EFFECT OF PRUNING TIME ON GROWTH, BLOOMING AND CONTENT OF CHEMICAL CONSTITUENTS IN LEAVES OF FOUR EARLY RIPENING PLUM CULTIVARS

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A B S T R A C T

In this experiment, early ripening plum trees were pruned at two different times. The experiment was conducted at the Fruit Experimental Station in Samotwór near Wrocław in 2001-2004. Objects of the study were 8 year-old plum trees of 'Herman', 'Čačanska Rana', 'Sanctus Hubertus' and 'Čačanska Lepotica' cultivars budded on 'Myrobalan' seedlings (*Prunus divaricata)*. The experiment was established in a randomised block design in three replications with 6 trees per plot. In 2001-2003, time of tree pruning was differentiated. Half of the trees were pruned only at the end of August (summer pruning after harvest of fruit). The other pruning took place at the end of March (dormant pruning before blooming time).

Time of pruning had no influence on vegetative growth and chemical composition of leaves. No matter what the time of pruning, the total sugars, reducing sugars, potassium, calcium, magnesium and phosphorus contents in leaves were similar. Sugars, calcium and phosphorus contents were significantly influenced by the year. Foliar nutrient content differed according to the plum cultivar. 'Sanctus Hubertus' showed markedly lower leaf K and Mg contents, whereas 'Čačanska Lepotica' had a higher P content. Pruning time had an influence on the crop efficiency index. Dormant-pruned trees were significantly more productive.

Key words: plum, pruning time, growth, blooming, leaves, chemical constituents

INTRODUCTION

Plum is one of the most important fruit species in Poland. According to the Polish Central Statistical Office, plum takes fifth place when considering the total yields received from Polish orchards. *Prunus divaricata* Ledeb. ('Myrobalan' seedlings) is the most popular rootstock in Polish

plum orchards. About 80-90% of trees produced in nurseries are grafted on this rootstock (Sitarek, 2001). The drawbacks of 'Myrobalan' seedlings are: high growth rate and relatively late cropping start (Rozpara and Grzyb, 1998; Sitarek et al., 2000). This failing is a very important problem in modern, intensive orchards. 'Myrobalan' seedlings are particularly not good for cultivars with a strong vegetative growth (Tehrani and Leuty, 1987). Pruning intervention should successfully reduce the volume of canopy, and improve yielding of adult trees (Mika, 1986). Summer pruning is more effective in reducing tree size than dormant pruning because it promotes the growth of short shoots, enabling fruiting. According to Mika and Piątkowski (1989), winter and summer pruning (in late July and early August) combined together gave the best results. Similarly, Morgaś et al. (2004ab) noticed better blooming and weaker vegetative growth of plum trees after summer pruning (at the beginning of August) combined with dormant pruning (at the end of March). Gonda (2006) from Hungary reported that the consequent application of green pruning during summer meant that the density of the orchards could be increased. The increase could be from the customary 300 tree/hectare of the previous years to 500 tree/hectare or more.

The aim of this experiment was comparing the effect of different pruning times on growth, blooming and chemical constituents in leaves of the several early ripening plum cultivars: 'Herman', 'Čačanska Rana', 'Sanctus Hubertus' and 'Čačanska Lepotica'.

MATERIAL AND METHODS

The experiment was conducted at the Fruit Experimental Station in Samotwór near Wrocław, in 2001-2004. The testing material included eight year-old trees of 'Herman', 'Čačanska Rana', 'Sanctus Hubertus' and 'Čačanska Lepotica' cultivars on 'Myrobalan' seedlings (*Prunus divaricata)* planted at a spacing of 4 x 3 m (833 trees per hectare). In 2001-2003, time of tree pruning was differentiated. Some of the trees were pruned only at the end of August (summer pruning after harvest of fruit – lack of shoot re-growth). The rest of the trees were pruned only at the end of March (dormant pruning before blooming time). The experiment was established in a randomised block design in three replications, with 3 trees per plot. All of the trees were trained with a spindle canopy. Herbicide fallow was maintained in the tree rows with grassy strips between the rows. Trees were not irrigated. Plant protection was carried out according to the current recommendations for plum orchards. In 2002-2004, growth, blooming and chemical constituents in leaves were estimated. Trunk girth and canopy size were measured every year. From the data, trunk cross-sectional area and canopy volume were calculated. Chemical analyses of sugar, K, Ca, Mg and P contents were done in dried leaves.

