

Evaluation of some Canadian apricot cultivars in the region of Belgrade

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Abstract. Evaluation of 11 introduced Canadian apricot cultivars was conducted in the region of Belgrade during a six-year period (2009–2014). Control cultivar for comparison was ‘Hungarian Best’. Studies have included time of flowering and ripening, yield, and fruit quality. In addition, self-(in)compatibility trait was studied by means of fluorescence microscopy. Canadian cultivars began to flower one to five days before ‘Hungarian Best’, while average harvest date was earlier in four cultivars, and later in seven cultivars. Compared with the control cultivar, significantly higher yield was achieved in cultivars ‘Harcot’, ‘Harojoy’, ‘Sundrop’, ‘Harogem’, and ‘Harostar’. Significantly larger fruit size was achieved in ‘Laycot’, while smaller size was found in cultivars ‘Harlayne’, ‘Harglow’, ‘Harostar’ and ‘Sundrop’. Most of the introduced cultivars had better scores for fruit appearance, while scores for fruit quality were lower or at the same level as in control cultivar. Nine of studied cultivars were self-incompatible, while only two were self-compatible (‘Harlayne’ and ‘Harogem’).

Keywords: *Prunus armeniaca*, yield, fruit quality, self-incompatibility, fluorescence microscopy

Introduction

Apricot assortment in Serbia is characterized by small number of cultivars and a short period of ripening. The most of apricot fruits are harvested in the season of ‘Hungarian Best’, widely grown cultivar, or at a short time (about ten days) later. In order to improve the assortment, a large number of new apricot cultivars from different countries were introduced, including 11 cultivars from Canada.

A lot of work has been done worldwide on development new apricot cultivars with improved characteristics, such as better adaptation to different ecological conditions, increased disease resistance, self-fertility, higher yield, and better fruit quality. The introduction of new foreign cultivars and their evaluation in given

climatic conditions allows better choice of cultivars, which could improve the apricot production in Serbia.

The most important apricot breeding program in Canada was located at the Research Center Harrow (Ontario). Within this program, during the period 1974–1995, 11 apricot cultivars were released (Hunter & Layne, 1998). Apricot breeding has been previously done in Morden (Manitoba), in Summerland (British Columbia), where cultivar ‘Sundrop’ was released, and in Vineland (Ontario), where cultivars ‘Veecot’ and ‘Velvaglio’ were released. Canadian apricot cultivars are characterized by good cold hardiness, and they are cultivated not only in Canada, but also in the Eastern US and in many European countries.

Knowledge of the self-(in)compatibility of new cultivars is of great importance for choosing the adequate pollenizers in new orchard plantings. Although

apricot cultivars of European eco-geographical group are generally considered to be self-compatible, the results of the studies done in the last 20 years indicate that self-incompatibility is relatively frequent (Burgos *et al.*, 1997; Milatović & Nikolić, 2007).

This study was aimed to evaluate 11 introduced Canadian apricot cultivars of different ripening time, in order to recommend the most suitable for growing in Belgrade area and other regions with similar ecological conditions. In addition, self-(in)compatibility trait of these cultivars was examined.

Material and Methods

The study was carried out at the Experimental Station 'Radmilovac' of the Faculty of Agriculture in Belgrade, over a period of six years (2009–2014). The apricot collection orchard was established in 2007. The rootstock was Myrobalan (*Prunus cerasifera* Ehrh.) seedling, and tree spacing was 4.5 m × 3 m.

The study included 11 apricot cultivars introduced from Canada: 'Harcot', 'Harglow', 'Hargrand', 'Harlayne', 'Harogem', 'Harojoy', 'Harostar', 'Laycot', 'Sundrop', 'Veecot' and 'Velvaglo'. Control cultivar for comparison was 'Hungarian Best' ('Magyar Kajszi'). All cultivars were represented by five trees.

Flowering was recorded according to recommendations of the International Working Group for pollination: start of flowering – 10% open flowers, full flowering – 80% open flowers, end of flowering – 90% of the petal fall (Wertheim, 1996).

Fruit characteristics were determined on the sample of 25 fruits per cultivar. Soluble solids content was determined by refractometer (Pocket PAL-1, Atago, Japan), and total acids content (expressed as malic acid) by titration with 0.1 N NaOH. Five panelists performed the sensory evaluation (fruit appearance and taste) on a scale from 1 to 5.

