and sylleptic shoots (Jordan et al., 2009). Generally, any measure promoting increased vigor and more intensive growth of fruit trees (irrigation, intensive pruning, nitrogen fertilisation) also contributes to more intensive sylleptic shoot formation (Chalmers et al., 1981; Jordan et al., 2009). In addition, shoot bending during the growing season can induce sylleptic shoot formation (Alméras et al., 2002). Apical bud damage caused by plant diseases or pests brings identical results. Nevertheless, the most important stimulators of sylleptic shoot development include plant hormones (cytokinins and auxins) (Cook et al., 1998; Cline & Dong-Il, 2002), as well as mechanical damage or removal of the shoot apex, i.e., decapitation (Ouellette & Young, 1994).

During the cultivation of different fruit species, sylleptic shoot formation can be both negative and positive. The development of sylleptic i.e., feather shoots is a desirable positive phenomenon in nursery seedling production (De Wit et al., 2002). On the other hand, during the second or third year after planting, the mass development of sylleptic shoots in young fruit trees can cause tree training problems, thus becoming viewed as a negative phenomenon. Under certain conditions, sylleptic shoots may significantly increase foliage biomass and tree vitality (Cline & Dong-Il, 2002). Also, in some fruit species, such as plums, which have a sparse crown and are susceptible to branch stripping, sylleptic shoot development is highly desirable.

In modern plum orchards under the High Density Planting System (HDP), summer pruning is a mandatory operation (Milošević et al., 2008; Cvetković & Glišić, 2020) employed, inter alia, to enhance sylleptic branching, prevent branch stripping and fruit from being borne only at the apex and periphery of the crown (Milošević et al., 2009).

One of the most widely grown plum cultivars in the region of Čačak and throughout Serbia is ‘Čačanska Rodna’, named and released at Fruit Research Institute Čačak (Milošević et al., 2021). This cultivar is of late ripening time and has fruits of high quality (Lukić et al., 2016), and is also characterized by high yielding potential, but its bearing branches rarely break under crop load (Nenadović-Mratinić et al., 2007).

Given the above, the objective of this study was to determine the optimal shoot heading date during summer pruning in ‘Čačanska Rodna’ trees during the first part of the growing season to promote the development of sylleptic shoots that have normal morphological traits. In addition, the sylleptic shoot anatomy of the plum cultivar was studied. This allowed a broad morphological and anatomical comparison, which contributes to a good understanding of sylleptic shoots in plum trees.

Materials and Methods

Plant material and field trial. Investigation was performed on the trees of the plum cultivar ‘Čačanska Rodna’ grafted on myrobalan seedling (*Prunus cersifera* Ehrh.) at 25 cm above ground level during fifth and sixth growing season.

The orchard trial was established at the village of Gornja Gorevnica near Čačak (43°53’N latitude; 20°21’E longitude; 390 m above sea level), western Serbia. Trees were planted at HDP using 4 m × 2 m spacing (1,250 trees ha^{-1}) and the Spindle Bush training system. The orchard management operations were consistent with the standard HDP practices, excepting irrigation. Summer pruning was used. In addition, there were similar climatic conditions in both years.

Experimental procedure and analysis of the morphology and anatomy of sylleptic shoots. Heading-back of shoots to four buds from the base during the growing season was conducted at five terms (T). The first heading-back date (T_1) was 30 days upon the beginning of shoot growth (stage 31 according to the BBCH monograph; Meier, 2018), and the remaining ones (T_2, T_3, T_4, and T_5) continued at 15-day intervals. Each of the five pruning terms involved heading-back of 20 shoots in four replications (a total of 80 shoots) and subsequent monitoring of sylleptic shoot development.

Sylleptic shoots were monitored during the first ten days of February of the following year. Firstly the number of sylleptic shoot was determined, and after that, their type (vegetative or flowering), as well as morphological and anatomical traits were analysed. The morphological traits under investigation included sylleptic shoot length and diameter (cm), node number, node length (cm), number of vegetative buds and number of flower buds per shoot. A ruler and a digital caliper (Starrett, 727 Series, Athol, New England, USA) were used. The following anatomical traits were measured: xylem area width (μm), number of vessels per mm^2 and vessel diameter (μm). Specimens to be anatomically examined were cut using a Reichert, Biocut 2030 sliding microtome (Germany). Permanent histological sections were prepared using standard procedures, and then tissue parameters were measured using microscopy (Reichert, Germany). Primary xylem width and trachea diameter were measured at 50× magnification, and number of tracheae per mm^2 was counted at 100× magnification. Photographs of cross-sections of sylleptic shoots were taken by a Leica DC 300 camera, and microscopic images were processed by Leica 1M 1000 software. Terminology of wood anatomical aspects followed Wheeler et al. (1989).