Obtained results of the experiment were statistically elaborated by multifactorial analysis of variance. The significance of differences between means was evaluated by Duncan's t-test at $p \leq 0.05$.

RESULTS AND DISCUSSION

Among the evaluated cultivars, 'Sanctus Hubertus' and 'Herman' plums showed the most tendency for alternate bearing (Tab. 1). Significant differences in blooming intensity observed in 2002-2003, were caused more by cultivar feature than pruning time. In 2004, time of pruning had no influence on blooming. By contrast, Morgaś et al. (2004b) found that plum trees that had additional prunings during summer bloomed better. In 2002-2004, vegetative growth was significantly affected by the cultivar (Tab. 1). 'Čačanska Rana' was the most vigorous, while 'Čačanska Lepotica' was characterised by the weakest growth. These cultivars characterised the lowest and the highest crop efficiency index, respectively. Sitarek et al. (2000), Blažek et al. (2004), Sosna (2004) and Gonda (2006) had similar observations about these cultivars. In this experiment, pruning time had no influence on vegetative growth of plum trees. However, dormant-pruned trees were significantly more productive. Similar results, connected with an influence of summer pruning on apple tree growth, were noted by other authors (Bootsma, 1984; Barden and Marini, 1997; Sosna, 2000). On the other hand, numerous scientists reported that summer-pruned apple or plum trees grew weaker in comparison to dormant-pruned ones (Platon and Zagrai, 1997; Poniedziałek et al., 2000; Morgaś et al., 2004a). In the Zamani et al. (2006) study, summer pruning effectively reduced the measured vegetative characters, especially at 90 days after full bloom. According to Dimkova and Vitanova (2001), the effect of pruning time on tree growth depended on the plum cultivar. Unlike 'Stanley', the trees of the cultivar 'Althan reinclaude' had a distinct trend of an influencing or stunted growth, due to the late summer pruning – September 15. Similarly, Tehrani and Leuty (1987) found, that only some plum cultivars showed reductions in trunk area as a result of mechanical summer-shearing (the first week of July).

In this experiment, clear differences between total sugars, reducing sugars, potassium, calcium, magnesium and phosphorus contents in leaves were not observed (Tab. 2, 3 and 4). Taking into consideration the means of the three year study, the content of chemical constituents did not depend on the time of pruning. These results differ from those obtained by Dimkova and Vitanova (2001). In their experiment, plum trees of 'Stanley' and 'Althan reinclaude' lost more quantities of phosphorus and potassium as a result of the late summer pruning. Sugars, Ca and P contents were significantly influenced by the year. In 2003, higher total sugars and phosphorus, while lower contents of reducing sugars in leaves of dormant-pruned

Table 1. Blooming intensity and vegetative growth of 4 early ripening plum cvs. depending on time of pruning, in 2002-2004

Treatment	Blooming intensity [0-5 scale] 0 – tree without flowers; 5 – very abundant blooming tree			Trunk cross-sectional area [cm^2]		Canopy volume [m^3]	Crop efficiency index [kg cm^{-2}]
	2002	2003	2004	autumn 2004	increment 2002-2004	autumn 2004	2002-2004
'Herman'							
Summer pruning	3.6 a*	1.9 a	3.5 a	150.0 a	33.4 a	8.1 a	0.74 a
Dormant pruning	3.4 a	2.4 a	3.7 a	152.9 a	37.2 a	9.1 a	0.78 a
'Čačanska Rana'							
Summer pruning	4.4 b	2.8 a	3.6 a	197.9 a	46.4 a	9.3 a	0.61 a
Dormant pruning	3.9 a	3.4 a	3.6 a	181.2 a	38.9 a	9.6 a	0.65 a
'Sanctus Hubertus'							
Summer pruning	4.3 b	0.9 a	4.3 a	176.2 a	39.8 a	7.8 a	1.02 a
Dormant pruning	3.5 a	1.8 b	3.7 a	157.1 a	34.9 a	8.4 a	1.15 a
'Čačanska Lepotica'							
Summer pruning	4.5 a	3.0 a	3.8 a	125.3 a	28.3 a	8.7 a	1.37 a
Dormant pruning	4.4 a	2.7a	3.8 a	101.0 a	23.0 a	8.9 a	1.55 b
Mean for cultivar							
'Herman'	3.5 a	2.2 b	3.6 a	151.5 b	35.3 b	8.6 a	0.76 b
'Čačanska Rana'	4.2 bc	3.1 c	3.6 a	189.6 d	42.7 c	9.5 a	0.63 a
'Sanctus Hubertus'	3.9 b	1.4 a	4.0 a	166.7 c	37.4 bc	8.1 a	1.08 c
'Čačanska Lepotica'	4.5 c	2.9 c	3.8 a	113.2 a	25.7 a	8.8 a	1.45 d
Mean for pruning time							
Summer pruning	4.2 b	2.2 a	3.8 a	162.3 a	37.0 a	8.5 a	0.94 a
Dormant pruning	3.8 a	2.6 b	3.7 a	148.0 a	33.5 a	9.0 a	1.03 b