Self-(in)compatibility of apricot cultivars was tested by monitoring pollen tube growth in the pistils self-pollinated in the laboratory and analyzed using fluorescent microscopy (Milatović & Nikolić, 2007).

The obtained data for yield and fruit weight were statistically analyzed using analysis of variance (ANOVA). 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 flowering time of introduced Canadian apricot cultivars was the last decade of March and the beginning of April (Tab. 1). Studied cultivars began to flower one to five days before the 'Hungarian Best'. Duration of flowering was 1–3 days longer than in the control cultivar.

Time of ripening was from June 25th ('Harcot') to July 10th ('Harlayne'). Harvest range was two weeks, from eight days before to seven days after the 'Hungarian Best'. Compared with the control cultivar, ripening was earlier in four cultivars ('Harcot', 'Velvaglo', 'Sundrop', and 'Laycot'), and later in seven cultivars ('Harojoy', 'Harglow', 'Harostar', 'Veecot', 'Hargrand', 'Harogem' and 'Harlayne').

The average yield per tree ranged from 4.4 kg in 'Hargrand' to 14.0 kg in 'Harcot' (Tab. 2). Significantly higher productivity than in control cultivar was achieved in five cultivars: 'Harcot', 'Harojoy', 'Sundrop', 'Harogem' and 'Harostar'.

With the exception of the first year (2010) of yielding, there were two years with high yields (2011 and 2014) and two years with low yields (2012 and 2013). The reason of the low yield in 2012 was the occurrence of winter frost (-20.7 °C on 9th of February), and late spring frost (-2.4 °C on 10th of April), while in 2013 there was very cold weather during the flowering, which resulted in low fruit set.

The obtained results are in accordance with the results of Vachun (2002), who studied the productivity of 24 apricot cultivars during six-year period and found variation of average yield from 3 to 20 kg per tree.

Self-(in)compatibility of apricot cultivars was tested by means of fluorescence microscopy. Cultivars were considered self-compatible if pollen tubes in the majority of pistils reached the ovary (Fig. 1). In self-incompatible cultivars, the cessation of growth of pollen tubes in the style was accompanied by the formation of characteristic swellings (Fig. 2). Results of fluorescence microscopy revealed that nine of studied cultivars were self-incompatible, while only two were self-compatible ('Harlayne' and 'Harogem'). Results confirm the findings of Burgos *et al.* (1997) who reported that cultivar 'Harlayne' was self-compatible, while cultivars 'Hargrand', 'Laycot', 'Sundrop', 'Veecot', and 'Velvaglo' were self-incompatible. The increasing number of new self-incompatible cultivars

Tab. 1. Flowering and harvest dates of studied apricot cultivars (average, 2009–2014)

