Characteristics of promising apricot (*Prunus armeniaca* L.) genetic resources in Central Serbia based on blossoming period and fruit quality

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Abstract

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This study presents results on the performance of apricot (*Prunus armeniaca* L.) genotypes in Central Serbia. The research included observation and recording of biological (i.e. phenological) traits and *in situ* sampling of fruits from 1,210 grafted trees for determination of pomological and sensorial traits. A total of 14 genotypes were selected and compared with Hungarian Best (control cultivar). The difference in blossoming time between two years was one month. In 2006, blossoming time was found to be earlier in three genotypes, simultaneous in five genotypes and later in six as compared to the control. In 2007, bloom was earlier in four genotypes, simultaneous in four and later in six genotypes. Average fruit weight ranged from 41.34 ± 0.8 to 81.50 ± 4.1 g, T-5 being the only genotype having the fruit weight lower than Hungarian Best (49.07 ± 2.2 g). The content of soluble solids, total sugars, and mineral matter ranged from 15.72–18.88%, 11.53–14.99%, and 0.29–0.43%, respectively, and total acidity was 0.77–1.08%. The appearance and the skin colour of the genotypes were highly attractive. They have promising traits which suggest that they can be useful parents in apricot breeding programmes.

Keywords: blossoming; breeding; diversity; genotype; fruit quality; *Prunus armeniaca* L.

Major limiting factors in the intensive spread of apricot in Serbia are identical to those in temperate continental and continental parts of Europe: blossoms killed by spring frosts (Milatović et al. 2006), sudden (premature) wilting – Apoplexy (Petrović, Milošević 1999), winter killing of flower buds prior to bloom (Djuric 1987; Pejkić et al. 1987), *Plum pox virus* infection in apricot trees and absence of modern growing technologies (Milošević et al. 2008).

Apricots are grown throughout Serbia, but either as individual trees or smaller groups of trees. Central Serbia, and particularly the region of Cacak are characterized by the great wealth of biodiversity as a source of apricot germplasm, and hence the abundance of different genotypes, clones, varieties, forms, and types. However, there are a much higher number of individual or grouped apricot trees grown in fields, farms or neglected areas. They are marked by great differences in terms of biological and pomo-

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logical traits. Some trees have respectable biological and pomological traits and are commonly grown in plantations around Cacak under different local names, together with the most popular cultivars such as Hungarian Best (over 50%), Krupna Rana, Keckemet Rose, and Roxana as a recent cultivar, due to their high adaptability and modest requirements in terms of environmental conditions and orchard maintenance (Petrović, Milošević 1999). Similar situations can be found in the region of Smederevo (the Danube river valley).

Information on the genetic variability of apricot is limited (Mehlenbacher et al. 1991). Apricot breeding programmes are under way in many countries, where specific attention is being focused on high quality fruits, resistance to winter and late spring frost, late blossoming and extended ripening season (Bolat, Güleryüz 1995; Bostan et al. 1995; Kazankaya 2002), as well as on the adaptability to different environmental conditions (Yalçinkaya et al. 1995). A multitude of studies examine selection from native apricot i.e. promising seedlings, with particular reference to both the Iran-Caucasian (Balta et al. 2002; Asma, Ozturk 2005; Asma et al. 2007) and European groups of representatives (Badenes et al. 1998; Vachůn 2003; Ruiz, Egea 2008b).

The main objective of the study was *in situ* examination of apricot genotypes that have respectable fruit traits in Central Serbia and that can be used for future breeding studies. Frost resistance, blossoming and ripening times and fruit quality in terms of fresh consumption were specifically evaluated.

MATERIAL AND METHODS

Plant material

The research included the genotypes from the autochthonous population of apricot (*Prunus armeniaca* L.) of the European group (Kostina 1969) in the regions of Cacak (43°53'N; 20°21'E) and Smederevo (44°40'N; 20°56'E) in Central Serbia in 2006 and 2007. The study included identification, observation and recording of phenological traits and *in situ* sampling from 1,210 grafted apricot trees (in the fields under cultivation practices, not in the orchards). The basic criteria used in genotype selection were the following: blossoming time, harvest date, yield, fruit size, and quality attributes, vitality, longevity, and tree health.

Selection was made on 14 genotypes that showed the highest quality of biological and pomological traits. The control (standard) used in the research was Hungarian Best, the predominant apricot cultivar in Serbia. All genotypes, including selected trees, and Hungarian Best were grafted on the rootstock developed from the local plum cultivar Belosljiva originating from *Prunus domestica* L.

