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PROMISING SOUR CHERRY HYBRIDS (*Prunus cerasus* L.) DEVELOPED AT FRUIT RESEARCH INSTITUTE ČAČAK

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At Fruit Research Institute in Čačak, major objectives of the work on breeding new sour cherry (*Prunus cerasus* L.) cultivars are high cropping, large, high-quality fruits and resistance to causal agents of diseases and pests. As a result of the planned hybridization, more than 10,000 hybrid seedlings have been developed from about 40 cultivars within more than 110 parental combinations, among which are 'Čačanski rubin' ('Shasse Morello' x 'Köröser Weichsel') and 'Šumadinka' ('Köröser Weichsel' x 'Heimanns

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Konserven Weichsel') which have been named and released. Ten-year study of 11 hybrids, selected from the population of about 3,000 hybrid seedlings, gave four hybrids which have been singled out as elite (III/23, III/31, II/40 i XII/57). These hybrids are currently under procedure of being released as new cultivars. The paper presents two-year results of the study of ripening time, pomological properties, biochemical composition of fruits, and field resistance to causal agents of diseases and pests attacking the above named genotypes which were compared to standard cultivar 'Heimanns Konserven Weichsel'. In the studied hybrids, fruit weight, soluble solids content and sugars content were higher than in standard cultivar. In addition, they exhibit substantial field resistance to causal agents of brown rot (*Monilinia laxa* /Ader et Ruhl./ Honey ex Whetz.), cherry leaf spot (*Blumeriella jaapii* (Rehm.) v. Arx.), shot-hole (*Clasterosporium carpophilum* (Lév.) Aderh.) and cherry fruit fly (*Rhagoletis cerasi* L.) attack.

Key words: promising hybrids, pomo-technological properties, resistance sour cherry

INTRODUCTION

Sour cherry is an attractive fruit species, important from the aspect of economy, in terms of its exquisiteness not only as raw material for various forms of industrial processing but also for fresh consumption. Sour cherry fruits are also important from the aspect of export. In Serbia, the production of sour cherry reached 99,893 t in 2007 (FAOSTAT database, 2009). Different clones of 'Oblačinska' and 'Cigančica' dominate the assortment which account for about 85% of the total sour cherry production in our country (CEROVIĆ and RADIČEVIĆ, 2008).

Besides high cropping, quality fruits and suitability for industrial processing and fresh consumption, which stand out as major requirements in breeding new sour cherry cultivars, some additional objectives have been set up, such as suitability of fruits for mechanized harvesting (fruit firmness, resistance to bruises, no juice leakage when stalk is separated from fruits), resistance to *Blumeriella jaapii* (Rehm) v. Arx, *Monilinia* sp., etc. Different ripening times has been another objective, as newly developed sour cherry cultivars are expected to have more than six weeks' period of harvesting (BROWN *et al*., 1996).

Sour cherry (*Prunus cerasus* L.) is an allotetraploid species supposed to result from natural hybridization between ground cherry (*Prunus fruticosa* L.) and sweet cherry (*Prunus avium* L.), producing unreduced gametes (DIRLWANGER *et al.*, 2007). Due to the polygenic inheritance of the majority of traits, it is hard to obtain the desired traits by conventional methods used in breeding work (MIŠIĆ, 2002).

As a result of the planned hybridization at Fruit Research Institute Čačak, more than 10,000 hybrid seedlings have been developed from about 40 cultivars within more than 110 parental combinations, among which are 'Čačanski Rubin' ('Shasse Morello' x 'Köröser Weichsel') and 'Šumadinka' ('Köröser Weichsel' x 'Heimanns Konserven Weichsel'), which have been named and released (MILENKOVIĆ *et al.*, 2006). In addition to conventional method in breeding of new

sour cherry genotypes, investigations are directed to identification of incompatibility alleles and mechanism of their inheritance and interaction by isoelectric focusing of stylar proteins and staining for RNase activity and PCR method, folowed by monitoring of pollen tubes growth in the style (TOBUTT *et al.*, 2004; BOŠKOVIĆ *et al.*, 2006).

Ten-year study of 11 hybrids, selected from the population of about 3,000 hybrid seedlings, gave four hybrids which have been singled out as elite (CEROVIĆ *et al.*, 1998; NIKOLIĆ *et al.*, 1999). These hybrids are currently under procedure of being released as new cultivars.