Tab. 1. *Datumi cvetanja i zrenja ispitivanih sorti kajsije (prosek 2009–2014)*

Cultivar <i>Sorta</i>	Date of flowering/ <i>Datum cvetanja</i>			Duration of flowering (days) <i>Trajanje cvetanja</i> (dani)	Harvest date <i>Datum berbe</i>	No. of days comparing to control <i>Broj dana u</i> <i>u odnosu na kontrolu</i>
	Beginning <i>Početak</i>	Full <i>Puno</i>	End <i>Kraj</i>			
‘Harcot’	March 24 th <i>24. mart</i>	March 27 th <i>24. mart</i>	April 2 nd <i>2. april</i>	8.5	June 25 th <i>25. jun</i>	-8
‘Harglow’	March 25 th <i>25. mart</i>	March 28 th <i>28. mart</i>	April 2 nd <i>2. april</i>	9.0	July 5 th <i>5. jul</i>	+2
‘Hargrand’	March 24 th <i>24. mart</i>	March 27 th <i>27. mart</i>	April 1 st <i>1. april</i>	8.2	July 9 th <i>9. jul</i>	+6
‘Harlayne’	March 26 th <i>26. mart</i>	March 28 th <i>28. mart</i>	April 2 nd <i>2. april</i>	8.0	July 10 th <i>10. jul</i>	+7
‘Harogem’	March 23 th <i>24. mart</i>	March 26 th <i>26. mart</i>	April 1 st <i>1. april</i>	9.3	July 9 th <i>9. jul</i>	+6
‘Harojoy’	March 25 th <i>25. mart</i>	March 28 th <i>28. mart</i>	April 3 rd <i>3. april</i>	9.2	July 4 th <i>4. jul</i>	+1
‘Harostar’	March 24 th <i>24. mart</i>	March 27 th <i>27. mart</i>	April 2 nd <i>2. april</i>	8.7	July 5 th <i>5. jul</i>	+2
‘Laycot’	March 22 th <i>22. mart</i>	March 25 th <i>25. mart</i>	April 1 st <i>1. april</i>	10.2	June 30 th <i>30. jun</i>	-3
‘Sundrop’	March 22 th <i>22. mart</i>	March 26 th <i>26. mart</i>	April 1 st <i>1. april</i>	10.2	June 28 th <i>28. jun</i>	-5
‘Veecot’	March 22 th <i>24. mart</i>	March 26 th <i>26. mart</i>	April 1 st <i>1. april</i>	9.8	July 5 th <i>5. jul</i>	+2
‘Velvaglo’	March 24 th <i>24. mart</i>	March 27 th <i>27. mart</i>	April 2 nd <i>2. april</i>	9.0	June 26 th <i>26. jun</i>	-7
‘Hungarian Best’ <i>Mađarska najbolja</i> (control/ <i>kontrola</i>)	March 27 th <i>27. mart</i>	March 29 th <i>29. mart</i>	April 3 rd <i>3. april</i>	7.0	July 3 rd <i>3. jul</i>	0

from recent breeding programs can be explained by using some of Asian or North American self-incompatible cultivars as parents to obtain new genotypes with the traits such as *Plum pox virus* resistance, frost tolerance or extending the harvest time. Since the number of new self-incompatible cultivars increases, there is a need to select the appropriate pollenizers for establishing new apricot orchards. This is of great importance, especially because more and more reports about cross-incompatibility among apricot cultivars have been shown in recent decades (Szabó & Nyéki, 1991; Egea & Burgos, 1996; Jie et al., 2005; Hajilou et al., 2006; Zhang et al., 2008; Halász et al., 2010; Milatović et al., 2010).

Fruit characteristics of studied apricot cultivars are shown in Table 3. Compared to the control cultivar (‘Hungarian Best’), significantly larger fruit size was achieved only in ‘Laycot’, while smaller size was found in ‘Harlayne’, ‘Harglow’, ‘Harostar’ and ‘Sun-

drop’. Stone weight ranged from 2.6 to 3.3 g, accounting 4.3–7.6% of the total fruit weight. All introduced Canadian cultivars have smaller stone size than the control cultivar.

Obtained results for fruit characteristics are in accordance with the previous findings for some cultivars (Vachun, 2003; Licznar-Malanczuk & Sosna, 2013). However, results for fruit weight in this study were lower than values reported in Canada (Layne & Hunter, 2003a; 2003b). These differences can be due to different conditions of cultivation (rainfall, yield, cultural practices, etc.).

Soluble solids content ranged from 13.4% in ‘Sundrop’ to 18.2% in ‘Harlayne’. Obtained results for soluble solids in this study were much higher than values reported in Canada (Layne & Hunter, 2003b; Hampson, 2005). This can be explained by warmer climate in Serbian conditions. Total acids content ranged from 1.23% in ‘Hargrand’ to 1.65% in ‘Sundrop’.