Traits evaluated and data analysis

The investigations focused on two segments. The first included recording of the phenological traits–first blossoming (FB), full blossoming (FBl), end of blossoming (EB), harvest date (HD) and period of fruit development (FD) and morphometric traits of the tree – grafting height (cm), circumference of the trunk 60 cm above the ground (cm) and crown dimensions: North-South width (cm), East-West width (cm), and crown height (cm).

The second segment comprised physical, chemical and sensorial traits of the fruit – fruit weight (FW, g), stone weight (g), soluble solids (SS, %), total sugars (TS, %), total acidity (TA, %), mineral matter (MM, %), fruit firmness (FFi), flesh colour (FC), skin colour (SC), fruit aroma (FA), and fruit usage (FU). A total of 30 fruits and stones were sampled per each genotype for physical analysis. Fruit and stone weights were determined on a technical scale Tehnica ET-1111 (Iskra, Kranj, Slovenia) (range of measurement 0.01–120.00 g, precision ± 0.01 g).

For chemical analysis, four replicates of ten fruits each were used for each genotype. Soluble solids content was obtained using a Milwaukee MR 200 hand digital refractometer (ATC, Belgium). An HPLC analysis of TS was performed using an HPLC and refractive index detector from Thermo separation products (Riviera beach, USA). Total acids were analyzed by HPLC, using an Aminex HPX-87H column (300 × 7.8 mm) (Bio-Rad, USA) associated with a UV detector set at 210 nm. For MM content, fruit samples were ashed at 550°C for 24 h.

Fruit firmness was measured on opposite paired cheeks (where the skin was removed) using a Bertuzzi Penetrometer (model FT-327, Alfonsine, Italy) equipped with an 8-mm cylindrical plunger. Flesh colour and SC were measured using a Minolta chroma meter (CR-300, Minolta, NJ) with tristimulus colour analyzer calibrated to a white porcelain reference plate. Fruit aroma and FU was evaluated based on Protection of New Varieties of Plants (UPOV).

The UPOV apricot descriptor list was used (Zanetto et al. 2002; Guerriero et al. 2006).

Table 1. Phenological characteristics of apricot genotypes

Genotype	First blossoming		Full blossoming		End of blossoming		Harvest date		Period of fruit development	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
T-1	3 Apr	8 Mar	9 Apr	17 Mar	13 Apr	21 Mar	27 Jun	16 Jun	80	91
T-2	7 Apr	13 Mar	13 Apr	21 Mar	17 Apr	25 Mar	11 Jul	27 Jun	90	98
T-3	2 Apr	7 Mar	8 Apr	16 Mar	12 Apr	20 Mar	03 Jul	19 Jun	87	95
T-4	4 Apr	9 Mar	10 Apr	18 Mar	13 Apr	22 Mar	06 Jul	22 Jun	88	96
T-5	1 Apr	6 Mar	7 Apr	15 Mar	11 Apr	19 Mar	07 Jul	23 Jun	92	100
T-6	3 Apr	8 Mar	9 Apr	17 Mar	13 Apr	21 Mar	08 Jul	24 Jun	91	99
T-7	1 Apr	6 Mar	7 Apr	15 Mar	11 Apr	19 Mar	06 Jul	25 Jun	91	102
T-8	4 Apr	9 Mar	10 Apr	18 Mar	14 Apr	22 Mar	08 Jul	27 Jun	90	101
T-9	3 Apr	8 Mar	9 Apr	17 Mar	13 Apr	21 Mar	07 Jul	26 Jun	90	101
T-10	3 Apr	7 Mar	8 Apr	16 Mar	12 Apr	19 Mar	08 Jul	27 Jun	92	103
T-11	4 Apr	9 Mar	11 Apr	18 Mar	15 Apr	22 Mar	07 Jul	26 Jun	88	100
T-12	3 Apr	8 Mar	9 Apr	17 Mar	13 Apr	21 Mar	09 Jul	28 Jun	92	103
T-13	5 Apr	10 Mar	11 Apr	19 Mar	15 Apr	23 Mar	10 Jul	29 Jun	91	102
T-14	4 Apr	9 Mar	10 Apr	18 Mar	14 Apr	23 Mar	09 Jul	28 Jun	91	102
HB[1]	3 Apr	8 Mar	8 Apr	17 Mar	12 Apr	21 Mar	07 Jul	26 Jun	91	101

[1]The control apricot cultivar Hungarian Best

All data are means of two years. The measured data were subjected to an analysis of variance (ANOVA) using the Statistical Analysis System (SAS) and means were separated by Dunett's test at *d'* < 0.05.