MATERIALS AND METHODS

In the research period (2006–2007), ripening time, pomological properties, biochemical composition of fruits, and field resistance to causal agents of diseases and pests attacking four sour cherry genotypes: III/23 ('Köröser Weichsel' x 'Heimanns Konserven Weichsel'), III/31 ('Köröser Weichsel' x 'Heimanns Rubin'), II/40 ('Köröser Weichsel' x 'Heimanns Konserven Weichsel') and XII/57 ('Čačanski Rubin' x 'Heimanns Konserven Weichsel') were studied. The above named properties were compared to those of standard cultivar 'Heimanns Konserven Weichsel'.

The study was conducted in a sour cherry planting at the Banjica site (region of Čačak). The sour cherry hybrids and standard cultivar were grafted on the wild cherry (*Prunus avium* L.) seedling. The planting included all genotypes, 24 trees each. It was raised in 2002, at planting distance 4 x 3 m. Conventional cultural and pomotechnical practices and measures of protection of sour cherry plantings from causal agents of diseases and pests were applied in the planting.

Fruit ripening time was determined in the period of full, technological ripeness. Standard morphometrical methods were used for the evaluation of fruit weight, stone and stalk mass, and stalk length. Fruit weight and stalk length were included when classifying genotypes, by the method of ALBERTINI and DELLA STRADA (2001). Mesocarp ratio in the total fruit weight was calculated manually.

The following parameters were determined by chemical analysis: soluble solids content (manual refractometer), total and inverted sugars content (volumetrically, according to Luff-Schoorl), total acids content, expressed in malic acid (by titration of 0.1 N NaOH with phenolphthalein indicator), existing acidity (CyberScan 510 pH/Conductivity Meter), sucrose content and gluc-acidophilic coefficient (calculated manually).

The investigation of field resistance to causal agents of brown rot (*Monilinia laxa* /Ader et Ruhl./ Honey ex Whetz.), cherry leaf spot (*Blumeriella jaapii* (Rehm.) v. Arx.), shot-hole (*Clasterosporium carpophilum* (Lév.) Aderh, and cherry fruit fly (*Rhagoletis cerasi* L.) attack were conducted according to the Value for Cultivation and Use procedure (VCU test, in compliance to the UPOV procedure). Symptom intensity was determined on a scale from 1–9 (1 – no attack, 3 – minor attack, 5 – moderate attack, 7 – strong attack and 9 – very strong attack).

The pressure of cherry fruit fly (*Rhagoletis cerasi* L.) was measured on a scale from 1 to 3, i.e. 1 – no pressure, 2 – moderate pressure, 3 – under pressure.

RESULTS AND DISCUSSION

Over the research period, the average time of fruit ripening in the studied hybrids was in the third decade of June, i.e. it ranged from June 22 - hybrid XII/57, to June 30 - hybrid III/31 (Tab. 1). According to NIKOLIĆ *et al.* (1999), this period of ripening is considered particularly favourable, as it coincides with ripening time of a large number of quality sour cherries, such as 'Heimanns Konserven Weichsel', 'Rexelle', 'Kelleris 16', etc. The most favourable ripening time was observed in hybrids II/40 and III/31 (end of June and early July).

Compared to standard cultivar 'Heimanns Konserven Weichsel', the studied cultivars had higher fruit weight (Tab. 1). In all hybrids, fruits are classified as large, whereas those of standard cultivar are described as medium-large. The highest fruit weight was observed in hybrid III/31 (7.45 g). Stalks are medium-long, except in XII/57 where it is long. This hybrid also had the largest stone (0.63 g), whereas these were smallest in II/40 (0.45 g).

Tab. 1. Ripening time and pomological properties of promising sour cherry hybrids

Hybrid /cultivar	*Ripening time*	*Fruit weight (g)*	*Stalk length (mm)*	*Stalk weight (g)*	*Stone weight (g)*	*Mesocarp ratio (%)*	*Skin colour*
III/23	25.06.	7.20	41.30	0.20	0.47	90.69	dark red
III/31	30.06.	7.45	48.90	0.13	0.53	91.14	light red
II/40	28.06.	7.15	44.35	0.10	0.45	92.31	rubi red
XII/57	22.06.	7.25	55.15	0.14	0.63	89.38	rubi red
'Heimanns Kons. Weichsel'	28.06.	6.00	44.75	0.10	0.57	88.83	dark red

Fruit ratio, the edible part of fruit (mesocarp and skin) in the total fruit mass is a most important parameter for processing industry. All the hybrids exhibited higher ratio as compared to the standard cultivar. The most favourable ratio was found in II/40 (92.31%), while it was lowest in XII/57 (89.38%), which is the result of the largest stone observed precisely in this hybrid.