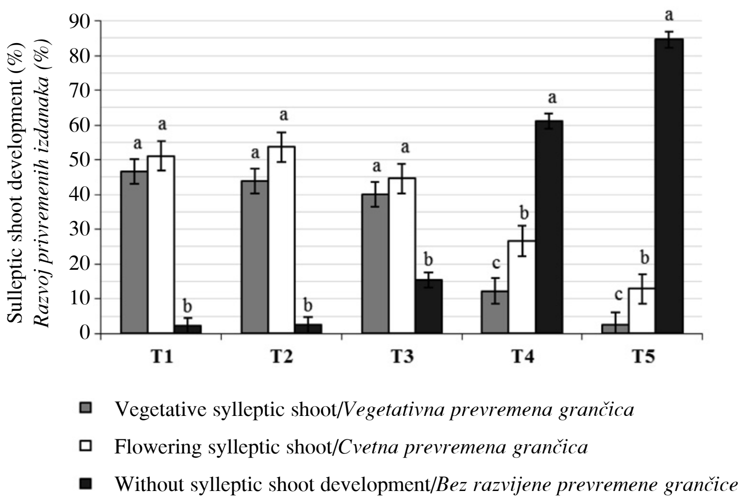
Data analysis. The obtained data were analysed as a factorial arranged in a randomised complete block design with four replications, with the shoot heading terms and years of study being factors. Analysis of variance (ANOVA) was performed at a significance level $P \leq 0.05$ and $P \leq 0.01$, followed by an LSD test at $P \leq 0.01$ using the MSTAT-C statistical package (Michigan State University, East Lansing, MI, USA).

Results

Number of sylleptic shoots. The data in Graph 1 showed that heading-back of shoots to four buds in the crown of plum cultivar 'Čačanska Rodna' in T_1, T_2 and T_3 induced the similar formation of sylleptic shoots in both years, whereas in T_4 and T_5 the proportion of sylleptic shoots was significantly lower at $P \leq 0.01$. Conversely, no significant differences were observed between vegetative and flowering sylleptic shoots. In addition, sylleptic shoots ranged from 84.61% in T_3 to 97.78% in T_1. Differences between years in the parameters tested were not observed, due to the similarity of climatic conditions in both years. Moreover, in 61.11% and 84.62% of samples in T_4 and T_5 respectively, sylleptic shoots did not develop on headed shoots (Graph 1).

The percentage of headed shoots in T_4 and T_5 that did not develop sylleptic shoots was significantly higher than that of headed shoots that developed sylleptic shoots at $P \leq 0.01$ in both years.

Morphological traits of sylleptic shoots. The data in Table 1 showed values obtained for the morphological traits of sylleptic shoots in T_1–T_5. The present study



Graph 1. Formation of different categories of sylleptic shoots as dependent upon term of shoot heading-back to four buds from the base, average from both years of investigation. The different lower-case letters assigned to columns show significant differences for $P \leq 0.05$ after applying LSD test

Grafik 1. Formiranje različitih kategorija prevremenih izdanaka u zavisnosti od termina prekraćivanja na četiri pupoljka od baze, prosek za obe godine istraživanja. Različita mala slova u stupcima označavaju značajne razlike za $P \leq 0.05$ nakon primene LSD testa revealed that 'Čačanska Rodna' had a highly significant length and diameter of sylleptic shoots at $P \leq 0.01$ in T_1, and a significant node number at $P \leq 0.05$ in T_1 and T_2, as compared to the other dates. Results revealed a tendency of sylleptic shoot length and diameter, node number and node length to decrease from T_1 to T_5. Year-to-year variations were not observed among the parameters tested. Also, there was no significant effect of the T/year interaction on the length and diameter of sylleptic shoots and node number.