RESULTS

Blossoming

The phenological characteristics of the selected apricot genotypes are presented in Table 1. The FB ranged from 1–7 April, 2006 and from 7–13 March, 2007. Full blossoming was registered on 7–13 April, 2006, and 15–21 March, 2007, and the EB in 2006 and 2007 was from 11–17 April and 19–25 March, respectively. The earliest blossoming dates were characteristic of T-5 and T-7, and the latest of T-2. Hungarian Best started to blossom on 3 April, FB was on 8 April, and the EB on 12 April in 2006, whereas in 2007 it was on 8, 17 and 21 March, respectively. In 2006, the earlier FB was registered in three genotypes (T-3, T-5, and T-7), simultaneous in five (T-1, T-6, T-9, T-10, and T-12), and later in six genotypes (T-2, T-4, T-8, T-11, T-13, and T-14), as compared to the Hungarian Best. In 2007, there were certain deviations; four genotypes (T-3, T-5, T-7, and T-10) blossomed earlier, four genotypes (T-1, T-6, T-9, and T-12) simultaneously, and six genotypes (T-2, T-4, T-8, T-11, T-13, and T-14) later than Hungarian Best. The difference in the FB was six days in 2006 and seven days in 2007.

The last frost occurrence in the Cacak region in the first four months of 2006 was registered on 5 February and it was as low as –0.2°C. Severe frost of –18°C in this year occurred on 25 and 26 January. In the first four months in 2007, frosts were recorded on 5 March and 6 April, their intensity being –0.6°C (Table 2).

Harvest date

The onset of harvest was genotype- and year-dependent (Table 1). In 2006, the earliest onset was in T-1 (27 June) and T-3 (3 July), and the latest in T-13 (10 July) and T-2 (11 July). The fruits of Hungarian

Table 2. The frost occurrence in Central Serbia over the 2006–2007 period

Year	Minimum winter temperatures		Frost before blossoming		Frost in full blossoming		Frost after blossoming	
	Date and frost occurrence (°C)	Percentage of frosted flower buds (%)	Date and frost occurrence (°C)	Damage (%)	Date and frost occurrence (°C)	Damage (%)	Date and frost occurrence (°C)	Damage (%)
2006	Jan 25–26 −18	67.30	No	0	No	0	Feb 5 −0.2	0
2007	No	0	No	0	No	0	Apr 4 −0.6	0

Best were ripe on 7 July, which suggested that the period of ripening was early in T-1, T-3, T-4, and T-7, and late in T-2, T-6, T-8, T-10, T-12, T-13, and T-14, whereas the fruits of T-5, T-9, and T-11 ripened simultaneously with the control cultivar. In 2007, the onset of harvest, as in 2006, was the earliest in T-1 (16 June) and T-3 (19 June).

The latest onset of harvest was recorded in T-13 (29 June). The onset of harvest of Hungarian Best in 2007 was on 26 June, which indicated that it was earlier in six genotypes (T-1, T-3, T-4, T-5, T-6, and T-7), simultaneous in two genotypes (T-9 and T-11) and later in six (T-2, T-8, T-10, T-12, T-13, and T-14), as compared to the control cultivar. The difference in HD between the genotypes, including Hungarian Best, was 14 days in 2006 and 13 days in 2007, the difference between the years ranged from 11 (T-1, T-7, T-8, T-9, T-10, T-11, T-12, T-13, T-14, and Hungarian Best) to 14 days (T-2, T-3, T-4, T-5, and T-6).

Fruit development

The period of FD (full blossoming – harvest) differed depending on the genotype and year (Table 1). It was shorter in 2006 than in 2007, ranging from 80 (T-1) to 92 days (T-5, T-10, and T-12) in 2006, i.e. from 91 days (T-1) to 103 days (T-10 and T-12) in 2007. The process in Hungarian Best lasted 91 days in 2006 and 101 days in 2007. In 2006, the period of FD was found to be shorter in seven genotypes (T-1, T-2, T-3, T-4, T-8, T-9, and T-11), identical in four genotypes (T-6, T-7, T-13, and T-14), and longer in three genotypes (T-5, T-10, and T-12), as compared to the control.