Tab. 2. Yield and self-compatibility of apricot cultivars

Tab. 2. *Prinos i samooplodnost sorti kajsije*

Cultivar <i>Sorta</i>	Yield (kg per tree)/ <i>Prinos (kg po stablu)</i>					Average <i>Prosek</i>	Self-compatibility <i>Samooplodnost</i>
	2010	2011	2012	2013	2014		
'Harcot'	6.4	15.5	16.4	1.3	30.6	14.0 a ¹	Self-incompatible <i>Samobesplodna</i>
'Harglow'	3.1	5.7	4.4	5.2	12.4	6.2 cd	Self-incompatible <i>Samobesplodna</i>
'Hargrand'	2.2	8.6	2.0	0.7	8.6	4.4 d	Self-incompatible <i>Samobesplodna</i>
'Harlayne'	5.4	13.7	10.3	5.6	16.5	10.3 abc	Self-compatible <i>Samooplodna</i>
'Harogem'	8.1	22.1	10.6	9.6	16.0	13.3 a	Self-compatible <i>Samooplodna</i>
'Harojoy'	6.9	22.7	4.8	11.9	22.7	13.8 a	Self-incompatible <i>Samobesplodna</i>
'Harostar'	10.8	17.9	5.1	3.8	21.6	11.8 ab	Self-incompatible <i>Samobesplodna</i>
'Laycot'	6.7	15.5	3.2	2.0	20.8	9.6 abc	Self-incompatible <i>Samobesplodna</i>
'Sundrop'	12.6	24.7	7.2	2.2	21.4	13.6 a	Self-incompatible <i>Samobesplodna</i>
'Veecot'	7.7	22.7	11.2	0.3	5.2	9.4 abc	Self-incompatible <i>Samobesplodna</i>
'Velvaglio'	6.7	17.7	0.5	6.8	9.4	8.2 bcd	Self-incompatible <i>Samobesplodna</i>
'Hungarian Best' <i>Mađarska najbolja</i> <i>(Control/Kontrola)</i>	2.1	10.8	2.0	3.0	10.3	5.6 cd	Self-compatible <i>Samooplodna</i>

¹Mean values followed by different letters within a column represent significant differences at P = 0.05 according to Duncan's Multiple Range Test/Srednje vrednosti u kolonama praćene različitim malim slovima su statistički značajno različite prema Dankanovom testu višestrukih intervala za P = 0.05

Tab. 3. Fruit characteristics of apricot cultivars (average, 2009–2014)

Tab. 3. *Osobine ploda sorti kajsije (prosek 2009–2014)*

Cultivar <i>Sorta</i>	Fruit weight <i>Masa ploda</i> (g)	Stone weight <i>Masa koštice</i> (g)	Stone share <i>Udeo koštice</i> (%)	Soluble solids <i>R. suva materija</i> (%)	Total acids <i>Ukupne kiseline</i> (%)	Sensory evaluation (Scale 1–5) <i>Senzorička ocena (Skala 1–5)</i>	
						Appearance <i>Izgled</i>	Taste <i>Ukus</i>
'Harcot'	49.4 cd ¹	3.3	6.7	16.5	1.50	4.1	4.1
'Harglow'	40.9 ef	3.1	7.6	15.0	1.52	3.4	3.5
'Hargrand'	53.2 bc	2.7	5.1	14.1	1.23	3.6	3.6
'Harlayne'	36.7 f	2.8	7.6	18.2	1.57	3.0	4.0
'Harogem'	47.5 cd	3.1	6.5	16.2	1.27	4.0	3.9
'Harojoy'	49.0 cd	2.9	5.9	16.1	1.49	4.2	4.1
'Harostar'	41.1 ef	2.7	6.6	15.8	1.41	4.2	4.1
'Laycot'	60.1 a	2.6	4.3	14.4	1.55	4.2	3.9
'Sundrop'	43.7 de	2.9	6.6	13.4	1.65	3.4	3.8
'Veecot'	50.8 c	2.9	5.7	15.7	1.47	4.0	3.6
'Velvaglio'	56.8 ab	3.0	5.3	13.2	1.39	4.2	4.0
'Hungarian Best' <i>Mađarska najbolja</i> <i>(Control/Kontrola)</i>	51.7 bc	3.8	7.4	15.7	1.37	3.6	4.1

¹Mean values followed by different letters within a column represent significant differences at P = 0.05 according to Duncan's Multiple Range Test/Srednje vrednosti u kolonama praćene različitim malim slovima su statistički značajno različite prema Dankanovom testu višestrukih intervala za P = 0.05