Conversely, high variability was observed in node length, and significant differences were found at $P \leq 0.01$ (Table 1). Term/year interaction significantly affected the tested parameter at $P \leq 0.05$, when no year-to-year variations were observed. Number of vegetative buds on sylleptic shoots was significantly higher in T_1, T_2 and T_3 than in T_4 and T_5, and in first than in second experimental year. The effect of term/year interaction on the number of vegetative buds on sylleptic shoots was not significant in 'Čačanska Rodna' plum.

Table 1. Morphological traits of sylleptic shoots during period of investigation
Tabela 1. Morfološke osobine prevremenih izdanaka u period ispitivanja

Treatment *Tretman*		Length of sylleptic shoot *Dužina prevremenih izdanaka* (cm)	Diameter of sylleptic shoot *Debljina prevremenih izdanaka* (cm)	Number of nodes *Broj internodija*	Length of node *Dužina internodija* (cm)	Number of vegetative buds *Broj vegetativnih pupoljaka*	Number of flower buds *Broj cvetnih pupoljaka*
Shoot heading terms (A)/*Termin prekraćivanja izdanaka (A)*							
T_1		58.80 ± 8.45a*	4.96 ± 0.84a	16.90 ± 1.03a	3.62 ± 0.23a	15.85 ± 1.09a	12.95 ± 0.49b
T_2		49.85 ± 5.43b	4.44 ± 0.57b	16.10 ± 0.84a	3.14 ± 0.23b	16.35 ± 0.84a	18.05 ± 0.59a
T_3		33.80 ± 2.40c	3.52 ± 0.26c	11.30 ± 0.84b	2.97 ± 0.17bc	12.60 ± 0.67b	14.85 ± 0.40b
T_4		13.60 ± 1.64d	3.29 ± 0.44d	5.02 ± 0.14c	2.70 ± 0.18c	5.12 ± 0.50c	9.36 ± 0.69c
T_5		9.59 ± 0.87d	3.01 ± 0.14e	4.56 ± 0.14c	2.09 ± 0.11d	4.71 ± 0.41c	8.11 ± 0.53c
Year (B)/*Godina (B)*							
First/*prva*		34.16 ± 3.76	3.90 ± 0.56	15.30 ± 0.94	2.90 ± 0.19	11.32 ± 0.89a	15.40 ± 0.51
Second/*druga*		31.86 ± 4.09	3.78 ± 0.55	14.23 ± 0.86	2.91 ± 0.22	10.53 ± 0.83b	15.60 ± 0.48
A × B							
T_1	first/*prva*	60.10 ± 8.95	5.16 ± 0.91	17.50 ± 1.09	3.29 ± 0.19b	17.50 ± 1.15	13.70 ± 0.53
	second/*druga*	57.50 ± 7.95	4.77 ± 0.77	16.30 ± 0.97	3.94 ± 0.27a	14.20 ± 1.03	12.20 ± 0.45
T_2	first/*prva*	50.00 ± 5.65	4.51 ± 0.55	16.90 ± 0.87	3.05 ± 0.22bc	16.40 ± 0.89	17.30 ± 0.60
	second/*druga*	49.70 ± 5.21	4.37 ± 0.59	15.30 ± 0.81	3.24 ± 0.24b	16.30 ± 0.79	18.80 ± 0.58
T_3	first /*prva*	37.00 ± 2.69	3.54 ± 0.22	11.50 ± 0.88	3.19 ± 0.18b	12.50 ± 0.65	15.20 ± 0.39
	second/*druga*	30.00 ± 2.11	3.50 ± 0.29	11.10 ± 0.80	2.76 ± 0.15bc	12.70 ± 0.69	14.50 ± 0.41
T_4	first/*prva*	13.88 ± 1.17	3.30 ± 0.27	5.05 ± 0.12	2.74 ± 0.18bcd	5.20 ± 0.45	9.97 ± 0.58
	second/*druga*	13.32 ± 1.56	3.28 ± 0.22	5.00 ± 0.16	2.66 ± 0.18cd	5.04 ± 0.56	8.76 ± 0.80
T_5	first/*prva*	10.40 ± 0.94	3.02 ± 0.17	4.59 ± 0.11	2.26 ± 0.14d	5.00 ± 0.38	8.12 ± 0.56
	second/*druga*	8.79 ± 0.81	3.00 ± 0.11	4.54 ± 0.17	1.93 ± 0.09e	4.41 ± 0.45	8.10 ± 0.50
ANOVA							
A		**	**	*	**	*	**
B		ns	ns	ns	ns	*	ns
A × B		ns	ns	ns	*	ns	ns