In 2007, seven genotypes (T-1, T-2, T-3, T-4, T-5, T-6, and T-11) showed a shorter period of FD, two genotypes (T-8 and T-9) had an identical period as Hungarian Best, whereas five genotypes (T-7, T-10, T-12, T-13, and T-14) were characterized by a longer period of FD as compared to the control cultivar.

Fruit and stone weight

The data on the FW and stone weight in apricot genotypes are presented in Table 3. The average FW of the selected genotypes in 2006–2007 ranged from 41.34 ± 0.8 g (T-5) to 81.50 ± 4.1 g (T-1). The T-1 genotype was followed by T-13 (80.27 ± 3.9 g), T-14 (72.68 ± 3.5 g), T-2 (69.98 ± 3.2 g), T-9 (68.77 ± 3.5 g), and T-6 (67.36 ± 3.9 g). Fruit weight in over 78.5% of genotypes was higher than 60.0 g, i.e. it was higher in thirteen genotypes (92.83%) than in the control cultivar, the T-5 genotype (41.34 ± 0.8 g) being the only one with FW lower than Hungarian Best (49.07 ± 2.2 g). Stone weight ranged from 2.98 ± 0.4 (T-5) to 5.01 ± 0.8 g (T-1), being 3.37 ± 0.6 g in Hungarian Best (Table 3).

Chemical and sensorial fruit traits

The chemical composition and the sensorial status of the apricot genotypes are presented in Table 3. The mesocarp content of SS, TS, and MM was 15.72–18.88%, 11.53–14.99%, and 0.29–0.43%, respectively, TA being 0.77–1.08%. The fruit of Hungarian Best contained 16.77% SS, 12.07% TS, 0.32% MM, and 1.03% TA. A substantially higher content of SS was found in the T-4, T-5, T-7, T-10, T-11, and T-12 genotypes, a higher content of TS was recorded for the genotypes T-1, T-2, T-5, and T-13 and a higher content of MM for T-1, T-5, T-6, T-7,

Table 3. Fruit characteristics of apricot genotypes

Genotype	Fruit weight (g)	Stone weight (g)	Soluble solids (%)	Total sugars (%)	Mineral matter (%)	Total acidity (%)	Fruit aroma	Fruit firmness	Flesh color	Skin color	Fruit usage
T-1	81.50 ± 4.1	5.01 ± 0.8	17.81$^{n.s.}$	13.37*	0.41*	1.06$^{n.s.}$	7	3	7	4	1
T-2	69.98 ± 3.2	4.04 ± 0.7	17.48$^{n.s.}$	12.88*	0.36$^{n.s.}$	0.77*	6	7	6	6	1
T-3	60.87 ± 1.8	3.69 ± 0.6	17.93$^{n.s.}$	12.51$^{n.s.}$	0.37$^{n.s.}$	0.89$^{n.s.}$	6	7	7	6	1
T-4	61.23 ± 1.5	3.37 ± 0.6	17.98*	12.49$^{n.s.}$	0.35$^{n.s.}$	0.88$^{n.s.}$	6	7	7	4	1
T-5	41.34 ± 0.8	2.98 ± 0.4	18.88*	13.40*	0.43*	0.93$^{n.s.}$	5	5	7	4	1
T-6	67.36 ± 3.9	4.08 ± 0.7	17.85$^{n.s.}$	12.55$^{n.s.}$	0.39*	1.00$^{n.s.}$	6	7	6	6	1
T-7	51.55 ± 1.5	3.16 ± 0.5	18.01*	11.71$^{n.s.}$	0.40*	0.83*	5	7	8	6	1
T-8	65.84 ± 3.6	3.71 ± 0.7	16.23$^{n.s.}$	12.72$^{n.s.}$	0.29$^{n.s.}$	0.93$^{n.s.}$	6	7	8	6	1
T-9	68.77 ± 3.5	3.54 ± 0.6	15.72$^{n.s.}$	11.53$^{n.s.}$	0.39*	1.05$^{n.s.}$	6	7	7	4	1
T-10	69.43 ± 4.0	3.86 ± 0.6	18.03*	12.98$^{n.s.}$	0.41*	1.04$^{n.s.}$	6	7	7	5	1
T-11	60.65 ± 3.8	3.22 ± 0.5	18.11*	12.49$^{n.s.}$	0.35$^{n.s.}$	1.01$^{n.s.}$	6	7	7	4	1
T-12	59.94 ± 3.6	3.34 ± 0.4	17.95*	12.21$^{n.s.}$	0.38$^{n.s.}$	1.00$^{n.s.}$	5	5	8	7	1
T-13	80.27 ± 3.9	3.98 ± 0.6	16.01$^{n.s.}$	14.99*	0.42*	1.08$^{n.s.}$	6	3	7	4	1
T-14	72.68 ± 3.5	4.04 ± 0.8	17.76$^{n.s.}$	12.43$^{n.s.}$	0.40*	0.99$^{n.s.}$	7	3	5	4	1
HB[1]	49.07 ± 2.2	3.37 ± 0.5	16.77	12.07	0.32	1.03	6	7	7	6	1