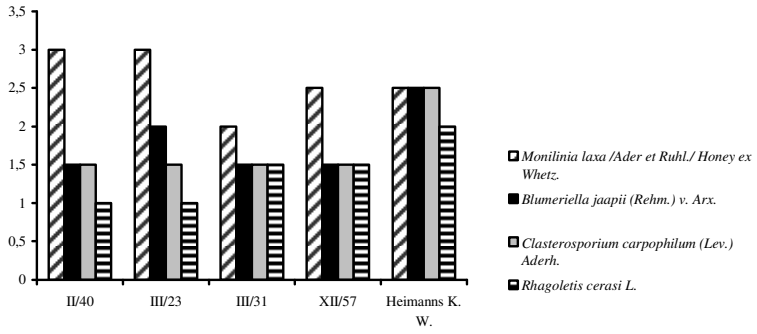
The highest and the lowest soluble solids content was found in hybrids III/31 (17.55%), and III/23 (13.55%) respectively (Tab. 2). The highest total and inverted sugars content was found in III/31 (11.85% and 10.06% respectively), and the lowest in XII/57 (9.63% and 8.66% respectively), whereas sucrose content ranged from 0.97% (III/23) to 1.83% (XII/57). As for the total acids content, the highest value (1.91%) was found in hybrid III/31, whereas the value of hybrid II/40

was lowest (1.17%). All the studied hybrids displayed higher pH value in fruit juice as compared to the standard cultivar.

Tab. 2. Biochemical composition of fruits of promising sour cherry hybrids

Hybrid/cultivar	Sugar content (%)				Fruit juice pH value	Total acids	Gluc-acidophilic coefficient
	SSC (%)	Total	Inverted	Sucrose			
III/23					2.99	1.64	6.05
III/31					3.22	1.91	6.20
II/40					3.41	1.17	8.82
XII/57					2.90	1.37	7.03
'Heimanns Kons. Weichsel'					2.89	2.09	4.77

The correlation of total sugars and total acids established gluc-acidophilic coefficient which serves as a significant indicator of fruit quality. The highest and the lowest values of the coefficient were observed in hybrids II/40 (8.82) and III/23 (6.05) respectively.



Graph. 1. Results of the study of resistance of sour cherry hybrids to causal agents and diseases under field conditions

Hybrid III/31 (Fig. 1) stands out for its attractive skin colour (light red) and fruit size. Genotypes with ruby red and dark red skin colour are particularly appealing in domestic and European markets, opposite to light red skinned cultivars which dominate the American market (NIKOLIĆ *et al.*, 1999). When breeding is for a highly pigmented sour cherry cultivar, intended for juice or liqueurs, anthocyanin content and sugar/acid ratio of fruits are critical (IEZZONI, 1996). The investigation of inheritance of ripening time, juice color and soluble solids content in sour cherry has

shown that these properties are inherited pollygenically, and that are accompanied by transgression to a higher or a lesser degree (STANČEVIĆ *et al.*, 1980).

As for the manifestation of the pressure of Blumeriella jaapii (Rehm.) v. Arx. and Clasterosporium carpophilum (Lév.) Aderh., the studied hybrids displayed better performance in comparison to the standard cultivar (Graph. 1). Symptom intensity of these pathogens was graded with 1.5 in hybrids II/40, III/31 and XII/57, whereas III/23 was graded with 2. Low pressure of Monilinia laxa /Ader et Ruhl./ Honey ex Whetz. was reported in II/40 and III/23 (graded with 3), being somewhat more pronounced than in standard cultivar, and in XII/57 (graded with 2.5). The best performance in terms of resistance to the above pathogen was observed in III/31 (graded with 2.0). Pressure intensity of cherry fruit fly (Rhagoletis cerasi L.) in hybrids II/40 and III/23 was graded with 1 (they are not prone to the pest attack), III/31 and XII/57 were graded with 1.5, whereas it was most pronounced in standard cultivar (moderately prone to the pest attack).