*Means followed by the same letter do not differ at P = 0.95 according to Duncan's multiple range t-test

Table 2. Effect of pruning time on content of sugars, in leaves of 4 early ripening plum cvs.

Treatment	Total sugars [% of dry weight]				Reducing sugars [% of dry weight]			
	2002	2003	2004	2002-2004	2002	2003	2004	2002-2004
'Herman'								
Summer pruning	5.36 a*	6.90 a	5.46 a	5.91 a	4.31 a	6.48 b	4.72 a	5.17 a
Dormant pruning	6.07 b	6.63 a	5.13 a	5.94 a	4.89 b	6.10 a	4.84 a	5.28 a
'Čačanska Rana'								
Summer pruning	5.42 a	6.17 a	4.67 a	5.42 a	4.33 a	5.75 a	3.98 a	4.69 a
Dormant pruning	5.43 a	7.82 b	4.44 a	5.90 a	4.80 b	5.88 a	3.89 a	4.86 a
'Sanctus Hubertus'								
Summer pruning	5.16 a	5.78 a	5.37 a	5.44 a	4.93 a	5.33 a	4.94 a	5.07 a
Dormant pruning	5.27 a	5.92 a	5.28 a	5.49 a	5.06 a	5.30 a	5.01 a	5.12 a
'Čačanska Lepotica'								
Summer pruning	5.60 a	6.97 a	4.38 a	5.65 a	4.31 a	5.22 b	4.07 a	4.53 a
Dormant pruning	5.65 a	6.72 a	4.73 a	5.70 a	4.43 a	4.38 a	4.32 a	4.38 a
Mean for cultivar								
'Herman'	5.72 b	6.77 b	5.30 b	5.93 a	4.60 b	6.29 d	4.78 b	5.22 b
'Čačanska Rana'	5.43 ab	7.00 b	4.56 a	5.66 a	4.57 b	5.82 c	3.94 a	4.77 ab
'Sanctus Hubertus'	5.22 a	5.85 a	5.33 b	5.46 a	5.00 c	5.32 b	4.98 b	5.10 b
'Čačanska Lepotica'	5.63 b	6.85 b	4.56 a	5.68 a	4.37 a	4.80 a	4.20 a	4.46 a
Mean for pruning time								
Summer pruning	5.39 a	6.45 a	4.97 a	5.60 a	4.47 a	5.70 b	4.43 a	4.86 a
Dormant pruning	5.61 a	6.77 b	4.90 a	5.76 a	4.79 b	5.42 a	4.51 a	4.91 a

*Explanations, see Table 1

Table 3. Effect of pruning time on K and Ca content in leaves of 4 early ripening plum cvs.