[1]The control apricot cultivar Hungarian Best
The asterisk in vertical columns indicates a significant difference between means at $d' < 0.05$ from Dunett's test; n.s. – non significant differences
Fruit aroma: 5 = intermediate, 6 = good, 7 = rich; Fruit firmness: 3 = soft, 5 = medium, 7 = firm; Flesh color: 5 = yellow, 6 = light orange, 7 = orange, 8 = deep orange; Skin color: 4 = yellow, 5 = light orange, 6 = orange, 7 = dark orange; Fruit usage: 1 = dessert (fresh)

T-9, T-10, T-13, and T-14 as compared to the fruit content of these substances in Hungarian Best ($d' < 0.05$). However, no significant differences in TA content were found between the control and most genotypes, except for T-2 and T-7 which had a significantly lower content of the above substances.

Fruit aroma in the genotypes ranged from intermediate to rich, and FFi from soft to medium and firm. The orange FC and yellow SC were registered in most genotypes (Table 3).

Tree characteristics of apricot genotypes

The data presented in Table 4 refer to the tree morphometry of apricot genotypes *in situ*. Age of trees ranged from 18 years (T-3) to 95 (T-9) years. The smallest trunk height, derived from the rootstock, was recorded in T-1 (90 cm) and the highest in T-12 (210 cm), the height in Hungarian Best and the other genotypes being 120 cm and above 100 cm, respectively. The circumference of the trunk 60 cm above the ground ranged from 35 cm in T-3 to 135 cm in T-9, which suggested the considerable age of the trees. The trunk circumference of Hungarian Best was 75 cm.

Crown dimensions did not show any clear regularity depending on the height of grafting and the trunk circumference. The lowest crown vigour was recorded in T-3 (400 cm N-S, 350 cm E-W, h = 300 cm), and the highest in T-13 (700 cm N-S, 750 cm E-W, h = 700 cm). The tree dimensions of Hungarian Best were medium (550 cm N-S, 500 cm E-W, h = 380 cm).

DISCUSSION

Analysis of blossoming period

The phenotypic expression of the cultivars of the species *P. armeniaca* L. results from the effect of different environmental conditions on genotype as well as from the rootstock effect. The FB immediately follows the end of the dormancy period. The end of the dormancy period is determined from the dry-weight increase of the flower buds (Andrés, Durán 1999), and the onset of apricot blossoming is dependent on the temperature increase after dormancy and is correlated with air temperature up to the end of March (Blasse, Hofmann 1993). Vachůn (1974) reported that the temperatures ranging from 7°C to 9°C determined the start of the phenophase "beginning of blossoming". In Central Serbia, apricots start to blossom towards the end of March or at the beginning of April, on average, the difference in the FB between the genotypes being 2–4 days under favourable environmental conditions or 6–8 days under less favourable ones (Milošević 1997). According to the author, apricots start to blossom in the Belgrade and Smederevo fruit-growing regions, located in the Danube river valley, about seven days earlier than in the region of Cacak. The FB of the clonally selected cultivars Aleksandar, Biljana, and Vera, bred for a later bloom period, under the environmental conditions of Cacak is in the first decade of April (Paunovic 2000).