* The different letters within columns indicate significant differences between means at $P \leq 0.01$ by LSD test; The * and ** in columns indicates significant differences between means at $P \leq 0.05$ and $P \leq 0.01$, respectively, by F test, while ns represents non-significant differences/*Različita slova u kolonama označavaju značajne razlike između srednjih vrednosti na nivou $P \leq 0.05$ primenom LSD testa; * i ** u kolonama označavaju značajne razlike na nivou $P \leq 0.05$ i $P \leq 0.01$, po redosledu, primenom F testa, dok ns označava razlike koje nisu statistički značajne*

There were significant differences among terms regarding the number of flower buds (Table 1). Namely, the value in T_2 (18.05 ± 0.59) was higher than those in T_1 (12.95 ± 0.49) and T_3 (14.85 ± 0.40). Moreover, the later heading date was observed to cause a reduction in the total number of flower buds on sylleptic shoots. On the other hand, there was an increase in the number of flower buds relative to the number of vegetative buds. Year-to-year variation and term/year interaction were not observed for number of flower buds.

Anatomical traits of sylleptic shoots. Results on the anatomical traits of sylleptic shoots that developed in the crown of 'Čačanska Rodna' plum in T_1–T_5 are given in Table 2 and Figures 1 and 2.

Statistical analysis (ANOVA) showed a significant effect of shoot heading terms on xylem area width in sylleptic shoots. Namely, width of xylem area in T_1 was 105.84 µm, as compared to the values obtained in T_2 and T_3 of 95.88 µm and 92.68 µm, respectively (Table 2). Moreover, width of the xylem area was smallest in sylleptic shoots in T_4 and T_5 (89.70 µm and 88.22 µm, respectively). Statisticaly significant impact of year-to-year variation and T/year interaction was not observed.

Table 2. Anatomical traits of sylleptic shoots during period of investigation
Tabela 2. Anatomske osobine prevremenih izdanaka u periodu ispitivanja

Treatment *Tretman*		Xylem area width *Širina ksilema* (µm)	Number of vessels per mm^2 *Broj sprovodnih sudova po mm^2*	Vessels diameter *Prečnik sprovodnih sudova* (µm)
Shoot heading dates (A)/*Termin prekraćivanja izdanaka (A)*				
T_1		105.84 ± 3.95 a*	150.75 ± 6.92a	3.15 ± 0.06
T_2		95.88 ± 4.65 b	143.22 ± 6.59b	3.12 ± 0.06
T_3		92.68 ± 3.91 bc	137.94 ± 8.11c	3.05 ± 0.04
T_4		89.70 ± 3.10 c	126.92 ± 7.62d	3.10 ± 0.05
T_5		88.22 ± 3.85 c	105.96 ± 4.76e	3.05 ± 0.05
Year (B) /Godina (B)				
First/*prva*		94.58 ± 4.09	133.27 ± 7.08	3.14 ± 0.06
Second/*druga*		94.34 ± 4.25	132.64 ± 7.34	3.05 ± 0.04
A × B				
T_1	first/*prva*	105.43 ± 4.11	151.94 ± 6.03	3.25 ± 0.07
	second/*druga*	106.25 ± 3.79	149.55 ± 7.81	3.05 ± 0.04
T_2	first/*prva*	95.66 ± 4.29	142.78 ± 6.85	3.22 ± 0.07
	second/*druga*	96.10 ± 5.02	143.66 ± 6.34	3.01 ± 0.04
T_3	first/*prva*	92.91 ± 3.87	138.17 ± 8.36	3.08 ± 0.04
	second/*druga*	92.45 ± 3.96	137.72 ± 7.87	3.02 ± 0.04
T_4	first/*prva*	90.51 ± 3.14	127.86 ± 9.11	3.1 ± 0.06
	second/*druga*	88.89 ± 3.06	125.99 ± 6.14	3.09 ± 0.04
T_5	first/*prva*	88.40 ± 3.80	105.64 ± 4.95	3.03 ± 0.04
	second/*druga*	88.04 ± 3.90	106.28 ± 4.58	3.07 ± 0.06
ANOVA				
A		*	**	ns
B		ns	ns	ns
A × B		ns	ns	ns