Treatment	K content [% of dry weight]				Ca content [% of dry weight]			
	2002	2003	2004	2002-2004	2002	2003	2004	2002-2004
'Herman'								
Summer pruning	4.54 a*	3.77 a	2.83 a	3.71 a	0.63 b	0.39 a	0.34 a	0.45 a
Dormant pruning	4.37 a	3.66 a	2.56 a	3.53 a	0.53 a	0.40 a	0.33 a	0.42 a
'Čačanska Rana'								
Summer pruning	5.04 a	3.87 a	3.21 a	4.04 a	0.88 b	0.61 a	0.34 a	0.61 a
Dormant pruning	5.07 a	3.85 a	2.99 a	3.97 a	0.78 a	0.62 a	0.32 a	0.57 a
'Sanctus Hubertus'								
Summer pruning	3.65 a	3.55 a	1.95 a	3.05 a	0.68 a	0.66 a	0.32 a	0.55 a
Dormant pruning	3.71 a	3.43 a	1.98 a	3.04 a	0.72 a	0.57 a	0.34 a	0.54 a
'Čačanska Lepotica'								
Summer pruning	5.00 a	3.46 a	2.83 a	3.76 a	1.12 b	0.65 a	0.31 a	0.69 a
Dormant pruning	5.41 a	3.73 b	3.10 a	4.08 a	0.81 a	0.55 a	0.30 a	0.55 a
Mean for cultivar								
'Herman'	4.46 b	3.72 bc	2.70 b	3.62 b	0.58 a	0.40 a	0.34 b	0.44 a
'Čačanska Rana'	5.06 c	3.86 c	3.10 c	4.01 c	0.83 c	0.62 b	0.33 ab	0.59 b
'Sanctus Hubertus'	3.68 a	3.49 a	1.97 a	3.05 a	0.70 b	0.62 b	0.33 ab	0.55 ab
'Čačanska Lepotica'	5.21 c	3.60 ab	2.97 c	3.92 bc	0.97 d	0.60 b	0.31 a	0.62 b
Mean for pruning time								
Summer pruning	4.56 a	3.66 a	2.70 a	3.64 a	0.83 b	0.58 a	0.33 a	0.58 a
Dormant pruning	4.64 a	3.67 a	2.66 a	3.66 a	0.71 a	0.54 a	0.32 a	0.52 a

*Explanations, see Table 1

Table 4. Effect of pruning time on Mg and P content in leaves of 4 early ripening plum cvs.

Treatment	Mg content [% of dry weight]				P content [% of dry weight]			
	2002	2003	2004	2002-2004	2002	2003	2004	2002-2004
'Herman'								
Summer pruning	0.47 b*	0.45 a	0.33 a	0.42 a	0.25 a	0.23 a	0.22 a	0.23 a
Dormant pruning	0.38 a	0.55 b	0.34 a	0.42 a	0.30 a	0.27 b	0.21 a	0.26 a
'Čačanska Rana'								
Summer pruning	0.43 a	0.43 a	0.35 a	0.40 a	0.35 b	0.25 a	0.22 a	0.27 a
Dormant pruning	0.42 a	0.44 a	0.37 a	0.41 a	0.28 a	0.25 a	0.22 a	0.25 a
'Sanctus Hubertus'								
Summer pruning	0.32 a	0.37 a	0.24 a	0.31 a	0.29 a	0.22 a	0.24 a	0.25 a
Dormant pruning	0.35 a	0.37 a	0.25 a	0.32 a	0.29 a	0.29 b	0.24 a	0.27 a
'Čačanska Lepotica'								
Summer pruning	0.44 a	0.40 a	0.35 a	0.40 a	0.35 a	0.33 a	0.31 a	0.33 a
Dormant pruning	0.43 a	0.38 a	0.35 a	0.39 a	0.38 a	0.36 a	0.30 a	0.35 a
Mean for cultivar								
'Herman'	0.43 b	0.50 c	0.34 b	0.42 b	0.28 a	0.25 a	0.22 a	0.25 a
'Čačanska Rana'	0.43 b	0.44 b	0.36 b	0.41 b	0.32 a	0.25 a	0.22 a	0.26 a
'Sanctus Hubertus'	0.34 a	0.37 a	0.25 a	0.32 a	0.29 a	0.26 a	0.24 a	0.26 a
'Čačanska Lepotica'	0.44 b	0.39 ab	0.35 b	0.39 b	0.37 b	0.35 b	0.31 b	0.34 b
Mean for pruning time								
Summer pruning	0.42 a	0.41 a	0.32 a	0.38 a	0.31 a	0.26 a	0.25 a	0.27 a
Dormant pruning	0.40 a	0.44 a	0.33 a	0.39 a	0.31 a	0.29 b	0.24 a	0.28 a