The deviations in the present study regarding the FB were induced by the mild winter of 2006/2007 and the very early onset of the growing season in Serbia in 2007 (Table 1). Namely, in the stated year, the very early blossoming apricot cultivars such as Precoce de Tyrinte started to blossom on 15 February, the phenomenon not being registered in the previous 60 years (Milošević et al. 2008). In many European countries, including Serbia, where apricot cultivars of the European group are being cultivated, apricot yields fluctuate due to the occurrence of frosts during blossoming as well as to the cultivation of cultivars intolerant to climate oscillations (Szalay, Szabo 1999). For example, under Hungarian conditions, apricots bear fruit five times in ten years due to climatic conditions (Porpaczy 1957), whereas in Polish yields were recorded in six out of ten years due to the negative effect of winter and spring frosts (Licznar-Małańczuk, Sosna 2005). Blasse and Hofmann (1993) also reported that the blossoming period lasted an average of ten days. The blossoming of cultivars and clones in the

Table 4. Tree characteristics of apricot genotypes

Genotype	Age of tree	Trunk height (cm)	Circumference of the trunk 60 cm above the ground (cm)	Crown dimensions (cm)		
				N-S Width	E-W Width	Crown height (h)
T-1	38	90	85	600	650	400
T-2	42	120	100	550	500	550
T-3	18	115	35	400	350	300
T-4	19	120	40	450	400	350
T-5	57	160	110	600	700	650
T-6	24	140	40	400	400	350
T-7	77	170	130	450	400	400
T-8	46	155	95	600	700	650
T-9	95	140	135	650	750	650
T-10	20	125	55	500	400	400
T-11	62	115	125	650	700	450
T-12	53	210	110	450	400	300
T-13	75	100	130	700	750	700
T-14	38	140	85	650	600	600
HB[1]	33	120	75	550	500	380

[1]The control apricot cultivar Hungarian Best, N-S: North-South, E-W: East-West

Poland conditions takes some eight days (Licznar-Małańczuk, Sosna 2005), being somewhat less than the results of the present study. There were evident differences in the FB in individual years (Table 1). The onset of apricot blossoming differs by about one month from year to year, but it most often occurs in mid-April, i.e. as in warmer-climate countries (Szalay, Szabo 1999), in other words, it is directly correlated with the climatic conditions of the country (Ruiz, Egea 2008a). The FB of the same cultivar can differ from year to year by 25 to 40 days depending on the cultivar and on the conditions of the year (Vachůn 1986). In twenty apricot genotypes, over a six-year period, it ranged from 21–29 days in individual years, and from 5–9 days between the genotypes from year to year (Vachůn 2003; Ruiz, Egea 2008b). The results of the present study serve as a confirmation of the results obtained by the cited authors.

The last frost occurrence in the region of Cacak at the beginning of 2006 was on 5 February (Table 2). It was as low as –0.2°C and, being such, it did not cause any damage to the apricot blossoms. However, the intensive winter frost of –18°C that occurred on 25 and 26 January 2006 (ecological dormancy period) induced 67.30% killing of flower buds that resulted in non-uniform low yields in the whole Serbia (Milošević et al. 2008). Low January temperatures, provided they range from –18°C to –25°C, always cause winter killing of flower buds in Serbia (Djuric 1987; Pejkić et al. 1987). The damage induces lower yields; yet, in certain years characterized by excessive flower bud differentiation, it can be even beneficial (Szabo et al. 1995). In the early spring of 2007, frost was registered on 5 March and 6 April. It was –0.6°C and it did not cause any damage to the set fruits nor to those of hazelnut-size later on (Table 2). However, the spring frosts of 1998, 2001 and 2002, their intensity being –4°C to –7°C during the full blossoming stage, destroyed the apricot fruits in Serbia (Milatović et al. 2006). In 2003, the spring frost of –2.0°C that occurred at the time of FBl killed 19.40% of apricot flowers in the region of Cacak (Milošević et al. 2008). In view of the above data, apricot production variations are generally induced by low winter and unstable early-spring temperatures (Rodrigo, Herrero 2002). The variations are even more pronounced in the countries north of Serbia (Hungary, Czech Republic, Poland), as opposed to Greece, where they are of lower intensity (Bassi, Karayiannis 1999), which confirms the fact that the range of distribution of this fruit species is directly associated with general climate characteristics of the country (Szalay, Szabo 1999; Ruiz, Egea 2008a, 2008b).