* The different letters within columns indicate significant differences between means at $P \leq 0.01$ by LSD test; The * and ** in columns indicates significant differences between means at $P \leq 0.05$ and $P \leq 0.01$, respectively, by F test, while ns represents non-significant differences/*Različita slova u kolonama označavaju značajne razlike između srednjih vrednosti na nivou $P \leq 0.05$ primenom LSD testa; * i ** u kolonama označavaju značajne razlike na nivou $P \leq 0.05$ i $P \leq 0.01$, po redosledu, primenom F testa, dok ns označava razlike koje nisu statistički značajne*

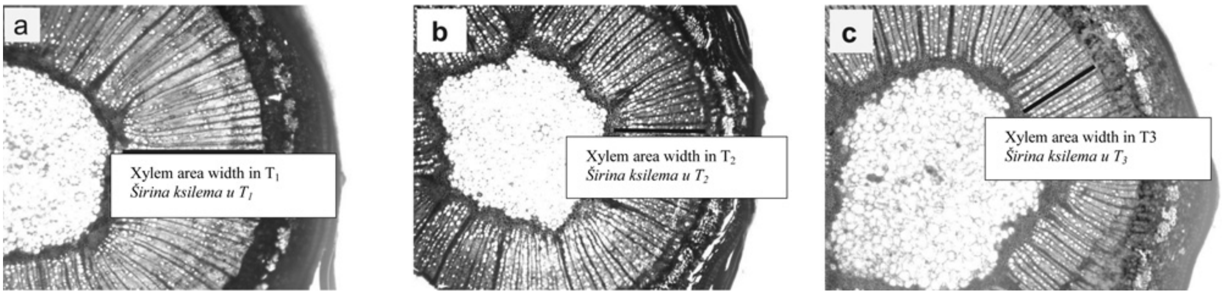


Figure 1. Horizontal cross-section of the sylleptic shoot – significantely greater xylem area width in T_1 (a) than in T_2 (b) and T_3 (c)
Slika 1. Poprečni presek prevremenih izdanaka – značajno veći prečnik ksilemma u T_1 (a) u odnosu na T_2 (b) i T_3 (c)

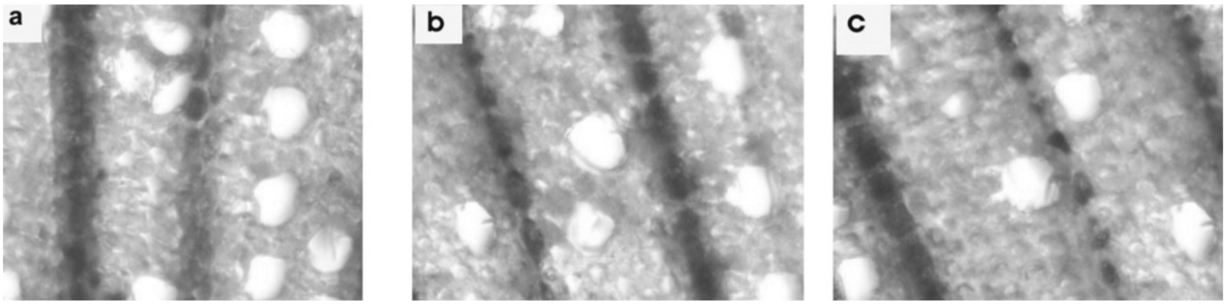


Figure 2. Horizontal cross-section of the sylleptic shoot – normally developed vessels at all three shoot heading dates with higher density of vessels per xylem area in T_1 (a) than in T_2 (b) and T_3 (c).
Slika 2. Poprečni presek prevremenih izdanaka – normalno razvijeni sprovodni sudovi u sva tri termina prekraćivanja sa većom gustinom sprovodnih sudova u odnosu na površinu ksilema u T_1 (a) u odnosu na T_2 (b) i T_3 (c)

Number of vessels in T_1 (150.75) significantly differed from the values in T_2 (143.22), T_3 (137.94), T_4 (126.92) and T_5 (105.96) at $P \leq 0.01$ (Table 2). No effect of year and T/year interaction on the parameter analysed was observed. On the other hand, values of vessel width among shoot heading dates and years were not statistically significant. Also, T/year interaction did not affect vessel diameter (Table 2).