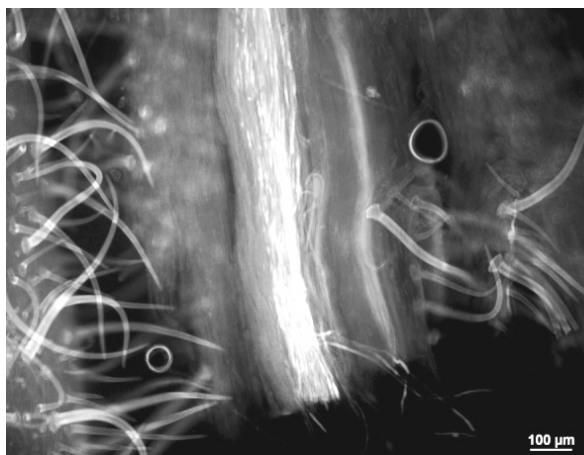


Fig. 1. The base of the style with a numerous pollen tubes in the self-compatible apricot 'Harogem', 96 hours after self-pollination
Sl. 1. Baza stubića sa velikim brojem polenovih cevčica kod samooplodne sorte kajsije Harogem, 96 sati nakon samooprašivanja

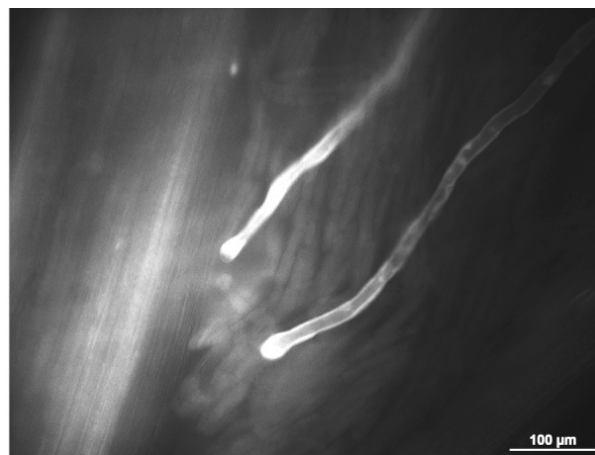


Fig. 2. Incompatible pollen tubes with a broadened tips in the middle of the style in the self-incompatible apricot 'Sundrop', 96 hours after self-pollination
Sl. 2. Inkompatibilne polenove cevčice sa proširenim vrhovima u sredini stubića kod samobesplodne sorte kajsije Sundrop, 96 sati nakon samooprašivanja

Most of the introduced cultivars have better fruit appearance, with the exception of 'Harlayne', 'Harglow', and 'Sundrop'. Scores for fruit taste were lower or at the same level ('Harcot', 'Harojoy' and 'Harostar') as in the control cultivar.

Conclusions

Among 11 introduced Canadian apricot cultivars, seven cultivars were singled out as promising for growing in the region of Belgrade. Ripening time of three cultivars was before 'Hungarian Best' ('Harcot', 'Velvaglo', and 'Laycot'), while in four cultivars it was later ('Veecot', 'Harojoy', 'Harostar', and 'Harogem'). Nine of studied cultivars are self-incompatible, while only two are self-compatible ('Harlayne' and 'Harogem').

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OCENJIVANJE NEKIH KANADSKIH SORTI KAJSIJE NA PODRUČJU BEOGRADA**Dragan Milatović, Dragan Nikolić, Dejan Đurović, Gordan Zec**

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Rezime

Na području Beograda ocenjivano je 11 introdukovanih kanadskih sorti kajsije u periodu od šest godina (2009–2014). Kontrolna sorta za poređenje je bila Mađarska najbolja. Istraživanja su obuhvatala vreme cvetanja i zrenja, prinos i kvalitet ploda. Pored toga, ispitivana je i samooplodnost sorti pomoću fluorescentne mikroskopije. Kanadske sorte su počinjale cvetanje jedan do pet dana pre sorte Mađarska najbolja, dok je prosečan datum berbe bio raniji kod četiri sorte, a kasniji kod sedam sorti. U poređenju sa kontrolnom sortom, značajno veći prinos je dobijen kod sorti Harcot, Harojoy, Sundrop, Harogem i Harostar. Značajno ve-

ća krupnoća ploda je dobijena kod sorte Laycot, dok je manja krupnoća ploda ustanovljena kod sorti Harlayne, Harglow, Harostar i Sundrop. Većina introdukovanih sorti je imala bolje ocene za izgled ploda, dok su ocene za ukus bile lošije ili na istom nivou kao kod kontrolne sorte. Među ispitivanim sortama, bilo je devet samobesplodnih i samo dve samooplodne (Harlayne i Harogem).

Ključne reči: *Prunus armeniaca*, prinos, kvalitet ploda, samobesplodnost, fluorescentna mikroskopija