Analysis of harvest time and fruit development

In our study, harvest time variations within a single year were attributable to the genetic background of the genotypes and those between the years to the effect of environmental factors, primarily climate, which directly or indirectly affected the course and dynamics of FD (Table 1). Similar results were obtained by a number of authors. The HD of Hungarian Best near Belgrade (140 km north of Cacak) was on 12 July (Mratinic-Nenadovic et al. 2003). The fruits of the new Serbian apricot cultivars Aleksandar, Biljana, and Vera obtained by clonal selection near Cacak and Smederevo (Paunovic 2000) ripen from 8–23 July, as confirmed by the results obtained in our study, but only by those for 2006, as the growing season in 2007 started one month earlier, inducing earlier ripening of the fruits of the genotypes and the control cultivar.

The period of FD in Serbia, in the so-called average years, lasts from 71 days in Krupna Rana to 121 days in Keckemet Rose (Pejkic, Ninkovski 1986). In Southern Moravia conditions (Czech Republic), the amplitude of days between the "beginning of blossoming" and the "beginning of picking maturity" for each of the six years observed in 20 apricot genotypes ranged from 95–107 days, and from 77–116 between the genotypes within a single year (Vachůn 2003), which was close to the results obtained in this study (Table 1).

Analysis of fruit and stone weight

The fruit of Hungarian Best is medium large under the environmental conditions of Serbia (Milosevic 1997; Mratinic-Nenadovic et al. 2003). Djuric (1992) singled out six promising clones (NS-1, NS-2, NS-3, NS-4, NS-5, and Ambrozia NS) in the Vojvodina (North Serbia). On average, the highest FW and size were recorded in the clones NS-4 and NS-2 whereas the FW of the other clones, excluding NS-1, was almost identical to that of Hungarian Best. In the present study, all genotypes, with the exception of T-5 and T-7, showed better traits related to the average FW as compared to the genotypes singled out by Paunovic (2000) and much better as compared to the selected seedlings of native apricot originating from the Iran-Caucasian group (Balta et al. 2002; Asma et al. 2007). The differences between our results and those of Balta et al. (2002) and Asma et al. (2007) could be due to the different ecogeographical groups of apricot cultivars studied.

The stone weight in the examined genotypes, as a significant trait used in cultivar determination and classification, ranged widely, the weight of the largest stone (T-1) being 1.68 times that of the smallest one (T-5), whereas the stone weight of Hungarian Best was somewhat greater as compared to the results reported by Mratinic-Nenadovic et al. (2003) for the cultivar (Table 3).

Analysis of chemical and sensorial fruit traits

The selected genotypes and Hungarian Best as the control, had a highly respectable amount of nutrients in the present study (Table 3). The fruit mesocarp of Hungarian Best in the Belgrade fruit-growing region gave lower contents of SS, TS, and TA (Mratinic-Nenadovic et al. 2003) as compared to the content in our study. The selected types in the our study had higher contents of SS, TS, MM, and TA as compared to the genotypes singled out by Paunovic (1988, 2000). Our range of values is in agreement with previous works in apricot (Audergon et al. 1991; Ruiz, Egea 2008b).

In terms of fruit aroma, fruit firmness, flesh colour and skin colour, the results of this study are highly consistent with those obtained by Paunovic (2000) and Krška et al. (2009). The fruits of all genotypes, along with Hungarian Best, are suitable for fresh consumption.

Analysis of tree characteristics of apricot types

The selected apricot types *in situ*, identified under severe ambient conditions lacking cultural and pomological practices, coupled with their age, exhibited certain morphometric characteristics (Table 4). The trait that is common for all types, as well as for Hungarian Best, is grafting on a rootstock at a great height above the ground, which suggests that the trunk is *de facto* derived from the rootstock. In this way, as it has been scientifically evidenced, the effect of fluctuating temperatures at the end of winter is diminished, the onset of the growing season is postponed, the harmful effect of late spring frosts is reduced and the occurrence of sudden or premature wilting (Apoplexy) is prevented in the cultivars introduced from Europe and North America into Serbia (Paunovic, Djuric 1991; Pejkić, Ninkovski 1986). The average height of apricot trees derived from the European group in Serbia is 350 to 700 cm (Milošević 1997), as confirmed by the results of the present study (Table 4).

CONCLUSION

The selected apricot genotypes *in situ* were identified under severe ambient conditions lacking any maintenance. Under the stated conditions, they achieved excellent performance in terms of FW, sensorial traits and resistance to spring frosts of up to –2.0°C intensity. The above traits surpass the characteristics of the control cultivar Hungarian Best. Further studies on the selected apricot types under modern orchard growing conditions and the investigation of their degree of adaptability to changed environmental conditions will provide a substantial basis for future apricot breeding programmes.

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