Discussion

Evaluation of morphological traits of sylleptic shoots. Shoot apical growth is associated with the complex mechanism of apical dominance that inhibits growth of axillary buds and their development into shoots (Cline, 1997; Bubán, 2000). Marini (2010) reported that apical dominance is a type of para-dormancy, where axillary bud growth is inhibited in the apical meristematic zone. In other words, axillary buds on fruit trees typically remain dormant for a prolonged period while the main shoot continues to grow.

In the present study, heading-back of shoots inside the crown of ‘Čačanska Rodna’ trees to four buds in T_1, T_2 and T_3, i.e. during the period of their intensive elongation resulted in activation of axillary buds and development of sylleptic shoots (Figure 1), which is in agreement with a previous study (Cline & Dong-Il, 2002). However, heading back of shoots in T_4 and T_5 did not significantly affect axillary bud activation and sylleptic shoot development. These terms were between 5 and 20 July, when intensive shoot elongation terminated and radial (secondary) thickening started under the climatic conditions of western Serbia (Bulatović & Mratinić, 1996). This fact can serve as an explanation for the absence of active waking axillary buds in our study. In addition, para-dormancy occurs in mid to late summer when buds do not grow because inhibitors produced in the leaves and terminal buds inhibit bud growth (Marini, 2010).

The morphological traits of sylleptic shoots developed at all dates showed significant differences (Table 1). A factor found to affect their traits, especially vigor, was the time of their formation during the vegetative cycle. The present results on syllepic shoot vigour are in agreement with those of Morgas et al. (1998), who reported that early summer pruning can induce vigorous growth of sylleptic shoots. Sylleptic shoots emerging as a result of early summer pruning, i.e. early heading back of shoots are usually more vigorous than those that develop later in the growing season (De Wit et al., 2002). In our study, late shoot heading-back during summer pruning induced the development of shorter sylleptic shoots with a smaller number and length of nodes, but a higher number of flower buds, which complies with the previous work on plum (Mika & Piatkovski, 1989). In addition, Tworkoski et al. (2006) reported that sylleptic shoots of peaches were 22.7 cm long and had a well-balanced vegetative/flower buds ratio, as confirmed by the results of the present study.

In general, sylleptic shoots obtained in T_3 in our study can be considered normal in view of their morphological traits. In addition, they developed under the overshadowing conditions inside the crown. Lemoine et al. (2002) reported that if shoot thinning is not performed during the growing season, a shadow in which the shoots and sylleptic shoots develop can notably affect their morphological and anatomical traits. Also, sylleptic shoots formed in T_3 were in largely horizontal position in the crown of 'Čačanska Rodna' plum. These shoots are typically less vigorous and have an optimal ratio of vegetative to flower buds (Wilson, 2000). On the other hand, they do not clutter the crown, but rather contribute to establishing a balance between vigour and cropping potential, which is in agreement with the previous work on plum (Morgas et al., 1998; Sosna, 2002).

Evaluation of anatomical traits of sylleptic shoots. The anatomical traits of sylleptic shoots are dependent upon a number of factors (Zhang, 1992; Vilotić, 2000; Hacke & Sperry, 2001), the most important among them including cultivar specificities and agroenvironmental conditions under which sylleptic shoots develop. The values for xylem area width and number of vessels per mm^2 (Table 2 and Figures 1 and 2) obtained in this study show that later sylleptic shoot development results in lower values of the said anatomical parameters. Sylleptic shoots that developed later had a lower diameter (Table 1) and, hence, smaller width of the xylem area (Figure 1).

Shoot heading in T_3 induced the development of sylleptic shoots with normal morphological traits. Namely, sylleptic shoots were moderately developed and showed uniform distribution of vegetative and generative buds. However, lower values for xylem area width and number of vessels per mm^2 were obtained at this date (Table 2). The vessels diameter was smaller in T_3 than in T_1 and T_2, but the differences were not significant; this finding suggesting normal development of vessels at all three dates (Figure 2).

The xylem area width is a complex trait depending upon a number of factors. For example, Esteban et al. (2010) report a significant effect of regional environmental conditions on tree and shoot traits, as well as on trachea traits. Rodríguez-Aguilar et al. (2006) and Venugopal & Liangkuwang (2007) showed the existence of strong correlation between climatic parameters, on the one hand, and cambium activities and xylem formation, on the other. Gonçalves et al. (2007) found differences in xylem width between the root, tree and shoot on a single tree, xylem width being larger in the root system. Furthermore, Mićić et al. (2009) reported that the anatomical traits of fruiting shoots exhibit differences not only among fruit species, but also among cultivars within a species, which is in line with the results of the present study.