Fig. 1. Promising sour cherry hybrid III/31 ('Köröser Weichsel' x 'Heimanns Rubin')

In some earlier investigations of resistance of sour cherry hybrids developed at Fruit Research Institute Čačak to *Blumeriella jaapii* (Rehm.) v., when no protection measures were applied, hybrids III/23 and XII/57 respectively were classified as moderately susceptible and moderately resistant (CEROVIĆ *et al.*, 1998). According to the authors, the latter is characterized by low rate of pressure of *Rhagoletis cerasi* L. WOLFRAM (2000) released five cultivars at Dresden-Pillnitz that were more resistant to brown rot (*Monilinia* spp) and leaf spot (*Blumeriella jaapii*) compared to cv. 'Schattenmorelle'. SCHUSTER and WOLFRAM (2008) showed that three new cultivars were also more resistant to diseases compared to cv. 'Schattenmorelle'. The fact that cv. 'Köröser', which occurs in pedigree of the majority of German cultivars that show resistance to causal agents of diseases, also occurs in pedigree of cultivars bred at Čačak is an interesting observation. No source of resistance to cherry fruit fly (*Rhagoletis cerasi* L.) has been identified among sour cherries. Although early ripening cultivars may avoid the larval stage of the cherry fruit fly, this breeding possibility has not been explored (IEZZONI, 1996).

CONCLUSION

The results of investigation of pomological properties, biochemical composition of fruits and resistance of hybrids developed at Fruit Research Institute

Čačak suggest that they are aptly undergoing this stage of research and the procedure of release as new cultivars. Their fruits are large, of attractive light red, ruby red and dark red skin color and their quality is high. Similarly, the studied hybrids exhibit a significant level of field resistance to economically most serious pests and causal agents of diseases attacking sour cherry.

Further work on breeding sour cherry cultivars will be based on the utilization of already known sources of resistance, and on genotypes displaying good pomo-technological properties. In this respect, promising hybrids studied in this work can serve as a relevant base for developing sour cherry genotypes with improved bio-economic properties.

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PERSPEKTIVNI HIBRIDI VIŠNJE (*Prunus cerasus* L.) STVORENI U INSITUTU ZA VOĆARSTVO U ČAČKU

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I z v o d

Oplemenjivački rad na stvaranju sorti višnje (*Prunus cerasus* L.) u Institutu za voćarstvo u Čačku kao osnovne ciljeve postavlja rodnost, krupnoću i kvalitet ploda, kao i otpornost prema prouzrokovačima bolesti i štetočinama. Kao rezultat planske hibridizacije oko 40 sorti u više od 110 roditeljskih kombinacija, stvoreno je preko 10 000 hibridnih sejanaca. Među njima, dva su do sada priznata za sorte - 'Čačanski rubin' ('Shasse Morello' x 'Köröser Weichsel') i 'Šumadinka' ('Köröser Weichsel' x 'Heimanns Konserven Weichsel'). Na bazi desetogodišnjih ispitivanja 11 hibrida, odabranih iz populacije od oko 3000 hibridnih sejanaca, četiri su izdvojena kao elitni (III/23, III/31, II/40 i XII/57), i u postupku su priznavanja za nove sorte. U radu su prikazani dvogodišnji rezultati ispitivanja vremena zrenja, pomoloških osobina, biohemijskog sastava ploda i poljske otpornosti prema prouzrokovačima bolesti i štetočinama ovih genotipova, poređenih sa osobinama standardne sorte 'Heimanns Konserven Weichsel'. Masa ploda, sadržaj rastvorljivih suvih materija i šećera kod ispitivanih hibrida su bili viši u odnosu na standardnu sortu. Oni takođe pokazuju značajan stepen poljske otpornosti prema prouzrokovačima monilioze koštičavih vrsta voćaka (*Monilinia laxa* /Ader et Ruhl./ Honey ex Whetz.), ljubičaste pegavosti lišća trešnje i višnje (*Blumeriella jaapii* (Rehm.) v. Arx.), šupljikavosti lišća trešnje i višnje (*Clasterosporium carpophilum* (Lév.) Aderh.), kao i napadu trešnjine muve (*Rhagoletis cerasi* L.)

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