*Explanations, see Table 1

trees were noticed. In 2002, leaf Ca content was higher for summer-pruned trees. Content of chemical constituents in leaves depended on the cultivar - which was in accordance with observations of Boyhan et al. (1998) and Olszewski et al. (1998). In consecutive years, contents of sugars were significantly variable. But, taking into consideration the means of the three year study, marked differences among cultivars were observed only in the contents of reducing sugars. 'Herman' and 'Sanctus Hubertus' cvs had more of these sugars compared to 'Čačanska Lepotica'. Similar results were obtained with foliar nutrient content. 'Čačanska Lepotica' showed significantly higher leaf P content than the other plum cultivars. Leaf K and Mg contents of cv. 'Sanctus Hubertus' were lower than those of the other ones. Amounts of calcium also differed among tested cultivars. 'Čačanska Lepotica' and 'Čačanska Rana' were characterised as having higher Ca contents in leaves compared to 'Herman'.

CONCLUSIONS

1. Taking into consideration the means of the three year study, time of pruning had no influence on vegetative growth and chemical constituents of leaves. No matter what the time of pruning was, total sugars, reducing sugars, potassium, calcium, magnesium, and phosphorus contents in leaves were similar.
2. Sugars, calcium and phosphorus contents were significantly influenced by the year.
3. Leaf K, Ca, Mg and P contents differed according to the plum cultivar. 'Sanctus Hubertus' showed markedly lower leaf K and Mg concentrations, whereas 'Čačanska Lepotica' had higher P concentration.
4. Pruning time had an influence on crop efficiency index. Dormant-pruned trees were significantly more productive.

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WPŁYW TERMINÓW CIĘCIA NA WZROST, KWITNIENIE I ZAWARTOŚĆ SKŁADNIKÓW CHEMICZNYCH W LIŚCIACH CZTERECH WCZEŚNIE DOJRZEWAJĄCYCH ODMIAN ŚLIWY

Ireneusz Sosna

S T R E S Z C Z E N I E

Celem badań było porównanie wpływu zróżnicowanych terminów cięcia na wzrost, kwitnienie i zawartość składników chemicznych w liściach kilku wczesnych odmian śliwy. Doświadczenie prowadzono w latach 2001-2004 w Sadowniczej Stacji Badawczej w miejscowości Samotwór pod Wrocławiem, należącej do Katedry Ogrodnictwa Uniwersytetu Przyrodniczego. Przedmiotem badań były ośmioletnie drzewa śliw 'Herman', 'Čačanska Rana', 'Sanctus Hubertus' i 'Čačanska Lepotica' okulizowane na siewkach ałyczy, posadzone w rozstawie 4 x 3 m (833 drzew/ha). Doświadczenie założono metodą losowanych bloków, w 3 powtórzeniach, po 3 drzewa na poletku. W latach 2001-2003 zróżnicowano terminy cięcia drzew. Połowę z nich (3 szt.) cięto tylko pod koniec sierpnia (cięcie letnie po zbiorach owoców), natomiast drugą połowę tylko pod koniec marca (cięcie zimowe przed kwitnieniem).

Spośród badanych odmian największą tendencję do przemienności kwitnienia wykazywały odmiany 'Sanctus Hubertus' oraz 'Herman'. Istotne różnice w kwitnieniu drzew w latach 2002-2003 były spowodowane bardziej cechami odmianowymi niż terminem cięcia. Zróżnicowane cięcie drzew nie miało wpływu na ich wzrost wegetatywny, lecz istotnie zwiększyło wskaźnik plenności. Najbardziej plonotwórczą odmianą okazała się 'Čačanska Lepotica', natomiast najsłabiej pod tym względem wypadła 'Čačanska Rana'. Na zawartość cukrów oraz makroskładników w liściach badanych odmian większy wpływ miały kolejne lata badań niż termin cięcia drzew. Biorąc pod uwagę średnią z 3 lat, zawartość cukru ogólnego, cukrów prostych, potasu, wapnia, magnezu i fosforu była zbliżona, niezależnie od terminu cięcia. Odmiana 'Sanctus Hubertus' zawierała najmniej potasu i magnezu, natomiast 'Čačanska Lepotica' charakteryzowała się najwyższą zawartością fosforu.

Słowa kluczowe: śliwa, termin cięcia, wzrost, kwitnienie, liście, związki chemiczne