The xylem area takes up much of the cross section relative to the pith. (Hsu et al., 2005), as confirmed by the present results obtained in T_1 (Figure 1a). Xylem area width in T_3 (Figures 1b and 1c) was lower, but it can also be considered normal (Dvorák, 1961), since the number of vessels enabled normal flow of water and mineral matters, leading to sylleptic shoots developing into quality one-year old shoots until the end of the growing season (Table 1). Saeed et al. (2010) reported that normally developed citrus shoots have 48.7 to 140.6 vessels per mm^2, which was confirmed by the results of this study.

Conclusion

Heading-back pruning in T_4 and T_5 resulted in the development of short flowering shoots, their lower number, however, being too low and insufficient for the said terms to be considered optimal for heading-back aimed at sylleptic shoot development. At the first three heading terms (T_1–T_3), a sufficient number of normal sylleptic shoots was obtained in terms of morphological and anatomical traits. However, when solely morphological traits are considered, sylleptic shoots exhibited high vigour in T_2, especially in T_1. Since they contribute to crown cluttering and overshadowing, they must undergo additional late summer or winter pruning intervention. It is for this reason that T_3 is given advantage over the other dates. Therefore, this study generally suggests that sylleptic shoot formation in 'Čačanska Rodna' is best stimulated by shoot pruning in T_3, i.e., 60 days after the onset of shoot growth. Sylleptic shoots that develop during the date are of moderate vigour, and have an optimal vegetative to flower buds ratio and normally developed primary xylem.

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MORFOLOŠKE I ANATOMSKE OSOBINE PREVREMENIH GRANČICA ŠLJIVE (*Prunus domestica* L.) RAZVIJENIH NAKON PREKRAĆIVANJA MLADARA U RAZLIČITIM TERMINIMA LETNJE REZIDBE

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Rezime

Proučavanja obuhvaćena ovim radom su sprovedena tokom dvogodišnjeg perioda u agroekološkim uslovima Čačka (zapadna Srbija). Cilj je bio da se utvrdi da li različiti termini prekraćivanja mladara tokom letnje rezidbe šljive utiču na broj razvijenih prevremenih grančica, kao i na njihove morfološke i anatomske karakteristike. Istraživanja su sprovedena u proizvodnom zasadu sorte Čacanska rodna okalemljene na sejanac džanarike i zasađene na rastojanju 4 m × 2 m (1,250 stabala ha^{-1}), u petoj i šestoj vegetaciji. U cilju indukovanja razvoja prevremenih grančica, mladari pomenute sorte su prekraćivani u pet različitih termina (20. maj, 5. jun, 20. jun, 5. jul i 20. jul). Nakon toga, na kraju zimskog mirovanja (februar) određen je broj prevremenih grančica koje su se razvile nakon prekraćivanja mladara u pomenutim terminima. Takođe, analizirane su i njihove morfološke [dužina i prečnik prevremenih grančica (cm), broj i dužina internodija (cm), kao i broj vegetativnih i cvetnih pupoljaka] i anatomske [širina ksilema (μm), broj trahea u odnosu na površinu ksilema i prečnik trahea (μm)] osobine. Rezultati su pokazali da prekraćivanje mladara u kasnijim terminima (T_4 i T_5) rezultira veoma malim brojem prevremeno razvijenih grančica do kraja vegetacije, dok ranije prekraćivanje mladara (T_1 i T_2) indukuje razvoj prevremenih grančica izražene bujnosti. Kao najpogodniji, može se izdvojiti treći termin (T_3). Na mladarima sorte šljive Čačanska rodna prekraćenim u ovom terminu su se razvile umereno bujne prevremene grančice, normalnih anatomskih karakteristika, sa veoma povoljnim odnosom vegetativnih i cvetnih pupoljaka. Dobijeni rezultati ukazuju na mogućnost regulisanja bujnosti i rodnosti stabala šljive gajenih u sistemima guste sadnje putem izbora vrste pomotehničkog zahvata tokom letnje rezidbe i termina njegove primene.

Ključne reči: morfološke i anatomske osobine, *Prunus domestica* L., prekraćivanje mladara, letnja rezidba, prevremene grančice